739 - Karuk Tribe, Lower Mid-Klamath (Red Cap /Perch Creek) Habitat Protection-Road Decommissioning Implementation Project

Table 7.5, Karuk Tribe Technical and Scientific Documentation Table		
Technical and Scientific Document Name	**Document Description**	**Relevant page #**
Karuk Tribe of California; Department of Natural Resources. Orleans, Karuk Ecosystem Restoration Program, Final Report	Prepared by the Karuk Department of Natural Resources which is Final Report of Karuk Ecosystem Restoration Program	
Carolyn Cook/ USFS, Forest Hydrologist, Orleans Transportation and Road Restoration Project Hydrology and Water Quality Report, 2007	Prepared as a specialist report in conjunction with the Orleans Environmental Assessment Orleans Transportation and Road Restoration Project (USFS 2007)	1-21
USFS ID Team/USDA Environmental Assessment Orleans Transportation and Road Restoration Project, 2007	An environmental assessment will address the issues, alternatives, and effects of implementing the management options for the transportation system outlined in the Orleans Road Assessment Protocol.	2,21
Supporting Documents provided digitally via the BMS upload and by CD		
Keir and Associates/ The Klamath Basin Fisheries Task Force, Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program 1991	Prepared in accordance to Public Law 99-552, the "Klamath Act," was adopted by the Congress on October 27, 1986 for the Federal-State cooperative Klamath River Basin Conservation Area Restoration Program for the rebuilding of the river's fish resources.	44, 45, 49, 50, 135, 146
Karuk Tribe Non-Point Source Assessment and Management Plan 1999	Prepared by the Karuk Department of Natural Resources which describes Non-Point Source Sediment sources and prioritize watersheds for restoration	all
Coho Salmon Recovery Team/CDFG, Recovery Strategy for California Coho Salmon , 2004	Prepared for the California Fish and Game Commission as a guide for the process of recovering coho salmon on the north and central coasts of California.	73, 74, 184, 202, 205, 280, 382
USFS ID Team/USFS, Orleans Roads Analysis and Off-Highway Vehicle Strategy, 2006	Orleans RAP and OHV Strategy analysis evaluates the remaining road system within the Orleans Ranger District (e.g. Level 1, 2, and non-system roads) for management options.	all

Orleans Transportation and Road Restoration Project
Hydrology and Water Quality Report

Prepared by Carolyn Cook
Forest Hydrologist

August 2006, Version 1
February 2007 Version 2

Introduction
The Klamath Watershed is widely recognized as having water quality concerns that are impacting watershed health and beneficial uses such as anadromous fish. The Klamath River is currently listed as water quality impaired under section 303(d) of the Clean Water Act for temperature, nutrients and dissolved oxygen. These water quality concerns are largely attributable to management activities above and outside the project area. Tributary watersheds within the analysis such as Blue, Bluff, Camp, and Red Cap Creek are important water quality refugia for anadromous fish and provide critical cool water habitat when Klamath River reaches lethal stream temperatures for anadromous fish during summer months. These watersheds are also Key Watersheds. Maintaining the habitat and cool water refugia of these tributaries is there critical to protecting beneficial uses and water quality.

Maintaining and improving water quality and fisheries habitat within these tributaries can be accomplished through minimizing future risk of sedimentation from roads. The following report will outline the watershed risks associated with roads, summarize the relevant literature, and analyze the direct affects and future risks to water quality from the various alternatives.

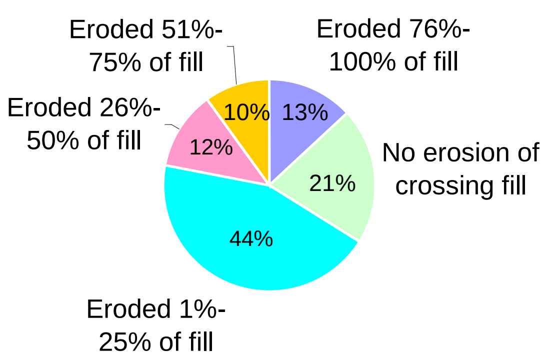
Roads and Sedimentation Risks
It has long been recognized that roads, particularly roads in steep, mountainous terrain, can have significant impacts to aquatic systems by accelerating erosion and sediment loading, by altering channel morphology, and by changing the runoff characteristics of watersheds (Furniss et al. 1991). Where forest roads are located in steep terrain, mass soil movement is a common mechanism of erosion and sediment delivery (Lyons and Beschta 1983). Also common are road-stream crossing failures that occur when culverts fail to pass wood, sediment or storm discharge. The plugging of culverts can result in the loss of the roadbed at the stream crossing or the diversion of the stream offsite, both of which can generate large erosional features and sedimentation of adjacent water bodies. Road cuts can also intercept groundwater and reroute subsurface water into streams. This increase in stream discharge can result in channel enlargement including downcutting and bank erosion.

On Six Rivers National Forest, roads are the leading source of management-related sediment inputs, predominantly associated with mass wasting features such as shallow debris slides and debris torrents. The majority of road-related erosion and sediment delivery are associated with large storm events that trigger culvert failures, stream diversions, and mass wasting such as debris slides and smaller slumps within the roadbed. With declining road maintenance funding, the risk of road failures and elevated sediment delivery is increasing, particularly in the event of large storms. As an example, during the recent New Years Eve storm of 2005/2006, a culvert on an abandoned road in the Bluff Creek watershed plugged and diverted the storm flow onto native hillslope triggering a 4acre landslide and delivering over 100,000 cubic yards of debris to Bluff Creek.

Storm Driven Culvert Failures and Erosion on Non-Decommissioned Roads:
Fill failures and diversions of road stream crossings have been shown to be significant contributors of fluvial hillslope erosion (Best et al. 1995; Weaver et al. 1995). Furniss et al. (1998) assessed stream crossing failures on non-decommissioned forest roads in Washington, Oregon and Northern California and found that after the winter floods of 1995 and 1996, significant portions of road fill were lost due stream crossing failures. Figure 5 illustrates the proportion of stream crossing fill eroded where streamflow overtopped the road. The data indicate that in approximately 35% of the culvert failures sampled, over 25% of the stream crossing fill eroded and that 44% of the failures had between 1 and 25% of the stream crossing fill eroded.

In addition to culvert failures and diversions, if a roadbed on a steep slope becomes saturated during storm events, there is an increased risk of road-triggered landslides (Switalski et al. 2004). In the Redwood National Park, non-decommissioned roads produced four times as much erosion as decommissioned roads, mostly in the form of landslides (Bloom A.L., 1998).

Figure 5. Proportion of road-stream crossing fill eroded where streamflow overtopped the road (n=171)



* (from Furniss et al. 1998)

Road Decommissioning and Erosion:
Road decommissioning can reduce the risk of long-term sedimentation risks, particularly in the event of a large landslide producing storm event. However, road decommissioning also results in short term sedimentation risks one to 3 years following treatment. Post-treatment erosion on excavated stream crossings is widely recognized as an inherent short-term impact that is offset by larger long-term gains in reducing the risk of major sedimentation resulting from road culvert failures. These short-term impacts are relatively small given the long-term gain in reducing the larger sedimentation risk if more roads were to fail during large storm events. In a recent study, the Six Rivers National

Forest evaluated over 73 miles of previously decommissioned roads and determined that post-treatment sedimentation was almost exclusively related to stream channel restoration and represented on average 3 to 5% of the fill volume removed from the stream crossing or 24 cubic yards (Cook and Dresser, in press). A recent post-treatment decommissioning study was conducted on the Redwood National Park (Madej 2001). Madej found that on stream crossing sites, post-treatment sedimentation was very small and the majority of the post-treatment erosion and sedimentation were attributable to treated roadbeds. Regardless of treatment, post-project erosion and sedimentation were a low percentage when compared to untreated sites. For the period 1980 to 1997, an average of 66 cubic yards of sediment delivery per stream crossing occurred. Klein (2003) conducted a post-treatment erosion and turbidity monitoring study on decommissioned roads within the Mattole watershed. Klein reported an average of 15 cubic yard of sediment delivery associated with restored stream crossings. Klein reported that during the first winter after treatment, erosion and elevated turbidity within the restored stream crossings was common but that the erosional responses diminished considerably over the winter sampling period.

When the post-decommissioning erosion is compared to the amount of erosion that occurs on non-decommissioned roads during storm events, it becomes clear that storm driven culvert failures are a far greater risks that road decommissioning. While the total percentage of storm-related stream crossing fill erosion on non-decommissioned roads varies (see figure 5), it is clear that the proportion lost due to post-treatment road decommissioning erosion is significantly less than the erosion that occurs during large storm events. Post-treatment road decommissioning erosion on the Six Rivers varies between 3 to 5% of the total stream crossing fill volume and is typically considerably less that the volume of erosion that occurs on untreated roads during large storm events which can be as high as 25 to 100% of the stream crossing fill volume.

Orleans Roads EA – Methods and Assumptions

Environmental Indicators

In order to effectively assess potential effects to water quality from roads that are proposed to be decommissioned or kept and maintained, environmental indicators must be identified that will facilitate a comparison of alternatives and the effects of those alternatives. Environmental indicators that will facilitate comparison of effects are miles of roads, number of stream crossings, stream crossing fill volume removed (yd^3), estimated post decommissioning stream crossing erosion (yd^3), and potential risk of stream crossing erosion (yd^3) from culvert failures and diversions assuming no road treatments or improvements. These indicators will be assessed for the Blue, Bluff, Camp, Lower Middle Klamath, and Red Cap watersheds. Methods, assumptions, and limitations associated with these indicators are described below.

Assumptions and Limitations

The assumption driving this analysis is that roads are a potential liability to water quality, particularly during large storm events when culverts fail and landslides are initiated. Chronic lack of road maintenance can also trigger water quality impacts in the absence of large storm events. The temporal scope of this analysis is 15 years (the duration of the EA) and a major assumption is that there will likely be at least one large storm event within the next 15 years that will trigger culvert failures, diversions and road-related landslides. In the past 15 years, there have been 3 large storm events that have triggered road failures that impacted water quality, those being the 1995, 1997 and 2005/2006 storm events. With chronic shortage in maintenance funding and a high probability of at least one large storm event within the next 15 years, it is very likely that there will be future road-related storm damage within the duration of this project.

This analysis only assesses water quality risks associated with stream crossing culvert failures and diversions and not landslides. Stream crossing fill volumes and diversion potential are relatively easy to determine and risks associated with their failure and subsequent sedimentation of stream channels is more readily assessed than estimating the potential for road related-landslide initiations. While it is widely recognized that roads in steep mountainous terrain, such as in this project area, are a potential risk for initiating landslides, there are no accepted models that can reliably estimate potential future road-related landslide volume. As such, the water quality estimates of potential erosion and sedimentation from road stream crossings alone are likely conservative and an underestimate of the amount of potential erosion and sedimentation that could occur during a large landslide initiating storm event.

Indicators that assess potential impacts to water quality from roads remaining on the transportation system and roads to be decommissioned are stream crossing fill volume (yd^3), post-decommissioning stream crossing erosion and sedimentation (yd^3) and risk of potential future stream crossing erosion and sedimentation (yd^3) from culvert failures and diversions assuming at least one large landslide triggering storm event and no road decommissioning.

Stream crossing fill volume (yd^3) is based on field-inventoried data on all roads that have culverts (this data is available in the project file in the Eureka Supervisors Office). When decommissioning roads and removing stream crossings, there is always some degree of post-treatment erosion and sedimentation. Based on the post-treatment road decommissioning monitoring results conducted on Six Rivers National Forest (Cook and Dresser, in press), on average 3% of the total stream crossing fill volume removed will be lost due to post-treatment erosion and sedimentation. This erosion and sedimentation is mostly a short-term water quality impact that is greatest during the first year after treatment and declines significantly in subsequent years as the rehabilitated stream-crossing site stabilizes. Little additional erosion and sedimentation occurs generally three to fives years after treatment, after which the site revegetates and becomes stable.

Stream crossing culvert failures and diversions due to storm-driven failures result in substantial water quality risks (Furniss et al, 1997, Weaver et al, 1995). Furniss et al (1998) determined that after the 1997 flood events in Washington, Oregon and Northern California, road stream diversions were very common and occurred in 48% of all stream crossing failures. This study also determined that stream crossing failures and erosion amounts were variable but significant. Based the proportions of storm stream crossing erosion determined by Furniss et al (1998), estimates of potential erosion and sedimentation from stream crossing culvert failures were made for each watershed (Blue, Bluff, Camp, Lower Middle Klamath, and Red Cap watersheds) using the proportions of culvert failures and erosion listed in table 1. These estimates of future potential erosion are based on the assumption that there would be at least one large landslide-producing storm within the next 15 years.

Table 1: Estimates of potential road-stream crossing fill eroded when streamflow overtops the road

Culvert fill volume by watershed	Percent Erosion
21%	0% erosion
13%	100% of fill erosion
44%	25% of fill erosion
12%	50% of fill erosion
10%	75% of fill erosion

In addition to assessing stream crossing erosion and sedimentation, miles of road and number of stream crossings are displayed to show differences between alternatives, however miles of road and number of stream crossings are relatively weak indicators for assessing potential impacts to water quality. Miles of roads do not effectively assess the potential water quality impact of any given road because a ridge top road with no culverts is not comparable to potential water quality risks associated with a mid slope road with multiple culverts with diversion potential. Similarly, number of stream crossings do not provide a means to distinguish between size of stream crossing and range of fill volume and hence risk of sedimentation. These indicators due however, provide a quick tally to illustrate how many miles of road and culverts will be removed associated with decommissioning versus how many culverts and miles will remain on the Forest Service transportation system and require long-term maintenance.

Direct and Indirect Affects – Environmental Consequences

Roads have the potential to adversely affect water quality when stream crossings plug, fail or divert, resulting erosion and downstream sedimentation of watercourses. Decommissioning roads also has the potential to temporarily adversely affect water quality when stream crossings are pulled and recontoured. However, the amount and duration of direct sedimentation impacts associated with road decommissioning and stream removal is considerably less that the potential *risk* of erosion and sedimentation amounts that would result in storm driven road failures.

Table 2 illustrates, by watershed and by alternative, the direct affects of erosion and sedimentation associated with decommissioning roads as well as the indirect risk (or potential) of future erosion and sedimentation associated with keeping roads.

Table 2: Stream Crossings by watershed with diversion potential and risk of diversions

Watershed	Number Stream Crossings	Number Stream crossings with diversion potential	Number of stream crossings likely to fail during large storm event	Range in Erosion resulting in stream crossing failure and diversion (yd3)
Blue	24	16	8	1,670 to 800,000
Bluff	519	294	147	67,000 to 14,700,000
Camp	103	69	35	23,400 to 3,500,000
Lower Middle Klamath	154	115	58	103,700 to 5,800,000
Red Cap	142	95	48	98,700 to 4,800,000
Total	**942**	**589**	**296**	**300,000 to 30,000,000**

Alternative 1: No Action

The No Action Alternative is the environmental baseline upon which other action alternatives can be compared. Under the No Action Alternative there would be no road decommissioning and rehabilitation of stream crossings nor would there be road improvements to reduce the risk of road failures during storm events. Approximately 658 miles of system and non-system roads would remain within the Orleans District. Given the probability of at least one large landslide-producing storm in the next 15 years, there is a likely *risk* that a proportion of the roads and their culverts would fail, resulting in adverse sedimentation of watercourses. Roads not having stream crossings were not included in the risk assessment to water quality. The estimate of potential sedimentation of watercourses described below does not include the potential for landslides resulting from roads and is therefore a conservative estimate.

The assessment of potential sedimentation of watercourses however, does include an estimate of sedimentation risks associated with road stream crossing diversion. Table 2 illustrates the number of stream crossings that have diversion potential by watershed. The potential range in risk of sedimentation affects associated from stream crossing diversions is considerable and can be as little as 2 yd^3 on small ephemeral channels to as large as 100,000 yd^3 on large perennial channels. Table 2 shows the range in sedimentation amounts at risk associated with stream crossing diversions by watershed. Assuming 50% of the stream channels with diversion potential actually divert in a large storm event, the results indicate that the potential future risk of erosion and sedimentation varies between 300,000 yd^3 to 30,000,000 yd^3. This is a significant risk that could potentially adversely impact water quality and downstream aquatic ecosystems.

In addition to erosion and sedimentation resulting from stream channel diversions, the potential for adverse water quality impacts resulting from stream crossing failures is also significant. Table 3 illustrates the potential future risk of sedimentation and erosion resulting from culvert failures in the event of a large flood-producing storm.

In the Blue Creek watershed, there are approximately 32 miles of road having a total of 16 stream crossings culverts (these numbers do not include the Elk Valley road 14N03 which is not included in this project). The volume of fill within these stream crossings is approximately 4400 yd^3. Based on the assumptions outlined above (Furniss et al 1998), there is a *risk* of an estimated 1700 yd^3 of potential eroded fill associated with culvert failures impacting the water quality of headwater streams, assuming a future large storm event. Combining both the risk of culvert failure and stream channel diversions, there is a potential future risk of 1700 yd^3 to 800,000 yd^3 that could adversely impact water quality in the event of a future large storm.

In the Bluff Creek watershed, there are approximately 220 miles of road and 515 stream crossings on those roads. Given the probability of at least one large landslide-producing storm in the next 15 years, it is likely that a proportion of those culverts will fail as well as divert, resulting in sedimentation of watercourses. There is a *risk* or potential of an estimated 66,400 yd^3 of eroded fill from culvert failures impacting the water quality of streams throughout the Bluff Creek watershed. Combining both the risk of culvert failures and stream channel diversions, there is a potential future risk of 67,000 yd^3 to 14, 800,000 yd^3 that could adversely impact water quality in the event of a future large storm. This estimate does not include the potential for landslides resulting from roads and is therefore a conservative estimate. Bluff Creek has a history of large landslides and roads are the leading trigger for management-related landslides.

In the Camp Creek watershed, there are roughly 98 miles of road and 94 stream crossings on those roads. An estimated 23,300 yd^3 of potentially eroded fill associated with culvert failures has the *risk* of impacting the water quality of headwater streams, under the no action alternative. The potential future risk of stream crossing erosion as well as diversion potential is between 23,300 yd^3 to 3, 500,000 $yd^{3.}$.

Likewise, in the Lower Middle Klamath watershed area, there are roughly 185 miles of road with 156 stream crossings. There is a *risk* of an estimated 103,600 yd^3 of eroded fill associated with culvert failures potentially impacting the water quality within this area and when the potential for stream diversions is included, the potential risk future erosion and sedimentation is between 103, 700 yd^3 to 5,900,000 $yd^{3.}$. In the Red Cap Creek watershed, there are 130 miles of road with 145 stream crossings. There is a *risk* of an estimated 98,600 yd^3 to 4,900,000 yd^3 associated with culvert failures and stream channel diversions potentially impacting the water quality within this area.

In summary, under this alternative there will be no road improvements or road decommissioning. Without treatments, there is the *risk* of erosion and sedimentation of stream channels associated with storm driven culvert failures and diversions that has the

Table 3. Sedimentation impacts and risks from roads

Alternatives /Watershed	Road Decommissioning					Roads Kept and Maintained			
	Road miles	Number stream crossings removed	Stream Crossing fill volume removed and saved (yd^3)	Estimated post-treatment sedimentation due to road decommissioning[1] (yd3)	Potential stream crossing fill lost assuming no decommissioning and fill loss during storm[2] (yd3)	Road miles	Number stream crossings kept	Stream Crossing fill volume kept (yd^3)	Potential Stream Crossing fill lost during storm[2] (yd3)
BLUE									
Alternative 1: No Action	0	0	0	0	0	32.3	16	4425	1660
Alternative 2: Proposed Action	14.6	7	2209	66	830	17.7	9	2216	830
Alternative 3:	14.6	7	2209	66	830	17.7	9	2216	830
BLUFF									
Alternative 1: No Action	0	0	0	0	0	219.8	509	177,110	66,400
Alternative 2: Proposed Action	88.9	271	68,750	1,995	25,800	130.9	243	108,360	40,600
Alternative 3:	91.9	279	69,845	2,095	26,200	127.9	231	107,302	40,200
CAMP									
Alternative 1: No Action	0	0	0	0	0	98.4	94	62,095	23,300
Alternative 2: Proposed Action	46.4	71	34,873	1046	13,100	52.0	23	27,222	17,000
Alternative 3:	46.4	71	34,873	1046	13,100	52.0	23	27,222	17,000
LOWER MIDDLE KLAMATH									
Alternative 1: No Action	0	0	0	0	0	184.5	156	276,269	103,600
Alternative 2: Proposed Action	35.8	42	35,858	1,076	13,400	148.7	114	240,411	90,200
Alternative 3:	33.7	37	24,876	746	9,300	152.1	120	251,393	94,300
RED CAP									
Alternative 1: No Action	0	0	0	0	0	130.6	145	262942	98,600
Alternative 2: Proposed Action	15.8	6	3424	103	1,300	114.3	139	259518	97,300
Alternative 3:	15.8	6	3424	103	1,300	114.3	139	259518	97,300

[1] Post treatment sedimentation estimated to be 3% of fill volume removed (Cook and Dresser, 2003)
[2] Stream crossing failure and associated sedimentation (Hydrology staff report, Cook 2006)

potential to deliver between 300,000 yd^3 to 30,000,000 yd^3 and adversely impact water quality (see table 4).

Table 4. Direct sedimentation risks associated with road decommissioning and maintaining roads.

Watershed	Alternative 1: No Action			Alternative 2: Proposed Action		Alternative 3	
	Direct Affect Erosion Deco yd^3	Future Risk Range in erosion risk from culvert failures and diversions[1] yd^3		Direct Affect Erosion Deco yd^3	Future Risk in erosion risk from culvert failures[2] yd^3	Direct Affect Erosion Deco yd^3	Future Risk in erosion risk from culvert failures[2] yd^3
Blue	0	1, 670	800,000	66	830	66	830
Bluff	0	67,000	14,770,000	1,995	40,600	2,095	40,200
Camp	0	23,400	3,523,000	1,046	17,000	1,046	17,000
Lower Middle Klamath	0	103700	5,904000	1076	90,200	746	94,300
Red Cap	0	98,700	4,898,600	103	97,300	103	97,300
Total	0	**300,000 to 30,000,000**		**4,286**	**245,900**	**4,056**	**249,600**

[1] Diversion potential assumes approximately 50% of culverts would divert during a large storm and erosion and sedimentation amounts could vary between 2 to 100,000 yd^3

[2] Road improvements would significantly reduce or even eliminate the risk of diversion potential. As such, Alternatives 2 and 3 assumes no erosion would occur due to diversion potential.

Alternative 2: Proposed Action

With this alternative, 455 miles of road will be kept and maintained on the NFS transportation system and 203 miles of road would be decommissioned. Road maintenance and upgrading activities as well as road decommissioning activities are expected to reduce the amount of fine sediment that is delivered to streams from surface erosion. Project activities are also expected to reduce the risk of mass-wasting events through reducing the risk of stream channel diversion, upgrading undersized culverts, and hardening road surfaces. However, streambanks may be disturbed when culverts and associated fills are upgraded, replaced or removed. This may result in accelerated short-term surface erosion from soil disturbance associated with the proposed road restoration activities [during implementation and/or during first storm event after completion] until vegetation is established at disturbed sites. The direct effectives of these activities will result in short-term impacts to water quality with long-term benefits once the treatment sites have recovered and stabilized.

Table 3 displays the amount of fill volume that will be saved associated with road decommissioning as well as the direct effect of erosion and sedimentation amounts following decommissioning and stream restoration activities. In general, erosion and sedimentation amounts following stream crossing removal on the Six Rivers National Forest are relatively small (24 yd^3 on average or 3% of fill volume removed) (Cook and Dresser, in press). Madej (2001) found that most excavated stream crossings in Redwood National Park "produced very little sediment" following treatment (average of about 22 yd^3 per crossing).

Table 3 shows by watershed and alternative, the estimated direct effects of erosion and sedimentation volumes that could occur from post-treatment channel adjustments well as the *estimated risk* of future erosion and sedimentation amounts should these stream crossing restoration activities not occur and culverts were left in place. The potential *risk* of erosion and sedimentation attributable to storm-driven culvert failures is approximately 13 times higher than the amount of erosion attributable to road decommissioning. The amount of erosion would be several orders of magnitude even higher if erosion rates associated with stream diversion potential were also included (see table 4).

While there is clearly a short-term impact associated with road decommissioning and stream channel restoration, this impact is significantly less than the erosion and sedimentation amounts that could occur when stream crossings fail and divert in large storm events.

Table 3 also assesses the *risk* of erosion and sedimentation volumes that could occur on roads that will be kept and maintained on the transportation system, given the likelihood of a large landslide producing storm event. When making road improvements, there is also a slight risk of direct sedimentation affects when installing rolling dips to correct for stream diversion potential or when replacing undersized or aging culverts. The amount of direct sedimentation associated with these activities is minimal and negligible and will significantly reduce the risk of road-related sedimentation impacts in the long-term.

Road improvements such as increasing culvert capacity and correcting culvert diversion potential will significantly reduce the risks of storm-driven erosion and sedimentation from needed roads. The reductions in potential sedimentation from eliminating stream crossing diversion potential (either through road decommissioning or road improvements) are enormous and are illustrated in Table 4.

Under Alternative 2, in the Blue Creek watershed, proposed road decommissioning will reduce the potential erosion and sedimentation *risks* from stream crossings during storm events by half. Approximately 2,209 yd^3 will be saved due to stream crossing removal and 2,2169 yd^3 will remain associated with needed roads. There will be a direct effect of approximately 66 yd^3 associated with road decommissioning activities.

In the Bluff Creek watershed, 68,750 yd^3 will removed (approximately 40% of the total stream crossing fill volume within Bluff Creek). The majority of the road decommissioning and stream crossing fill removal within the project area (District) will occur within the Bluff Creek watershed. An estimated 2,000 yd^3 of erosion and sedimentation will result from the road decommissioning but this is anticipated to be a short-term impact that will be greatest the after the first winter and decline to minimal amounts within 3 to 5 years after treatment when vegetation is re-established. There will be a direct effect of approximately 2,000 yd^3 associated with road decommissioning activities. This amount would be spread out over the watershed over the 15 years of the project.

In the Camp Creek watershed, 34,873 yd^3 will be removed (more than 50% of the total stream crossing fill volume within Camp Creek) and 27, 222 yd^3 of stream crossing fill will remain. An estimated 1,046 yd^3 of erosion and sedimentation will result from the road decommissioning as compared to a potential risk of 13,000 yd^3 should these stream crossings fail in a large storm event.

In the Lower Middle Klamath watersheds, 35, 868 yd^3 will be removed through stream crossing restoration (approximately 13% of the total fill volume) and 240, 411 yd^3 will remain. Due to proximity of private land holdings, the risk of wildfire, and fuel treatment opportunities, the majority of the roads within this watershed were considered essential to keep on the transportation system. Roads within this watershed area have the largest potential future *risk* of culvert failure and sedimentation within the District. Opportunities to upgrade roads to reduce the risk associated with storm-driven road failures will be prioritized within this watershed. There will be a direct effect of approximately 1,080 yd^3 associated with road decommissioning activities. These activities are located throughout multiple small watersheds draining into the mainstem Klamath River and the sedimentation effects will be minimal.

In the Red Cap watershed, 3,420 yd^3 will be removed through stream crossing restoration (approximately 1% of the total fill volume) and 259,500 yd^3 will remain. An estimated 103 yd^3 of erosion and sedimentation will result from the road decommissioning. The majority of stream crossing fill volume are associated with level 3 roads that are critical for access as well as alternative emergency access routes out of Orleans when HWY 96 closes.

<u>Alternative 3:</u>
For the Blue, Camp and Red Cap Creek watersheds, there are no differences between Alternatives 2 and 3 relative to stream crossing fill volume removed and potential erosion and sedimentation. The potential impacts to water quality are the same.

In the Bluff Creek watershed, there is an additional 3 miles of road decommissioning (12N13D, portion of 12N13H, 12N13H.2, 12N31A) with slight increases in stream crossing fill volume removed (approximately 1000 yd^3). In the Lower Middle Klamath watershed area, approximately 11,000 yd^3 of stream crossing fill will remain as part of the transportation system as compared to Alternative 2. This stream crossing fill is associated with 5 stream crossings that will remain on the transportation system due to a need for road access for future fuels reductions projects and opportunities (roads 11N18, 11N26A, and 13N14.1).

<u>Comparison of Alternatives</u>
In summary, roads represent considerable long-term liabilities with respect to risk to water quality, particularly given the present trend in declining road maintenance funding. Periodic large storm events are the typical triggers that initiate road failures that impact water quality. The potential for future risk of erosion and sedimentation from roads associated with the No Action alternative clearly indicates that there is a significant

potential to adversely impact water quality by several orders of magnitude greater than Alternatives 1 and 2. Direct affects to water quality associated with Alternative 2 and 3 are mostly related to post-decommissioning erosion. This erosion is relatively small (3-5% of fill volume removed) and of short-term duration (1-5 years) for a long-term benefit. Reducing or eliminating the risk of stream channel diversion and replacing old and aging culverts has the potential to significantly reduce water quality risks and benefit long-term watershed health. Alternative 2 ranks slightly higher than Alternative 3 relative to reducing water quality risks due to a slightly higher stream crossing fill volume that would be removed under Alternative 2. However, these differences are negligible when considered in a larger watershed context relative to natural sedimentation rates associated with large storm events.

Cumulative Watershed Effects

A cumulative impact results from the incremental effect of an action when combined with other past, present and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. The key steps in a cumulative effects analysis are to identify the beneficial uses of concern, determine the cause-effect relationships of the proposed action on the beneficial uses, and determine the magnitude and significance of the environmental consequences resulting from the proposed action in relation to other past, present and future actions. The significance of effects should be determined based on context and intensity. Factors that would be used to define context and intensity of effects include their magnitude, geographic extent, duration and frequency.

The beneficial uses of concern within the project area are anadromous and resident fish (see Fisheries Biological Assessment) as well as domestic water sources for the Orleans Community (Crawford Creek) and surrounding local rural residents (tributaries such as Pearch, Cavanaugh, Jo Marine, Aikens, Allen, Slate, Crawford, Cheenitch, Wilson, Rosaleno, Saint Rest’s, Mud, and Donahue Flat Creeks as well as Chimmekanee, Owl, Whiteys and Sawhill Gulches). Within the project area, all main spawning tributaries as well and the tributaries mentioned above fall into one of five 6th field Hydrologic Unit Codes (HUC) assessed in the preceding sections.

The cumulative watershed affects assessment includes all roads within the affected watersheds, with the exception of state, county roads and private roads, which are limited in extent and mostly located along the river corridor of the Klamath River. All reasonably foreseeable future actions were included in the analysis, which includes proposed road decommissioning in Blue Creek on the Smith River National Recreation Area as well as a possible addition of six miles of temporary road associated with the Orleans Community Fuels Reduction (OCFR) project presently under development. Silvicultural and fuels treatments associated with the OCFR project would have minimal short term water quality impacts at the site level, but have a long term reduction in water quality risks.

All watersheds within the project area have experienced in varying degrees, extensive land-use management such as timber harvesting and road building, and are recovering from past and recent storm events. The affected watersheds are considered properly functioning or functioning at risk as defined by the *USDA FS Region 5 Watershed*

Condition Assessment (USDA 2000). Although the Klamath River is listed as sediment, nutrient, and temperature impaired under the section 303(d) of the Clean Water Act, none of these tributary watersheds to the Klamath are considered impaired.

Nevertheless, the quality of anadromous habitat and surrounding riparian areas have the potential to be adversely impacted from roads as a result of episodic large flood producing storms. Many of the roads within the project area are in poor condition with actively eroding surfaces and culverts poised for failure in the next moderate storm (10 to 15 year flood storm). Actions proposed in Alternatives 2 and 3 are designed to reduce these sedimentation risks during large storm events. A comparison of cumulative watershed effects can be accomplished through assessing the differences in road and culvert densities by alternative and are displayed below in Table 5.

Table 5. Cumulative watershed effects associated with roads and stream crossings by alternative.

Watershed (6th field HUC)	Watershed Area (sq mi)	Road Miles	Road Density (mi/sq mi)	Number Stream Crossing Culverts	Road Stream Crossing Density (#/sq mi)	CWE Risk Rating**
Alternative 1 (No Action) - Past and Current Road and Stream Crossing Densities						
Blue	125	187.8*	1.50	50	0.40	Low
Bluff	74	219.8	2.9	509	6.9	Moderate
Camp	43	98.4	2.3	94	2.2	Moderate
Lower Middle Klamath	94	184.5	1.9	156	1.7	Low
Red Cap	66	130.6	1.9	145	2.2	Low
Alternative 2 (Proposed Action)						
Blue	125	168.8*	1.35	41	0.33	Low
Bluff	74	130.9	1.8	243	3.3	Low
Camp	43	52.0	1.2	23	0.53	Low
Lower Middle Klamath	94	148.7	1.6	114	1.2	Low
Red Cap	66	114.3	1.7	139	2.1	Low
Alternative 3						
Blue	125	168.8*	1.35	41	0.33	Low
Bluff	74	127.9	1.7	231	3.1	Low
Camp	43	52.0	1.2	23	0.53	Low
Lower Middle Klamath	94	152.1	1.6	120	1.3	Low
Red Cap	66	114.3	1.7	139	2.1	Low

*includes roads for the entire watershed (Orleans RD and Smith River NRA)
** road density ratings: >4 mi/sq mi is high watershed disturbance; 2 to 4 mi/sq mi is moderate watershed disturbance; <2 mi/sq mi is low watershed disturbance; these assumptions are based on best professional judgement

Road and culvert densities can be used as indicators of watershed disturbance and help describe past and current watershed conditions and cumulative effects. Limitations associated with using road density include the lack of geographic context. For example, road density does not capture whether or not the bulk of the roads are located on mid to upper hillslopes versus valley bottoms. Roads located in the valley bottoms or mid slopes are generally much more disruptive to watershed processes than ridge top roads. However, road density is a commonly used indicator that is easy to replicate, and can give a generalized overview of the extent of watershed disturbances associated with road building. Road densities greater than five mi/sq mi are considered indicative of very high watershed disturbance levels where cumulative watershed impacts might be a concern. Road densities lower than two mi/sq mile are generally considered indicators of low watershed disturbance.

Similarly, stream-crossing density is a useful indicator describing the extent of hydrologic connectivity of roads within a watershed. Although this indicator is not as commonly used as road density, it is another indicator to describe extent of watershed disturbance. Bluff Creek has triple the stream crossing density of the surrounding watersheds. Reducing the extent of hydrologic connectivity (stream crossing density) in Bluff Creek would significantly reduce the risk of potential cumulative watershed effects associated with storm-driven road failures.

Based on the information displayed in the above table, it is evident that cumulative watershed effects have occurred in the past. However, these past disturbances have not resulted in adverse cumulative watershed effects with the exception of Bluff Creek and to a lesser extent Red Cap and Camp Creek. These watersheds were severely impacted by the 1964 flood and have yet to fully recover relative to sedimentation. These watersheds are considered functioning at risk. Alternatives 2 and 3 would not result in adverse cumulative watershed effects but would instead result in improvements to watershed condition. Alternatives 2 and 3 would result in a lessening of cumulative watershed effects for all watersheds through implementation of road decommissioning and road water quality improvements for remaining roads. There would be minimal short-term impacts (duration, magnitude, and extent) associated with road restoration actions, but these would not result in adverse cumulative watershed effects but rather reduce the potential for long-term adverse cumulative effects. Alternative 1 has the potential of resulting in adverse cumulative watershed effects should a large flood-producing storm result in significant road failures.

Aquatic Conservation Strategy Consistency

A key component of the Northwest Forest Plan is the Aquatic Conservation Strategy (ACS), which outlines specific objectives in the management of aquatic and riparian resources. The Aquatic Conservation Strategy (ACS) has four components that are designed to restore and maintain the ecological health of watersheds and aquatic ecosystems contained within them on public lands. These components include:

- Riparian Reserves – lands along streams where special standards and guidelines direct land use.

- Key Watersheds – a system of large refugia comprised of watersheds that are crucial to at-risk fish species and provide high water quality. Blue, Bluff, Red Cap and Camp creek are designated key watersheds. The watersheds comprising the Lower Middle Klamath are not key watersheds.
- Watershed Analysis – an analysis that evaluates geomorphic and ecologic processes operating in specific watersheds. Watershed Analyses were completed for Red Cap Creek (USDA 1995) and the Lower Middle Klamath (USDA 2003). A Preliminary Watershed Analysis for watershed restoration projects was completed for Bluff Creek in 1994. A watershed analysis for Blue Creek was completed in 1996 that focused on Port Orford Cedar and watershed restoration. No watershed analysis has been completed for Camp Creek.
- Watershed Restoration – comprehensive, long-term program of watershed restoration to restore watershed health and aquatic ecosystems. The Orleans Transportation and Road Restoration Project is specifically designed to address this component while providing for safe public and administrative access.

Recommendations in all of the Blue, Bluff, Red Cap and Lower Middle Klamath Watershed Analyses focus on the need to implement watershed restoration activities. In particular, recommendations explicitly address the need to decommission high risk and unneeded roads through the removal of culverts and other drainage structures as well as storm-proof needed roads to reduce risks associated with road failures during large storm events. Road restoration activities outlined in the Orleans Transportation and Road Restoration Project clearly address the road-related restoration recommendations in all the completed watershed analyses for Blue, Bluff, Red Cap and Lower Middle Klamath watersheds.

The ACS spells out nine objectives regarding the Forest goals in the management of aquatic and riparian resources. Complying with the Aquatic Conservation Strategy objectives means that the Forest must manage the riparian-dependent resources to maintain the existing conditions or implement actions to restore conditions. The baseline from which to assess maintaining or restoring the conditions is typically developed through a watershed analysis. However, the lack of a watershed analysis (as in the case of Camp Creek) should not preclude implementing watershed restoration activities that address urgent risk to aquatic resources, particularly when those actions have insignificant localized effects and a short recovery period.

In 2004, a supplemental EIS was prepared that clarified language in the ACS. The Record of Decision clarified the proper spatial and temporal scale for evaluating progress toward attainment of ACS objectives and clarified that no project-level finding of consistency with the ACS objectives is required. Land managers would be required to demonstrate that projects comply with applicable standards and guidelines, such as riparian buffer widths, and to document how applicable watershed analysis was used to provide context for project planning. If watershed analysis is not required or available, or does not contain relevant information, the project record will provide evidence that project effects were considered relative to the watershed condition. The 2004 supplemental emphasized that road decommissioning is a priority for Key Watersheds (see supplemental EIS for more information (USDA and USDI. 2004).

This supplemental EIS does not change direction and guidance on watershed analysis requirements in riparian reserves received by the Forests in 1995. This earlier direction came about after deliberation with governmental partners, the Intergovernmental Advisory Committee (IAC), members of FEMAT, members of the SEIS team, and the Regional Ecosystem Office (REO). They drafted direction and guidance pertaining to actions within riparian reserves that may proceed without a need for watershed analysis (BLM, USDA, July 5, 1995; FS/BLM Memorandum No. OR-95-123). This memorandum provides guidance that a watershed analysis is not needed when proposed actions address determinants such as urgent public safety needs and urgent risk to aquatic resources. Actions within this project address both urgent public safety and urgent risk to aquatic resources through upgrading and storm-proofing critical public access roads as well as decommissioning high risk and low needed roads.

This memorandum also provides guidance on evaluation indicators that stress that for actions to proceed without a watershed analysis, the actions should maintain or restore aquatic ecosystems. Specifically, actions must result in negligible risk to aquatic resources, would not contribute to cumulative adverse effects, would have insignificant localized effects and have short recovery times. Furthermore, relevant analysis are available that are site-specific and incorporate larger scale ecosystem analysis.

The actions described in the Orleans Transportation and Road Restoration Project meet all the evaluation indicators described above. Large scale and interdisciplinary assessments were conducted through the Orleans Roads Analysis Process (Orleans RAP) that were based on detailed and site-specific road condition information (site-specific road data available upon request at the Eureka Supervisors Office). Environmental consequences indicate that the sedimentation effects associated with road decommissioning are minor and short-term and are considerably less than the risks of sedimentation that might occur should the roads fail during a large storm event. The proposed actions also would not contribute to adverse cumulative watershed effects. Impacts, both short and long term, to coho salmon, Chinook and steelhead were analyzed in the Fisheries Biological Assessment and Biological Evaluation. The conclusion of this analysis was that while impacts may occur, the effects to anadromous resources would be negligible. The National Marine Fisheries Service concurred with this determination for coho salmon (see project file). For these reasons, a determination was made that a watershed analysis was not needed in order for a decision to be made on the Orleans Transportation and Road Restoration Project.

Conclusions

Based upon analysis of direct, indirect and cumulative effects, the proposed activities would result in a minor short-term impairment to water quality with a long-term improvement in water quality. Combined with effects of past, present and foreseeable future actions, the proposed action may result in localized increases in suspended sediment during the first few precipitation runoff events following project activities. However, the proposed activities would not result in cumulative watershed effects that threaten impairment of long-term water quality objectives. Implementation of project design standards and use of specific erosion and sediment control measures through Best

Management Practices are incorporated in the Proposed Action. The actions proposed comply with the Clean Water Act and applicable water quality control plans and will not result in adverse impacts to water quality.

References:

Bloom, A.L. 1998. An assessment of road removal and erosion control treatment effectiveness: a comparison of 1997 storm erosion response between treated and untreated roads in Redwood Creek Basin, northwestern California (MS thesis). Arcata, CA: Humboldt State University.

Cook and Dresser. (in press) Erosion and Channel Adjustments following Forest Road Decommissioning, Six Rivers National Forest.

Furniss M.J. T.S., M. Love, S.A. Flanagan. (1997). "Diversion Potential at Road Stream Crossings." USDA, Forest Service San Dimas Technology and Development Center. No.9777-1814.

Furniss, M.J. T.S. Ledwith, M.A. Love, B.C. McFadin, S.A. Flanagan. (1998). "Response of Road-Stream Crossings to Large Flood Events in Washington, Oregon, and Northern California. USDA, Forest Service San Dimas Technology and Development Center. No.9877-1806.

Furniss, M.J., T.D. Roelofs, and C.S. Yee, 1991. Road construction and maintenance. In: Meehan, W.R., ed. Influences of forest and rangeland management. Special Pub. 19. Bethesda, MD: American Fisheries Society: 297-324. Chapter 8.

Klein, R. 2003. Erosion and Turbidity Monitoring Report – Sanctuary Forest Stream Crossing Excavations in the Upper Mattole River Basin, 2002-2003. Prepared for: Sanctuary Forest, Inc. P.O. Box 166, Whitethorn, CA. 95589.

Lyons, J.K. and R.L. Beschta, 1983. Land use, floods, and channel changes: Upper Middle Fork Willamette River, Oregon. *Water Resources Research* **19**(2): 463-471.

Madej, M.A., 2001. Erosion and sediment delivery following removal of forest roads. *Earth Surface Processes and Landforms* **26**: 175-190.

Switaliski, TA, JA Bissonette, TH DeLuca, CH Luce, and MA Majey. 2004. Benefits and impacts of road removal. Front Ecol Environ: 2(1):21-28.

Weaver, W.E., D.K. Hagans, and J.H. Popenoe. 1995. "Magnitude and Causes of Gully Erosion in the Lower Redwood Creek Basin, Northwestern California." In: *Geomorphic Processes and Aquatic Habitat in the Redwood Creek Basin, Northwestern California.* K.M. Nolan, H.M. Kelsey, and D.C. Marron, eds. U.S. Geological Survey Professional Paper 1454.

USDA, BLM. July 5, 1995. FS BLM Memorandum No. OR-95-123. Watershed Analysis for Management Activities in Riparian Reserves.

USDA, Forest Service. 1994. Preliminary Watershed Restoration Assessment Bluff Creek, Six Rivers National Forest.

USDA, Forest Service. 1995. Red Cap Watershed Analysis. Six Rivers National Forest

USDA, Forest Service. 1996. Blue Creek Ecosystem Analysis at the Watershed Scale: An Assessment of Riparian Reserve Conditions and *Phytophthora* Risk to Port Orford cedar with Treatment Recommendations, Six Rivers National Forest.

USDA, Forest Service. 2003. Lower Middle Klamath Watershed Analysis. Six Rivers National Forest.

United States Department of Agriculture

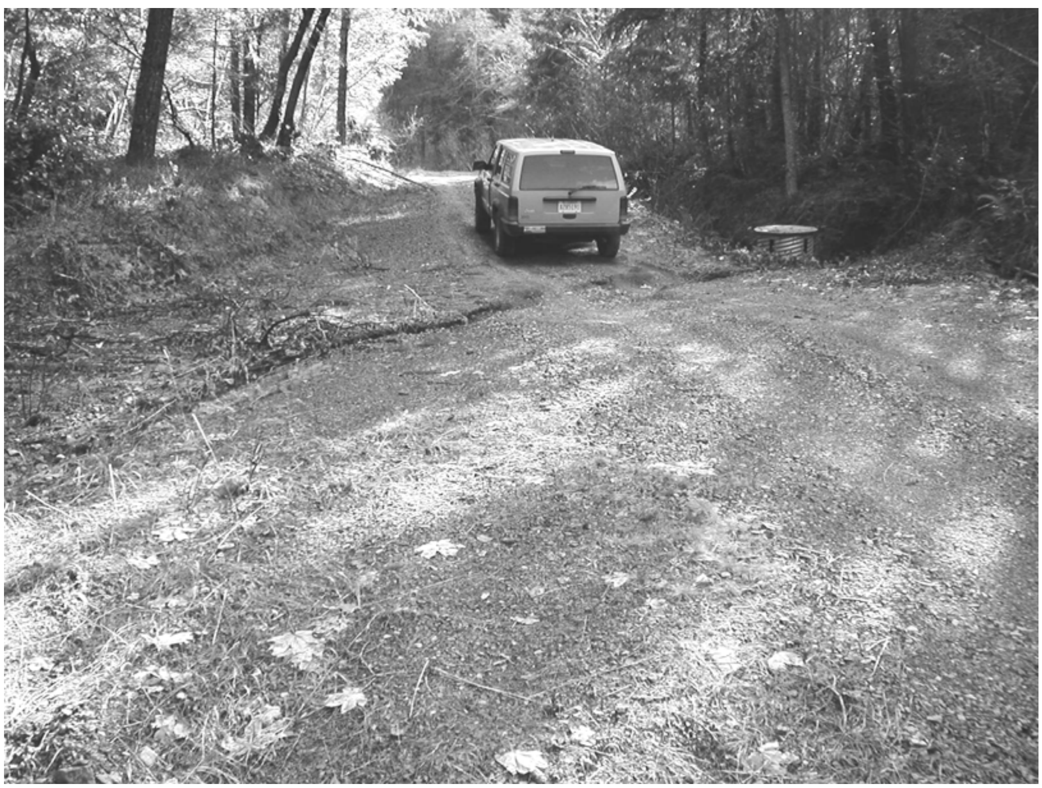
Forest Service

January 2007

Environmental Assessment

Orleans Transportation and Road Restoration Project

Orleans Ranger District
Six Rivers National Forest
Humboldt, Siskiyou, and Del Norte Counties, California



For Information Contact: Carolyn Cook
Team Leader
(Phone) 707-441-3551

The U. S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, or marital or family status. (Not all prohibited bases apply to all programs.) persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write: *USDA, Director, Office of Civil rights, Room 326-W, Whitten Building, 14th and Independence Avenue, SW, Washington DC 20250-9410* or call (202) 720-5964 (voice and TDD). USDA is an equal opportunity provider and employer.

TABLE OF CONTENTS

1.0 PURPOSE AND NEED FOR ACTION....1

1.1 BACKGROUND....1
1.2 WHAT ACTIONS WE PROPOSE TO DO....1
1.3 WHY WE PROPOSE THESE ACTIONS (PURPOSE AND NEED)....2
1.4 WHAT ARE THE APPLICABLE FOREST SERVICE MANAGEMENT DIRECTIONS....2
1.5 WHERE ACTIONS WOULD OCCUR....4
1.6 WHAT OUR DECISION WILL ADDRESS....4
1.7 HOW WE INVOLVED THE PUBLIC....5
1.8 HOW WE INVOLVED AFFECTED TRIBES....6
1.9 HOW WE INVOLVED OTHER AGENCIES AND FOREST SERVICE PERSONNEL....6
1.10 ISSUE IDENTIFICATION....6
1.11 HOW WE ADDRESSED THE ISSUES....8
1.12 APPLICABLE LAWS....10

2.0 ALTERNATIVES....12

2.1 HOW ALTERNATIVES WERE DEVELOPED....12
2.2 DESCRIPTION OF ALTERNATIVES ANALYZED IN DETAIL....12
2.2.1 Alternative 1 (No Action)....12
2.2.2 Alternative 2 (Proposed Action)....12
2.2.3 Alternative 3....14
2.2.4 Management Requirements and Project Design Features....16
2.3 COMPARISON OF THE ALTERNATIVES....17

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES....19

3.1 WATER QUALITY....19
3.1.1 Water Quality Summary and Comparison of Alternatives....19
3.1.2 Affected Area and Existing Condition....19
3.1.3 Alternative 1 (No Action)....20
3.1.4 Alternative 2 (Proposed Action)....23
3.1.5 Alternative 3....25
3.1.6 Cumulative Watershed Effects....25
3.2 FISHERIES....27
3.2.1 Affected Area and Existing Condition....27
3.2.2 Alternative 1 (No Action)....30
3.2.3 Alternative 2 (Proposed Action)....30
3.2.4 Alternative 3....31
3.3 RECREATION AND PUBLIC ACCESS....31
3.3.1 Affected Area and Existing Condition....31
3.3.2 Alternative 1 (No Action)....31
3.3.3 Alternative 2 (Proposed Action)....32
3.3.4 Alternative 3....32
3.4 WILDLIFE....32
3.4.1 Affected Area and Existing Condition....32
3.4.2 Alternative 1 (No Action)....34
3.4.3 Alternative 2 (Proposed Action)....34
3.4.4 Alternative 3....44
3.5 FIRE AND FUELS....44
3.5.1 Affected Area and Existing Condition....44
3.5.2 Alternative 1 (No Action)....45
3.5.3 Alternative 2 (Proposed Action)....46
3.5.4 Alternative 3....46
3.6 PORT-ORFORD CEDAR....47
3.6.1 Affected Area and Existing Condition....47

3.6.2 Alternative 1 (No Action) *48*
3.6.3 Alternative 2 (Proposed Action) *48*
3.6.4 Alternative 3 ..... *49*
3.7 VEGETATION MANAGEMENT 50
3.7.1 Affected Area and Existing Condition *50*
3.7.2 Alternative 1 (No Action) *51*
3.7.3 Alternative 2 (Proposed Action) *51*
3.7.4 Alternative 3 ..... *51*
3.8 BOTANY/NOXIOUS WEEDS 51
3.8.1 Alternatives 1, Alternative 2 and Alternative 3 ..... *53*
3.9 HERITAGE AND CULTURAL RESOURCES 53
3.9.1 Alternative 1, Alternative 2 and Alternative 3 ..... *53*
3.10 ECONOMIC ANALYSIS 53

4.0 CONSULTATION AND COORDINATION 54

5.0 REFERENCES 55

6.0 APPENDICIES 58

6.1 APPENDIX A. ALTERNATIVE 2 - PROPOSED ACTION 59
6.1.1 Table 1. Orleans Transportation and Road Restoration Project - Blue Creek *59*
6.1.2 Table 2. Orleans Transportation and Road Restoration Project - Bluff Creek *60*
6.1.3 Table 3. Orleans Transportation and Road Restoration Project - Camp Creek *70*
6.1.4 Table 4. Orleans Transportation and Road Restoration Project - Lower Middle Klamath *75*
6.1.5 Table 5. Orleans Transportation and Road Restoration Project - Red Cap Creek *84*
6.2 APPENDIX B. ALTERNATIVE 3 89
6.2.1 Table 6. Orleans Transportation and Road Restoration Project - Blue Creek *89*
6.2.2 Table 7. Orleans Transportation and Road Restoration Project - Bluff Creek *90*
6.2.3 Table 8. Orleans Transportation and Road Restoration Project - Camp Creek *100*
6.2.4 Table 9. Orleans Transportation and Road Restoration Project - Lower Middle Klamath *105*
6.2.5 Table 10. Orleans Transportation and Road Restoration Project - Red Cap Creek *114*
6.3 APPENDIX C. MAPS FOR ALTERNATIVE 2 AND ALTERNATIVE 3 120
6.4 APPENDIX D. RESPONSE TO COMMENTS 121
6.5 APPENDIX E: ANNUAL-SEASONAL ROAD CLOSURES ASSOCIATED WITH PORT-ORFORD CEDAR. 133
6.6 APPENDIX F. ECONOMIC ANALYSIS 134
6.7 APPENDIX G. BEST MANAGEMENT PRACTICES IMPLEMENTATION 137
6.8 APPENDIX H. MANAGEMENT INDICATOR SPECIES 139
6.9 APPENDIX I. ROAD MAINTENANCE LEVEL DESCRIPTIONS (FSH 7709.58) 144

LIST OF TABLES

Table 1-1. Summary of public issues with significance 7
Table 2-2. Road Treatments in Alternative 3 differing from Alternative 2 15
Table 2-3. Comparison of alternatives 17
Table 3-1. Stream crossings by watershed with diversion potential and risk of diversions 21
Table 3-2. Sedimentation impacts and risks from roads 22
Table 3-3. Direct sedimentation risks associated with road decommissioning and maintaining roads 23
Table 3-4. Cumulative watershed effects associated with roads and stream crossings by alternative. 26
Table 3-5. Forest Service road segments that lie within 300’ of coho habitat. 28
Table 3-6. Stream crossings found within ¼ mile of coho habitat along Forest Service Roads. 29
Table 3-7. Recreation and public access roads open to public use by alternative (in miles) 32
Table 3-8. Criteria for prioritizing road access for fire suppression and fuels management 44
Table 3-9. Fire suppression and fuels management access (road miles) by alternative 45
Table 3-10. Weed sites on roads proposed for decommissioning 52

Document Structure

This Environmental Assessment has been prepared in compliance with the National Environmental Policy Act (NEPA) and other relevant federal and state laws and regulations. This Environmental Assessment discloses the direct, indirect, and cumulative environmental impacts that would result from the proposed action and alternatives. The document is organized into five chapters:

Chapter 1 - Purpose and Need for Action: *This chapter explains what action we are proposing, why we need this action, where the action would occur, and what our decision would address. This chapter also discusses how we invited public participation and how we addressed public issues.*

Chapter 2 - The Alternatives: *This chapter provides a more detailed description of the proposed action as well as alternative methods for achieving the purpose and need. It discusses how alternatives were developed from relevant issues and summarizes the differences of effects of each alternative. Other alternatives that were considered but eliminated from detailed study are also identified.*

Chapter 3 - The Affected Environment and Environmental Consequences: *This chapter defines the existing condition in enough detail to set the context for predicting the impacts that would occur as a result of implementing the alternatives. This chapter also describes the environmental effects of implementing the proposed action and other alternatives. This analysis is organized by the major resource issues identified in the Purpose and Need chapter. Under each relevant resource issue the existing condition, direct/indirect, and cumulative effects of each alternative are discussed.*

Chapter 4 – Consultation and Coordination: *This chapter provides a list of preparers and agencies consulted during the development of the environmental assessment.*

Chapter 5 – References: *This chapter lists the references and citations referred to in the environmental assessment, including those specialist reports prepared for this assessment..*

Appendices*: The appendices provide more detailed information that supports the analyses presented in the environmental assessment.*

Additional documentation, including the supporting analysis listed in the Reference Section, may be found in the project planning file located at the Supervisor Office, Six Rivers National Forest, Eureka, CA

This Page Intentionally Blank

1.0 PURPOSE AND NEED FOR ACTION

1.1 Background

The Orleans Roads Analysis and Off-Highway Vehicle Strategy (Orleans RAP 2006) outlined management options for keeping and maintaining roads, decommissioning roads, designating routes and identifying motorized and non-motorized trails within the Orleans Ranger District of the Six Rivers National Forest.

This environmental assessment will address the issues, alternatives, and effects of implementing the management options for the transportation system outlined in the Orleans RAP. Actions from the Orleans RAP that are being carried forward would occur in locations as shown on the Proposed Action map. Appendices A and C outlines the site-specific road treatments proposed within the Orleans District. Each road within the Orleans District was evaluated with respect to its need for landowner access, public access (recreation), land management needs such as wildfire and fuels management, vegetation management, as well as for environmental risks (water quality, fisheries, Port-Orford cedar root disease) and cultural uses.

1.2 What Actions We Propose to Do

The Orleans Ranger District proposes to revise the existing transportation system on the Orleans District and also proposes to restrict motorized vehicle use to designated roads and trails. A summary of the Proposed Action is presented below. The Proposed Action is presented in full detail in Chapter 2 - Alternatives. Tables describing the Proposed Action on a road-by-road basis are found in Appendix A. A map of the Proposed Action is found in Appendix C.

Proposed actions include:

Keeping and maintaining 455 miles of road Roads in this category would remain on the National Forest transportation system. Roads in this category include roads that would be either:

1/**kept and maintained** at their current designated maintenance level (see Appendix I for definitions of maintenance levels);
2/**upgraded** to a higher objective maintenance level. Upgrading roads also includes bringing unauthorized (non-system) roads onto the transportation system (e.g. river access, access to dispersed camping locations, etc). Approximately 4.2 miles of unauthorized roads are proposed to be added to the Orleans District transportation system and are included in the 455 miles of road;
3/**downgraded** to a lower objective maintenance level or;
4/**designating motorized trails**. A total of 3.6 miles of motorized trail are also proposed for designation and/or type of use. These miles are in addition to the 455 miles of road described above. No new motorized trails are being constructed under this alternative.

All categories of roads described above will be storm-proofed to reduce water quality and sedimentation risks through culvert and road surface improvements, including redesigning of culverts for fish passage (as funding permits).

Chapter 1

Purpose and Need for Action

In Chapter 1 you will find:

- What actions we propose to do
- Why we propose these actions
- What are the applicable management directions
- Where actions would occur
- What our decision will address
- How we involved the public
- How we addressed public issues
- Applicable laws

Decommissioning 203 miles of roads on National Forest System (NFS) roads and trails on the Orleans District over the next 15 years.

Roads in this category would be removed from the transportation system and are not accessible to motorized traffic. Actions associated with decommissioning range from a simple road barricade (e.g. roadbed remains untouched) to removal of culverts and roadbed (e.g. requires use of heavy equipment). All decommissioned roads remain open for non-motorized use. Decommissioning includes converting a road to a non-motorized trail. Approximately 6.5 miles of road would be converted from a road to non-motorized trail for non-motorized use.

Associated Opportunity

There is an opportunity to remove downed woody material lying within the road prism on roads proposed for decommissioning. Prior to decommissioning a road, the road must be cleared to allow heavy equipment access to treatment sites. Where downed woody debris exists (e.g. wind-throw trees) that qualifies as firewood or has merchantable value, this downed wood could be removed commercially and/or made available to the general public. Only the wood lying within the road prism would be removed. Portions of woody debris extending past the road prism would remain in place.

1.3 Why We Propose These Actions (Purpose and Need)

The purpose and need of this action is to manage the National Forest transportation system on the Orleans Ranger District so that it is consistent with the *Six Rivers National Forest Land and Resources Management Plan* (LRMP), the 2001 Roads Rule, 2005 Travel Management Rule, the Region 5 Route Designation Process, as well as current funding levels.

There is a need to determine the minimum transportation system that:

- Provides public and Forest Service administrative access to achieve forest land and resource management goals
- Is affordable, manageable, and sustainable
- Has minimal negative effects on the land and resources (e.g. water quality and fisheries)

There is a need to:

- Identify needed and unneeded routes
- Identify road-associated environmental and public safety risks
- Identify site-specific priorities and opportunities for road improvements and decommissioning
- Identify areas of special sensitivity (e.g. high public use areas with risk of spreading of Port-Orford cedar root disease), unique resource values, or both

1.4 What are the Applicable Forest Service Management Directions

Roads Rule

On January 12, 2001, the Forest Service issued the *Administration of the Forest Development Transportation System; Prohibitions; Use of Motor Vehicles Off Forest Service Roads; Final Rule*, often referred to as the 'Roads Rule' (Federal Register/Vol. 66, No. 9). This rule revised regulations concerning the management, use and maintenance of the National Forest Transportation System. The final rule is intended to help ensure that:

- Additions to the National Forest System road network are essential for resource management and use
- Construction, reconstruction, and maintenance of roads minimize adverse environmental impacts
- Unneeded roads are decommissioned and restoration of ecological processes is initiated

Final Travel Management Rule

On November 9, 2005, the Forest Service issued 36 CFR Parts 212, 215, 261, and 295 Travel Management; Designated Routes and Areas for Motor Vehicle Uses; Final Rule (Federal Register/Vol. 70, No. 216). This rule revised regulations regarding travel management on National Forest System lands to clarify policy related to motor vehicle us, including the use of off-highway vehicles. This rule established Forest Service policies and procedures to ensure that the use of motorized vehicles on public lands will be controlled to protect the resources, to promote the safety of all users of those lands, and to minimize conflicts among the various uses of those lands.

This final rule requires designation of those roads, trails, and areas that are open to motor vehicle use. The clear identification, by means of a Motor Vehicle Use Map, of roads, trails, and areas for motor vehicle use on each national forest will enhance management of National Forest System lands; sustain natural resource values through more effective management of motor vehicle use; enhance opportunities for motorized recreation experiences on National Forest System lands; address needs for access to National Forest System lands; and preserve areas of opportunity on each National Forest for non-motorized travel and experiences. In addition, the Region 5 OHV Route Designation Guidebook was considered in the development of this project.

Orleans Roads Analysis and Off-Highway Vehicle Strategy

The actions proposed in this analysis have been developed from management options identified in the *Orleans Roads Analysis and Off-Highway Vehicle Strategy* (Orleans RAP, March 2006). The Orleans RAP was completed and sent to the interested publics in April 2006. The Orleans RAP followed the process outlined in the document entitled *Road Analysis: Informing Decisions about Managing the National Forest Transportation System (*USDA Forest Service 1999*)* which provides consistent national direction for road management decisions throughout National Forests. Included in the Orleans RAP was the integration of both the 2001 Roads Rule and the 2005 Final Rule on travel management. The Orleans RAP evaluated access needs and resource risks for roads and potential OHV routes on the Orleans Ranger District to balance these needs and risks with available funding. Roads addressed in this analysis include both system and unauthorized (non-system) roads. Unauthorized roads are included in this analysis because of potential resource risks and public needs (including OHV routes). Extensive public involvement occurred in the development of the Orleans RAP and facilitated refinement of road management options.

Six Rivers National Forest Land and Resource Management Plan

This proposal is consistent with the management direction for the project area. The *Six Rivers National Forest Land and Resource Management Plan* (LRMP) outlines management direction related to transportation facilities. The LRMP states that the Forest should provide a safe, efficient and cost-effective transportation system as well as provide public access for the use and enjoyment of its natural resources. Motorized recreation is the most popular recreation activity occurring within NFS administered lands and is a legitimate use (LRMP IV-122). The Orleans Ranger District proposes to restrict motorized vehicle use to designated roads and trails as per SRNF LRMP motorized recreation standard and guideline 18-21 (LRMP IV-24). The LRMP also recognizes that existing permanent roads not necessary for administration, recreation, resource protection, commercial and/or public access should be closed after all project work has been completed (LRMP IV–115).

The LRMP delineated Key Watersheds and Late Successional Reserves that have specific management directions and standards and guidelines relative to the Forest transportation system. The LRMP states that in Key Watersheds, the existing system and non-system road mileages should be reduced (LRMP IV-111). Key Watersheds serve as refugia crucial for maintaining and recovering habitat for at-risk stocks of anadromous salmonids and resident fish species. On the Orleans District, Blue, Bluff, Camp and Red

Cap watersheds are listed as Key Watersheds. Key Watersheds are the priority areas for watershed restoration activities and the LRMP states that watershed restoration should focus on removing and upgrading roads (LRMP IV-111). The LRMP also states that roads should be assessed relative to meeting Aquatic Conservation Strategies objectives by reconstructing roads and drainages that pose a substantial risk or impact to riparian resources or closing or obliterating roads that pose a risk to aquatic resources (LRMP IV-49).

The LRMP also designated areas as Late Successional Reserves (LSR) to provide protection for animals associated with mature and old growth forests. LSRs on the Orleans District are found within the Blue, Bluff, and Red Cap watersheds. The LRMP direction for transportation management within LSRs is to minimize the mileage of open roads. Roads not providing a primary travel access should be closed (LRMP IV-44).

The LRMP states that to reduce the spread of the Port-Orford cedar root disease, a risk analysis will be completed for all projects in watersheds containing Port-Orford cedar. Transportation plans will evaluate the risk of spread of the disease through road upgrades, seasonal closures, permanent closures, maintenance and decommissioning (LRMP IV-129).

The risk of wildfire remains a key concern in managing NFS administered lands and although the Six Rivers LRMP does not explicitly address the importance of roads in relation to fire fighting or fire suppression abilities, there is a clear link between roads and the ability to access a fire. The goal of fire and fuels management on the Six Rivers National Forest is to provide a well-planned and executed fire protection and fuel management program that are responsive to land and resource management objectives (LRMP IV-117). All roads will be assessed relative to their utility in fighting wildfire as well as firefighter safety.

When decommissioning a road, the removal of woody debris that lies within the road prism (e.g. wind-throw trees) is an opportunity to provide firewood and merchantable saw logs to the community. Wind-throw trees (or any fallen trees) that lie within the road prism are eligible for removal under Forest standards and guidelines and are consistent with the Late Seral Reserve Assessment recommendations (LRMP IV-40; Forest-Wide LSR Assessment 6-29 and 6-32).

1.5 Where Actions Would Occur

The project area is the Orleans District, which includes Township 13N to 9N and Range 3E to 7E. Detailed, site-specific areas and locations are displayed on the map in Appendix C.

1.6 What Our Decision Will Address

The decision to be made is whether to implement the proposed action as described above, to vary the design of the proposed action to meet the purpose and need for action, or to defer any action at this time.

The framework of the decision will focus on which roads to:

- Keep and maintain
- Upgrade or downgrade
- Add to the National Forest System transportation network
- Designate motorized trails and/or type of use
- Decommission or make a non-motorized trail.
- Apply seasonal use periods.

In making a decision, critical factors such as recreational access, administrative needs, driver safety, private property access, resource risks, and funding levels will all be considered.

1.7 How We Involved the Public

Public involvement was a key component in developing this environmental assessment. Public involvement was first initiated through the *Orleans Road Analysis and Off-Highway Vehicle Strategy* (Orleans RAP), which was initiated in October 2005 and completed in March 2006. The purpose of the Orleans RAP was to engage the public in order to:

- Increase awareness and knowledge about the roads analysis process
- Provide information on transportation routes
- Gather information on public issues and concerns relating to road use and management
- Seek public help in identifying opportunities regarding road management, access, resource protection and OHV management

In October of 2005, the Orleans RAP was initiated through a news release to the Six Rivers media contact list. The news release explained the process and requested replies from those interested in being placed on the Orleans RAP mailing list. An information-sharing meeting was held on October 25, 2005, where questions about the project were addressed. In addition to the news releases, on October 12, 2005 over 600 individuals on the Orleans Ranger District mailing list, as well as the Smith River National Recreation Area, Lower Trinity and Mad River Ranger Districts mailing lists were sent an information letter giving an overview of the project, outlining meeting dates, and asking for public input. A web page address was also included in the information letter and was available on-line on October 25, 2005. Individuals attending the October 25 meeting, as well as people that expressed interest by mail or by phone, were given information on draft recommendations for the Orleans District transportation system and a map outlining draft recommendations. A total of 44 publics requested an informational package and those were mailed. In addition, this information package was also mailed to those individual or groups that expressed interest, including recreationists, environmental communities, commodity/user groups, elected officials, federal and state agencies, community groups, and private landowners.

On November 21, 2005, a second public notice was published in the Eureka Times-Standard and Kourier announcing a second workshop meeting. In addition, a total of 600 post office box holders (landowners) within the towns of Weitchpec, Orleans and Somes Bar were sent notification of this November 29th meeting. Notices of this meeting were also posted at all the local news bulletin boards within the Orleans community. During the November 29, 2005 workshop meeting, public comments on the draft recommendations for the Orleans District transportation system were received on individual roads as well as general comments as to the need to keep roads open and the environmental impacts of road decommissioning. On January 10, 2006, a meeting was held in Eureka to gather information and comments from OHV clubs.

Information from individuals and groups that responded with letters, or comments during the meetings, were incorporated into the final Orleans RAP, which was completed in March 2006. The Orleans RAP was sent to over 80 individuals or groups that expressed interest, including recreationists, environmental communities, federal and state agencies, community groups, and private landowners. Included in the mailing of the Orleans RAP document was an announcement that an environmental assessment tiering to the Orleans RAP was scheduled to begin in spring 2006.

On May 11, 2006 a public scoping document was sent to over 80 publics that expressed an interest in the recently completed Orleans RAP document. Included in this scoping document was a map and table indicating location and type of actions proposed as they relate to the Orleans transportation system. In addition to this scoping document, an abbreviated scoping document was sent to 800 boxholders in the communities of Orleans, Somes Bar, and Weitchpec, asking for public input on the proposed action and indicating how to obtain more information on the proposed action if interested. The comment period for initial public scoping was 30 days, ending June 13, 2006. The proposal was also listed on the spring 2006 Forest's Quarterly Schedule of Proposed Actions.

By the close of the public scoping period, 48 letters and email letters had been received from environmental groups as well as local residents. A synthesis of the comments from the public and the response to comments is found in Appendix D.

1.8 How We Involved Affected Tribes

Formal governmental consultation was initiated on the Orleans District RAP with the federally recognized Karuk, Yurok, and Hoopa Tribes by letter May 19, 2005, explaining the roads analysis process and requesting tribal participation and consultation. Enclosed in this letter was a list of all the roads and a map with draft recommendations for keeping, upgrading, or decommissioning of roads. A request was made for a review of the enclosed information and any input on the opportunities to focus our maintenance funds, as well as the identification of tribal issues, concerns, and needs regarding keeping, upgrading or decommissioning roads.

A follow-up meeting was held with Hoopa Tribal staff with discussions regarding tribal concerns of access to traditional gathering areas, the maintenance of key alternate routes for Orleans residences during emergencies, and opportunities for decommissioning work and cooperative agreements on road management.

Meetings with Yurok Tribal staff and with its Cultural Committee took place. Tribal staff provided written comments that expressed concerns with the protection of cultural sites as well as concerns with access to cultural sites by elders. In addition the Yurok staff discussed the Tribe's Transportation Plan, the need for specific Forest roads for emergency egress, and the need for access for wildland fire emergencies. They also expressed an interest in opportunities associated with road decommissioning work as well as cooperative roads management.

Meetings were held with Karuk Tribal staff to discuss their views. Written comments were received from Tribal staff outlining their concern with the current condition of the road network and the need to allow for access to cultural resources. At the same time they expressed a concern about non-point source pollution that contributes to degradation of fish habitat and overall water quality, and specific concerns for specific roads. Formal written comments were received from the Karuk Tribal Council. However, no formal written comments from the Yurok and Hoopa Tribal Councils were received.

We have incorporated the comments and concerns of Tribal councils and staffs into this analysis.

1.9 How We Involved Other Agencies and Forest Service Personnel

Other Agency Consultation and Coordination: In May 2006, scoping letters were sent to the North Coast Water Quality Control Board, National Marine Fisheries Service (NMFS) and US Fish and Wildlife Service (USFW). No comments were received. A meeting on May 23, 2006, initiated discussions with NMFS and USFW.

Interdisciplinary Team Review: On June 21, 2006, an interdisciplinary team met to review the public comments. Issues related to the proposed action were identified based upon comments and by the team's technical knowledge of the area.

1.10 Issue Identification

Comments from the public were first brought forward during the development of the Forest-wide and Orleans RAPs (RAP, USDA 2003, Orleans RAP, USDA 2005). The Orleans RAP incorporated the recommendations from the Forest-wide RAP. The Orleans RAP was used as a basis of the purpose and need and the proposed action of this environmental Assessment.

During scoping for this proposed action, additional site-specific information related to both access restrictions and the reduction of environmental effects on roads was brought forward and used in the development of an additional alternative. A summary of all of the comments received during scoping can be found in the comments-response document in Appendix D.

Out of comments, public and otherwise, often come issues. An issue is a point of debate, dispute, or disagreement regarding anticipated effects of the proposed action. As part of this analysis, the Forest Service separated issues from non-issues. Submitted comments deemed relevant as issues were analyzed by applying established FS criteria for identifying significant issues. The Council on Environmental Quality (CEQ) NEPA regulations guide Federal agencies in handling non-significant issues by directing them to "…identify and eliminate from detailed study the issues which are not significant or which have been covered by prior environmental review (Sec. 1506.3)…" (40 CFR Part 1501.7). Relevant issues are considered to be significant unless they are:

Decided – Issue raised is already decided by law, regulation, forest plan, or other higher level decision.

Conjectural – Issue raised is based on a conjectural assertion, not supported by scientific evidence or project-site conditions.

Scope - Issue raised is beyond the scope of the purpose and need of the proposed action.

Request additional project definition – An issue is not actually raised, but a concern is raised that the proposed action needs to be more fully defined. Such additional description of the proposed action is given in the prior section.

Irrelevant – No issue raised, comment is irrelevant to the decision being made. Often commenter requests to be kept on mailing list(s), and informed of upcoming information made publicly available.

Significant issues have been classified into three categories as follows:

<u>Alternative formulated</u> – Issue raised would be considered via the formulation of an alternative to the proposed action and analysis of the alternative's effects. One additional alternative was developed in response to public comments.

<u>Mitigation identified</u> – Issue raised will be resolved through implementation of a mitigation measure, incorporated into the project.

<u>Subject of analysis</u> – Issue raised will be evaluated through analysis, and results of the analysis are summarized in this document.

Identifying an issue as significant does not mean that a significant environmental effect is expected to result from the project; significant issues can usually be resolved to prevent occurrence of an adverse environmental effect.

The discussion below focuses on the determination of significance of relevant comments summarized below in Table 1-1. A detailed project comment-response document is contained in Appendix D. Listed below are those issues that are considered to be significant. Indicators to evaluate environmental effects of these issues are summarized after the tables.

Table 1-1. Summary of public issues with significance

Issue Category	Summary of Comments Addressed in Analysis	How the Issue was Addressed
Aquatic Concerns (water) Fisheries Concerns (effects to native fisheries)	Roads and road decommissioning have the potential to impact water quality and native fisheries.	Assessed in Chapter 3 Helped Formulate Alternative
Recreation and Public Access	Project will result in a loss of current recreational opportunities.	Assessed in Chapter 3

Issue Category	Summary of Comments Addressed in Analysis	How the Issue was Addressed
Wildlife Concerns	Roads and road restoration activities have the potential to impact wildlife.	Assessed in Chapter 3 Helped Formulate Alternative
Fire and Fuels	Reducing road access has the potential to impact ability to fight fire.	Assessed in Chapter 3 Helped Formulate Alternative
Port-Orford cedar	Vehicular traffic introduces and spreads Port-Orford cedar root disease.	Assessed in Chapter 3 Helped Formulate Alternative
Botanical Concerns	Roads are potential vectors for the introduction and spread of invasive and noxious weeds.	Assessed in Chapter 3
Heritage and Cultural Resources	Heritage and cultural sites near roadways are potentially subject to disturbance	Assessed in Chapter 3
Vegetation Management	Loss of future vegetation management due to decreased access	Assessed in Chapter 3

1.11 How We Addressed the Issues

The following is the list of significant issues as determined from review by the responsible official. Each issue is described as to how it relates to the proposed action (cause/effect) and how each issue will be addressed (indicators or measures of resource impacts).

Non-significant issues were addressed as comments in Appendix D. Public comments were evaluated by the Interdisciplinary Team and incorporated into the project design or dismissed. Appendix discloses each of the comments brought forward by the public and how they were resolved. Significant Issues are decided by the Line Officer.

1.11.1 Significant Issues

Water (Aquatic Environment): Roads have the potential to impact water quality, particularly during large landslide-producing storms. Roads have the potential to adversely affect water quality when stream crossings plug, fail or divert, resulting erosion and downstream sedimentation of watercourses. Decommissioning roads also has the potential to temporarily adversely affect water quality when stream crossings are pulled and recontoured. All of the public comments received commented on the need to improve and protect the aquatic environment. The action alternatives address this concern by incorporating various design features to protect the aquatic environment. There is a concern that more roads need to be decommissioned in order to protect water quality. There is also a concern that project implementation may result in increased sediment and undesirable effects to the aquatic environment. The following measures will be used to compare the alternatives in terms of the aquatic environment:

- Miles of roads
- Number of stream crossings
- Stream crossing fill volume removed (yd^3)
- Estimated post decommissioning stream crossing erosion (yd^3)

Potential risk of stream crossing erosion (yd^3) from culvert failures and diversions assuming no road treatments or improvements. These indicators will be assessed for the Blue, Bluff, Camp, Lower Middle Klamath, and Red Cap watersheds.

Fisheries (Affects to Native Fisheries): The measures listed above under Water Quality are the same measures that will be used to compare the differences for impacts to Threatened and Forest Service sensitive fish species. Little differences exist between the action alternatives as far as the “activities distance to fish habitat”.

Recreation and Public Access: Dispersed recreational use occurs throughout the District ranging from hunting and gathering to recreational motorized trail use. The proposed action addresses this concern by incorporating this varied recreational use into the project design. There is a concern that project implementation may result in a loss of current recreational opportunities. The following measures will be used to compare the alternatives in terms of recreational use:

- Miles of existing open drivable road open to public use
- Number of dispersed campsites open to public use
- Miles of existing motorized use trail within project area open for public use

Wildlife: Roads and road restoration activities have the potential to affect wildlife from the vehicular traffic on roads. Road decommissioning, water quality improvements and upgrading work can have a season-of-implementation effect on nearby wildlife that is sensitive to the noise and visual disturbance of that work, especially during their breeding season

Numerous roads with low administrative need exist within Late Successional Reserves (LSR). Public comments indicated a desire to decommission roads with low administrative needs within LSRs.

The following measures will be used to compare the alternatives in terms of effects to wildlife:

- The number of acres of unsurveyed suitable marbled murrelet and northern spotted owl nesting habitat potentially affected by the noise and visual disturbance of road decommissioning with heavy equipment.
- Average open road density per section within LSRs

Fire and Fuels: Roads provide important access for fighting fire and for providing access for fuel treatment opportunities. Reducing road access has the potential to impact the ability to fight fire. The following measures will be used to compare the alternatives in terms of affects to fighting fire and fuels treatment opportunities:

- Miles of road with (High, Medium, and Low) fire access by alternative

Port-Orford cedar: Extensive stands of uninfected Port-Orford cedar (POC) exist within the District. These Port-Orford cedar stands provide high ecological diversity and are critical to aquatic ecosystem function and stability. There is a concern with the spread of *Phythophthroa lateralis,* a fatal root disease fungus that kill Port-Orford cedar. In order to maintain critical ecological functions, the risk of introducing and spreading POC root disease should be reduced. The following measures will be used to compare the alternatives in terms of reducing risk of spread of POC root disease:

- Acres of high risk Port-Orford cedar stands by alternative
- Miles of high risk Port-Orford cedar roads to be decommissioned

Botany/Noxious Weeds: Roads have the potential to be vectors for the introduction and spread of invasive and noxious weeds. A weed-risk rating and an inventory of existing weeds have been completed. Analysis indicates a moderate risk of the spread of weeds along roads with existing infestations that are proposed for decommissioning or closure. Appropriate management requirements will be incorporated into project design as required by law and policy. Project design features will be incorporated into all action alternatives to insure that the risk of introduction and spread of noxious weeds is low.

Also included will be an assessment of the potential to impact federally listed, sensitive and survey and manage botanical species. Effects to sensitive botanical species are displayed in the biological evaluation prepared for this project.

Vegetation Management: Roads provide important access for vegetation management opportunities. Vegetation management can be for a variety of purposes, including reducing hazardous fuels, enhancing wildlife habitat, promoting forest health and resiliency, and producing forest products. Eliminating existing road access into some portions of the District could limit future opportunities for economical vegetative management treatments in those areas. The following measures will be used to compare the alternatives in terms of potential effects to vegetation management opportunities:

- Miles of road accessing "High" and "Medium" priority vegetation management opportunities

Heritage and Cultural Resources:

Heritage and cultural sites near and around roadways are potentially subject to disturbance. Road closures and reduction of road access have the effect of lowering the likelihood of damage to sites and cultural areas. All of the alternatives involve management activities confined to previously disturbed roadbed areas.

Past inventories have been completed throughout the area (Project File – Heritage Resources.) Management actions will be confined to roadways and are considered to be in previously disturbed areas. Therefore, it is expected that there would be no direct effects to heritage and cultural sites during the project implementation. Actions are part of a class of undertakings exempt from further review or consultation by the appropriate regulatory agency.

1.12 Applicable Laws

A number of laws provide direction for activities on public lands, including the Multiple-Use Sustained Yield Act (1960), Wilderness Act (1964), Forest and Rangeland Renewable Resources Planning Act (1974), National Forest Management Act (1976), Federal Land Policy and Management Act (1976), and the California State Wilderness Act (1984).

While not specific to road management, other laws relevant to the proposed action include the National Historic Preservation Act (1966), Endangered Species Act (1973), Clean Water Act (1977), and the Magnuson-Stevens Fishery Conservation and Management Act (1996).

1.12.1 Historic Preservation Act

The National Historic Preservation Act requires protection of all significant cultural resources, including archeological sites. Under the terms of the First Amended Regional Programmatic Agreement Among the USDA Forest Service, Pacific Southwest Region, the California State Historic Preservation Officer (SHPO), and the Advisory Council on Historic Preservation (ACHP), the project management actions fall under an exempt class of undertakings and are considered exempt from further review or consultation under the terms of the Programmatic Agreement as defined in Stipulation II.C, and pursuant to Stipulation III.E. Screened exemptions are determined so by the forest Heritage Resource Manager, include activities whose area of potential effect (APE) are entirely within obviously disturbed contexts and the disturbance is such that the presence of historic properties is considered highly unlikely. Roadways are considered to be such areas, and are therefore exempt after screening by the Heritage Resource Manager.

1.12.2 Endangered Species Act

Section 7(a) of the Endangered Species Act (ESA) requires Federal agencies to consult with National Marine Fisheries Service and U.S. Fish and Wildlife Service (FWS), as appropriate, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their critical habitats. The purpose of the Endangered Species Act (16 U.S.C. 1531-1544) is to conserve "the ecosystems upon which endangered and threatened species depend" and to conserve and recover listed species. Coho salmon, bald eagle, marbled murrelet, and northern spotted owl are federally listed species that occur or have suitable habitat within the analysis area. There are no federally listed plant species within the analysis area.

1.12.3 Clean Water Act

The Federal Clean Water Act (Section 303) (CWA) requires states to adopt water quality standards (water quality objectives and beneficial uses). Under the oversight of the Environmental Protection Agency (EPA), the North Coast Regional Water Quality Control Board is the local entity responsible for implementing CWA in northwest California. Pursuant to the Clean Water Act, the EPA and North Coast Water Quality Control Board have been involved in the assessment of water quality effects associated with the project.

1.12.4 Magnuson-Stevens Fishery Conservation and Management Act

In addition to the ESA, the 1996 Amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSA), (16 U.S.C. 1801 et seq.) requires the identification of Essential Fish Habitat (EFH) for federally managed commercial fishery species. Essential fish habitat means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. The species that the MSA covers include coho and Chinook salmon. Consultation with NOAA Fisheries on potential impacts to Essential Fish Habitat will be accomplished under the biological assessment prepared for ESA listed salmon species.

2.0 ALTERNATIVES

This chapter describes and compares alternatives to the proposed action that are considered in this analysis. It includes a description and map of each alternative considered. This section also presents the alternatives in comparative form, sharply defining the differences between each alternative and providing a clear basis for choice among options by the decision maker and the public. This comparison is based upon the objectives and issues identified in Chapter 1 and the measures defined in Section 1.11.

Design features that are used to reduce adverse impacts to a resource are included in the description as well as other required design features.

Chapter 2

The Alternatives

In Chapter 2 you will find:

- How alternatives were developed
- Description of alternatives analyzed in detail
- Comparison of the alternatives

2.1 How Alternatives Were Developed

Three alternatives are analyzed in detail (see Section 2.2). Public and internal issues were reviewed to determine alternative approaches to achieving the purpose and need. In order to incorporate comments and concerns from the public, the Proposed Action as identified in scoping has been modified and a new Alternative 3 has been developed. Issues raised by the public and tribes that were incorporated in Alternative 3 include: 1) addition of roads to the proposed decommissioning list due to risk of spread of POC root disease, 2) removal of roads from the proposed decommissioning list due to fire suppression needs and future fuel treatment opportunities (e.g. Orleans Community Fuel Reduction Project), and 3) re-assessing 40+ miles of roads originally proposed for decommissioning in the draft Orleans RAP for the purpose reducing open road density to meet Late Seral Reserve (LSR) goals outlined in the Forest Land and Resource Management Plan (LRMP).

2.2 Description of Alternatives Analyzed in Detail

2.2.1 Alternative 1 (No Action)

Under the No-Action Alternative, there would be no road decommissioning and rehabilitation of stream crossings nor would there be road improvements to reduce the risk of road failures during storm events. Approximately 658 miles of system and non-system roads would remain within the Orleans District. The existing POC seasonal road closures (gates) currently in place (Appendix E) during the rainy season would continue to be implemented.

2.2.2 Alternative 2 (Proposed Action)

Under the Proposed Action, the Orleans Ranger District proposes to revise the existing transportation system on the Orleans District by **keeping and maintaining 455 miles of road** and **decommissioning 203 miles of roads** on non-motorized National Forest System (NFS) roads and trails on the Orleans District over the next 15 years. Proposed actions are described in detail by road number in Appendix A and include the following:

2.2.2.1 *Keeping and Maintaining 455 miles of road*

Roads in this category would remain on the National Forest transportation system. Roads in this category include roads that would be either:

1/**kept and maintained** at their current designated maintenance level (see Appendix I for maintenance level descriptions);

2/**upgraded** to a higher objective maintenance level. Upgrading roads also includes bringing unauthorized (non-system) roads onto the transportation system (e.g. river access, access to dispersed camping locations, etc). Approximately 4.2 miles of unauthorized roads are proposed to be added to the Orleans District NFS transportation system and are included in the 455 miles of road;
3/**downgraded** to a lower objective maintenance level or;
4/**designating motorized trails**. A total of 3.6 miles of motorized trail are also proposed for designation and/or type of use. These miles are in addition to the 455 miles of road described above.

National Forest System roads within the Orleans Ranger District are open to any highway-licensed vehicles including highway-licensed OHV use (e.g. dual use vehicles such as licensed motorcycles) for all objective maintenance level 2, 3, 4, and 5 roads). On operation maintenance level 1 roads, motorized use by the public is not permitted; however level 1 roads are still open to non-motorized public use except when POC access restrictions are in effect during the wet season. Registered Green Sticker off-highway vehicles (OHV) are permitted only on operation maintenance level 2 roads or designated trails. Designation of motorized trails identifies where and what type of vehicular use is authorized. Access for all motorized Forest transportation roads and trail include parking along designated routes and at terminal facilities associated with designated routes. This includes parking a motor vehicle adjacent to a road or trail so that all parts of the vehicle are within one vehicle length from the edge of the road or trail surface when it is save to do so and without causing damage to National Forest System resources or facilities.

Tables 1 through 5 (Appendix A) identify the current and proposed objective maintenance level for each road within the Orleans Ranger District as well as designated motorized trails and/or type of use.

In instances where a maintenance level for a given road would increase, such as from a maintenance level 1 to a 2, access and drivability would improve. A reduction in maintenance levels (such as from a level 3 to a level 2) would result in a higher degree of user difficulty for vehicle access, potentially requiring 4-wheel drive rather than a sedan or passenger vehicle.

All categories of roads described above would be storm-proofed to reduce water quality and sedimentation risks through culvert and road surface improvements (as funding permits). Examples of water quality improvements are described below:

Storm-proofing measures and upgrades would include:

1. Re-sizing culverts to pass the 100-year flood flow and associated debris.
2. Constructing rolling dips to minimize stream diversion potential.
3. Culvert inlet reconfiguration to maximize hydraulic capacity including:
    a. Metal end sections
    b. Concrete wing walls
    c. Trash racks
4. Surface upgrades to minimize surface erosion including:
    a. A/C patching
    b. Chip sealing
    c. Placement of surface aggregate
    d. Construction of rolling dips.

These actions would occur over 455 miles of road as funding allows and improve culvert stream crossings where site specific needs were identified.

The Proposed Action designates the vehicle class to motorized vehicles $\leq$ 50 inches on the existing 3.1 miles motorized trail (Lubbs Trail) and adds 0.5 miles of non-system short road segments that access dispersed hunters' camps to the District transportation system. No new motorized trails are being constructed under this alternative.

Seasonal Use Periods

In addition to the actions described above, there would also be annual seasonal road closures during the rainy season, normally between October 22 and June 15, on selected roads (see Appendix E) for the purpose of reducing the risk of introduction and spread of Port-Orford cedar root disease. These roads would be seasonally closed with the onset of the fall rainy season and remain in place until road surfaces dry out in late spring or early summer (normally between October 22 and June 15). This covers the highest risk period of the year when rain and wet conditions are conducive to spreading spore-laden mud from infected to un-infected areas, minimizing the possibility of human activity spreading the disease.

2.2.2.2 *Decommissioning 203 miles of road*

Roads in this category would be removed from the transportation system and are not accessible to motorized traffic. Actions associated with decommissioning range from a simple road barricade (e.g. roadbed remains untouched) to removal of culverts and roadbed (e.g. requires use of heavy equipment). All decommissioned roads remain open for non-motorized use

Decommissioning includes converting a road to a non-motorized trail. Converting a road to non-motorized trail is similar to road decommissioning (e.g. includes pulling stream crossing culverts and associated fill and making sure that the remaining travel way is hydrologically disconnected), however more detail is given to providing a more accessible trail than in a decommissioned road. No motorized traffic would be allowed on the trails, but they would be open to foot and horse travel. Approximately 6.5 miles of road would be converted from a road to non-motorized trail for non-motorized use.

Decommissioning would include the removal of stream crossings and the subsequent reestablishment of the natural stream channel as well as the removal of any cross drains. (A cross drain is a culvert that does not convey water from a stream channel, but rather from a road ditch.) All fill material within the stream crossings would be removed and stored in a stable area along the road and shaped to enhance natural drainage patterns.

Rolling dips on the remaining road surface would be installed to further re-establish natural drainage patterns; while at the same time decreasing water concentrated and diverted down-road.

In areas along roads that show signs of road failure due to slope instability, the fill would also be removed and outsloped to reduce the risk of slumps and landslides.

Associated Opportunity

There is an opportunity to remove downed woody material lying within the road prism on roads proposed for decommissioning. Prior to decommissioning a road, the road must be cleared to allow heavy equipment access to treatment sites. Where downed woody debris exists (e.g. wind-throw trees) that qualifies as firewood or has merchantable value, this downed wood could be removed commercially and/or be made available to the general public. Only the wood lying within the road prism would be removed. Portions of woody debris extending past the road prism would remain in place.

2.2.3 Alternative 3

Under this alternative 457 miles of road would remain on the transportation system, 201.6 miles would be decommissioned, and approximately 6.5 miles of road would be converted from road to non-motorized trail. While Alternative 3 is very similar to Alternative 2 in terms of total treated road miles, prescriptions on selected individual roads have been modified based on public input. Appendix B (Tables 6-10) outlines in detail the proposed treatments in Alternative 3. The road treatments under Alternative 3 that are different from Alternative 2 are summarized in Table 2-1.

Modifications to roads within Alternative 3 were based on input from local and non-local publics, the Karuk Tribe, local watershed interest groups, and further internal administrative staff review. Roads from the 40+ miles that were previously proposed to be decommissioned in the Draft Orleans RAP that had a low management need within Late Seral Reserves (LSR) were reduced from level 2 to level 1 to address concerns of open road density. Roads necessary for fire suppression and fuels reduction projects were reassessed based on comments from the public as well as administrative needs. As a result of these comments and assessment, several roads within the Lower Middle Klamath watershed around the community of Orleans were changed from a proposed road decommissioning to keep and maintain the road on the transportation system.

Table 2-2. Road Treatments in Alternative 3 differing from Alternative 2

Watershed	Road #	Length	Alternative 2 Treatments	Alternative 3 Treatments
Blue Creek	No Changes	No Changes	No Changes	No Changes
Bluff Creek	12N13D	1.53	**Keep and maintain**	**Decommission**
	12N13H	2.7	**Upgrade to level 2** entire 2.7 miles, acquire CIP funding, improve condition and reduce water quality concerns	**Upgrade** to level 2 road 1.9 miles, **Decommission** last .76 miles due to high POC concerns and water quality concerns
	12N13H.2	0.25	**Upgrade** and add to Forest system as level 2	**Non-motorized trail** high POC concerns
	12N31A	0.42	Already partly decommissioned; **Decommission** remainder of road (.42 mi)	**Keep and maintain** to 12N31F, remaining .16 mi already decommissioned
	12N31B	0.69	**Keep and maintain**	**Downgrade** to level 1
	12N31D	0.64	**Decommission**	**Keep and maintain**
	13N01	36.0	**Keep and maintain**	**Upgrade** old road access over Aiken Creek slide (1 mi), decommission 1.5 mi that blew out in 2006 storm, **Keep and Maintain** remaining 34 miles road
Camp Creek	12N04	0.32	**Keep and maintain** as level 2 road	**Downgrade** to level 1 road
	12N04A	0.34	**Keep and maintain** as level 2 road	**Downgrade** to level 1 road
	12N35B	0.85	**Keep and maintain** as level 2 road	**Downgrade** to level 1 road
	12N36B	0.63	**Keep and maintain** as level 2 road	**Downgrade** to level 1 road
	12N37G	0.36	**Keep and maintain** as level 2 road	**Downgrade** to level 1 road
	12N39C	0.22	**Keep and maintain** as level 2 road	**Downgrade** to level 1 road

Watershed	Road #	Length	Alternative 2 Treatments	Alternative 3 Treatments
	12N40F	0.64	**Keep and maintain** as level 2 road	**Downgrade** to level 1 road
	12N49	0.64	**Keep and maintain** as level 2 road	**Downgrade** to level 1 road
	12N53	0.19	**Keep and maintain** as level 2 road	**Downgrade** to level 1 road
Lower Middle Klamath	10N13.3	0.5	**Decommission**	Non-system road. **Upgrade** to level 1
	10N13A	0.6	**Decommission**	**Keep and maintain**
	10N13F	0.4	**Decommission**	**Keep and maintain**
	11N18	2.1	**Decommission**	**Keep and maintain**
	11N26A	0.3	**Decommission**	**Upgrade** to level 2
	13N18.1	0.5	**Decommission**	**Upgrade** to level 1
	JG507	0.1	**Decommission**	**Upgrade** to level 1
Red Cap Creek	No Changes	No Changes	No Changes	No Changes

2.2.4 Management Requirements and Project Design Features

Management Requirements and Design Features are described below and apply to all action alternatives (2 and 3). These requirements have been successfully used in many other restoration projects on the Six Rivers National Forest. These measures are necessary to effectively implement the selected alternative.

Water Quality: To reduce the risk of sediment delivery to streams, applicable BMPs (Appendix G) would be implemented. Streams would be dewatered prior to any activity involving heavy equipment taking place in perennial streams. Specific dewatering methods (pipe, pump, etc) would be determined on a site-by-site basis. Typically, decommissioning and storm-proofing activities involving streams is implemented during the dry season when intermittent streams and swales are dry or have very low flow. Rocks to stabilized recontoured stream crossings would be installed where needed to reduce post-treatment channel adjustments. In addition, a combination of native mulch and native seed would be applied on treated road surfaces to reduce surface erosion. .

All roadwork would cease during the wet season (generally from around October 15 until April 15).

Wildlife: A limited operating period will be applied restricting the decommissioning of low priority roads using heavy equipment that produces noise above ambient levels or increased human visibility within 500 feet of un-surveyed suitable northern spotted owl nesting habitat from February 1st until July 9th. If, for project logistics, work on any of these lower priority roads needed to be implemented sooner than July 9th, there could be three options: 1) conduct protocol surveys covering the season of operations and the area of disturbance to establish non-occupancy within this area; 2) re-initiate consultation with the FWS, which would also be required if the area of disturbance was found to be occupied by nesting spotted owls; 3) if there is any “banked” unused incidental take from high or moderate priority roads (eg. when work on these roads started later than July 9th), those acres could be applied to the decommissioning of low priority roads and no seasonal LOP restrictions would need to apply.

All work producing noise above ambient levels or increased human visibility within 500 feet of un-surveyed suitable marbled murrelet nesting habitat in Zone 1 (all murrelet habitat areas northwest of the Klamath River such as Bluff, Slate, and Camp Creek watersheds) would have a daily restriction of no noise or visually disturbing work occurring on these roads from two hours before sunset until two hours after sunrise until September 15th. An exception would be for the decommissioning of road 11N28, which runs through an occupied site, where work could not be initiated within 500 feet of suitable nesting habitat until after September 15th.

All incidental take for northern spotted owls and marbled murrelets will be reported annually to the SRNF Level 1 team.

For work accomplishing simple water quality improvements (e.g. storm-proofing), using heavy equipment would be restricted within 500 feet of suitable un-surveyed northern spotted owl nesting habitat between February 1st and July 9th. Work of this nature occurring within 500 feet of un-surveyed "high quality" suitable marbled murrelet nesting habitat would not start until September 15th, and if within 500 feet of un-surveyed "low quality" suitable nesting habitat would not start until August 5th, with daily restrictions where no heavy equipment work would start until two hours after sunrise and stop two hours before sunset until September 15th. The assessment of marbled murrelet nest habitat quality will be made by a field reconnaissance by a wildlife biologist.

All road treatments with the potential to result in noise disturbance, within ¼ mile or ½ mile line-of sight of an active bald eagle nest or within a nest protection zone of an active nest site, will only begin after August 1.

All roadwork will cease during the wet season (generally from around October 15 until April 15).

Vegetation (Noxious Weeds and POC root disease): Noxious weed satellite populations would be assessed and removed prior to road decommissioning activities and certified weed free mulch usedwhere mulching is prescribed. Inspect and clean heavy equipment (and gear) for presence of noxious or invasive plant seed before entering the project area. All heavy equipment would be cleaned prior to entry in Port-Orford cedar areas to reduce the risk of spread of POC root disease.

2.3 Comparison of the Alternatives

Table 2-3 summarizes the differences between the alternatives. Comparisons are based upon the project objectives and the issue measures. Chapter 3 describes the resource impacts in more detail. This comparison is provided in tabular form to allow the reader to more readily see the differences and tradeoffs between the alternatives.

Table 2-3. Comparison of alternatives

Issues/ Concerns	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3
Water Quality and Fisheries			
Miles of road decommissioned	0	203	201.6
Number of stream crossings removed	0	397	400
Stream crossing fill volume removed (yd^3)	0	145,114	135,227
Estimated post decommissioning stream crossing erosion (yd^3)	0	4,286	4,056
Potential risk of stream crossing erosion (yd^3) from culvert failures and diversions	300,000 to 30,000,000	245,900	249,600

Issues/ Concerns	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3
Recreation and Public Access			
Miles of existing open drivable road open to public use	464.7	363.2	357.3
Number of dispersed campsites open to public use	20	20	20
Miles of existing motorized trail within project area open for public use	3.6	3.6	3.6
Wildlife			
Acres of unsurveyd suitable MAMU and NSO nesting habitat potentially disturbed	None	MAMU: 5,447 acres NSO: 3,618 acres	MAMU: 5,380 acres NSO: 3,540 acres
Average open road density per section in LSRs	2.38 mi./sq.mi.	1.42 mi./sq.mi.	1.43 mi./sq.mi.
Fire and Fuels			
Miles of road with (H, M, L) fire access by alternative			
High	457.8	373.5	374.5
Moderate	82.0	39.8	40.4
Low	77.4	34.8	33.7
Port-Orford cedar			
Miles of high risk POC roads to be decommissioned	0	36	37
Acres of POC stands no longer at risk of infection from roads	9034	4349	4679
Vegetation Management			
Miles of road accessing High and Medium priority vegetation management opportunities	332.83	295.60	296.50
Botany/Noxious Weeds			
Risk of introducing or spreading noxious weeds	No Effect	No Effect	No Effect
Heritage and Cultural Resources			
	No Effect	No Effect	No Effect

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

Chapter 3

The Affected Environment and Environmental Consequences

In Chapter 3 you will find:

- Water Quality
- Fisheries
- Recreation
- Wildlife
- Fuels and Fire
- Port-Orford Cedar
- Vegetation Management
- Botany/Noxious Weeds
- Cultural Resources

This chapter defines the existing condition in enough detail to set the context for predicting the impacts that would occur as a result of implementing the alternatives. This chapter also describes the environmental effects of implementing each alternative described in Section 2.2 of the environmental assessment. This analysis is organized by the major resource issues identified in the Purpose and Need chapter. Under each relevant resource issue the existing condition, direct/indirect, and cumulative effects of each alternative are discussed. It presents the scientific and analytical basis for the comparison of alternatives presented in the chart in Section 2.3.

Resources not affected by the Proposed Action are not addressed. In order to set the context for cumulative effects, the impacts of past, present, and reasonably foreseeable actions are assessed relative to each resource.

3.1 Water Quality

3.1.1 Water Quality Summary and Comparison of Alternatives

Roads represent considerable long-term liabilities with respect to risk to water quality, particularly given the present trend in declining road maintenance funding. Periodic large storm events are the typical triggers that initiate road failures that impact water quality. The potential for future risk of erosion and sedimentation from roads associated with the No Action alternative clearly indicates that there is a significant potential to adversely impact water quality by several orders of magnitude greater than Alternatives 1 and 2. Direct effects to water quality associated with Alternative 2 and 3 are mostly related to post-decommissioning erosion. This erosion is relatively small and of short-term duration for a long-term benefit. Reducing or eliminating the risk of stream channel diversion and replacing old and aging culverts has the potential to significantly reduce water quality risks and benefit long-term watershed health as well as maintain the long-term functionality of the transportation network.

Based upon analysis of direct, indirect and cumulative effects, the proposed activities would result in a minor short-term impairment to water quality with a long-term improvement in water quality. Combined with effects of past, present and foreseeable future actions, the proposed action may result in localized increases in suspended sediment during the first few precipitation runoff events following project activities. However, the proposed activities would not result in cumulative watershed effects that threaten impairment of long-term water quality objectives. Implementation of project design standards and use of specific erosion and sediment control measures through Best Management Practices are incorporated in the Proposed Action (Appendix G). The Proposed Action complies with the Clean Water Act and applicable water quality control plans.

3.1.2 Affected Area and Existing Condition

The Klamath Watershed is widely recognized as having water quality concerns that are impacting watershed health and beneficial uses such as anadromous fish. The Klamath River is currently listed as water quality impaired under section 303(d) of the Clean Water Act for sediment, temperature, nutrients and dissolved oxygen. With the exception of sediment, these water quality concerns are largely attributable to management activities above and outside the project area. Tributary watersheds within the analysis area such as Blue, Bluff, Camp, and Red Cap Creek are important water quality refugia for anadromous fish and provide critical cool water habitat when Klamath River reaches lethal stream temperatures for anadromous fish during summer months (Lower Middle Klamath WA 2003). These watersheds are also Key Watersheds. Reducing sedimentation risks, and maintaining the habitat and cool water refugia of these tributaries is critical to protecting beneficial uses and water quality.

Maintaining and improving water quality and fisheries habitat within these tributaries can be accomplished through minimizing future risk of sedimentation from roads. On Six Rivers National Forest, roads are the leading source of management-related sediment inputs, predominantly associated with mass wasting features such as shallow debris slides and debris torrents. Where forest roads are located in steep terrain, mass soil movement is a common mechanism of erosion and sediment delivery. The majority of road-related erosion and sediment delivery are associated with large storm events, such as the January 2006 storm, that trigger culvert failures, stream diversions, and mass wasting such as debris slides and smaller slumps within the roadbed. With declining road maintenance funding, the risk of road failures and elevated sediment delivery is increasing, particularly in the event of large storms.

As described above, roads have the potential to adversely affect water quality, however decommissioning roads also has the potential to temporarily adversely affect water quality when stream crossings are pulled and recontoured. Nevertheless, the amount and duration of direct sedimentation impacts associated with road decommissioning and stream crossing removal is considerably less than the potential risk of erosion and sedimentation amounts that would result in storm driven road failures.

In order to effectively assess potential effects to water quality from roads that are proposed to be decommissioned or kept and maintained, environmental indicators have been identified that would facilitate a comparison of alternatives and the effects of those alternatives. Environmental indicators that facilitate comparison of effects are:

- miles of roads,
- number of stream crossings,
- stream crossing fill volume removed (yd^3),
- estimated post decommissioning stream crossing erosion (yd^3), and
- potential risk of stream crossing erosion (yd^3) from culvert failures and diversions assuming no road treatments or improvements.

These indicators will be assessed for the Blue, Bluff, Camp, Lower Middle Klamath, and Red Cap watersheds. Methods, assumptions, and limitations associated with these indicators are described in the *Hydrology and Water Quality Report* written for this project (Cook 2006). Tables 3-1, 3-2 and 3-3 illustrate, by watershed and by alternative, the direct affects of erosion and sedimentation associated with decommissioning roads as well as the indirect risk (or potential) of future erosion and sedimentation associated with keeping roads.

3.1.3 Alternative 1 (No Action)

Direct and Indirect Effects

Under this alternative there would be no road decommissioning and rehabilitation of stream crossings nor would there be road improvements to reduce the risk of road failures during storm events. Approximately 658 miles of system and non-system roads would remain within the Orleans District. Given the probability of at least one large landslide-producing storm in the next 15 years, there is a likely risk that a proportion of the roads and their culverts would fail, resulting in adverse sedimentation of watercourses. Roads not having stream crossings were not included in the risk assessment to water quality. The estimate of potential sedimentation of watercourses described below does not include the potential for landslides resulting from roads and is therefore a conservative estimate.

The assessment of potential sedimentation of watercourses however, does include an estimate of sedimentation risks associated with road stream crossing diversion. Table 3-1 illustrates the number of stream crossings that have diversion potential by watershed. The potential range in risk of sedimentation affects associated from stream crossing diversions is considerable and can be as little as two cubic yards on small ephemeral channels to as large as 100,000 yd^3 on large perennial channels. Table 3-1 shows the range in sedimentation amounts at risk associated with stream crossing diversions and failures by watershed. Assuming 50% of the stream channels with diversion potential actually divert in a large storm event, the results indicate that the potential future risk of erosion and sedimentation varies between 300,000 yd^3 to 30,000,000 yd^3. This is a significant risk that could potentially adversely impact water quality and downstream aquatic ecosystems.

Table 3-1. Stream crossings by watershed with diversion potential and risk of diversions

Watershed	Number Stream Crossings	Number Stream crossings with diversion potential	Number of stream crossings likely to fail during large storm event	Range in Erosion resulting in stream crossing failure and diversion (yd3)
Blue	24	16	8	1,670 to 800,000
Bluff	519	294	147	67,000 to 14,700,000
Camp	103	69	35	23,400 to 3,500,000
Lower Middle Klamath	154	115	58	103,700 to 5,800,000
Red Cap	142	95	48	98,700 to 4,800,000
Total	**942**	**589**	**296**	**300,000 to 30,000,000**

There is a high potential for adverse water quality impacts resulting from stream crossing failures. Table 3-2 illustrates the potential future risk of sedimentation and erosion resulting from culvert failures in the event of a large flood-producing storm. Table 3-2 also shows the potential erosion risk from culverts if proposed road decommissioning were not implemented.

In the Blue Creek watershed, there are approximately 32 miles of road having a total of 16 stream crossings culverts (these numbers do not include the Elk Valley road 14N03 which is not included in this project). The volume of fill within these stream crossings is approximately 4,400 yd^3. Based on the assumptions outlined in the *Hydrology and Water Quality Report* (Cook 2006), there is a risk of an estimated 1,700 yd^3 of potential eroded fill associated with culvert failures impacting the water quality of headwater streams, assuming a future large storm event. Combining both the risk of culvert failure and stream channel diversions (see Table 3-3), there is a potential future risk of 1,700 yd^3 to 800,000 yd^3 that could adversely impact water quality in the event of a future large storm.

In the Bluff Creek watershed, there are approximately 220 miles of road and 515 stream crossings on those roads. Given the probability of at least one large landslide-producing storm in the next 15 years, it is likely that a proportion of those culverts would fail as well as divert, resulting in sedimentation of watercourses. There is a risk or potential of an estimated 66,400 yd^3 of eroded fill from culvert failures impacting the water quality of streams throughout the Bluff Creek watershed. Combining both the risk of culvert failures and stream channel diversions, there is a potential future risk of 67,000 yd^3 to 14,800,000 yd^3 that could adversely impact water quality in the event of a future large storm. This estimate does not include the potential for landslides resulting from roads and is therefore a conservative estimate. Bluff Creek has a history of large landslides and roads are the leading trigger for management-related landslides.

Table 3-2. Sedimentation impacts and risks from roads

Alternatives /Watershed	Road Decommissioning					Roads Kept and Maintained			
	Road miles	Number stream crossings removed	Stream Crossing fill volume removed and saved (yd^3)	Estimated post-treatment sedimentation due to road decommissioning[1] (yd3)	Potential stream crossing fill lost assuming no decommissioning and fill loss during storm[2] (yd3)	Road miles	Number stream crossings kept	Stream Crossing fill volume kept (yd^3)	Potential Stream Crossing fill lost during storm[2] (yd3)
BLUE									
Alternative 1: No Action	0	0	0	0	0	32.3	16	4425	1660
Alternative 2: Proposed Action	14.6	7	2209	66	830	17.7	9	2216	830
Alternative 3:	14.6	7	2209	66	830	17.7	9	2216	830
BLUFF									
Alternative 1: No Action	0	0	0	0	0	219.8	509	177,110	66,400
Alternative 2: Proposed Action	88.9	271	68,750	1,995	25,800	130.9	243	108,360	40,600
Alternative 3:	91.9	279	69,845	2,095	26,200	127.9	231	107,302	40,200
CAMP									
Alternative 1: No Action	0	0	0	0	0	98.4	94	62,095	23,300
Alternative 2: Proposed Action	46.4	71	34,873	1046	13,100	52.0	23	27,222	17,000
Alternative 3:	46.4	71	34,873	1046	13,100	52.0	23	27,222	17,000
LOWER MIDDLE KLAMATH									
Alternative 1: No Action	0	0	0	0	0	184.5	156	276,269	103,600
Alternative 2: Proposed Action	35.8	42	35,858	1,076	13,400	148.7	114	240,411	90,200
Alternative 3:	33.7	37	24,876	746	9,300	152.1	120	251,393	94,300
RED CAP									
Alternative 1: No Action	0	0	0	0	0	130.6	145	262942	98,600
Alternative 2: Proposed Action	15.8	6	3424	103	1,300	114.3	139	259518	97,300
Alternative 3:	15.8	6	3424	103	1,300	114.3	139	259518	97,300

[1] Post treatment sedimentation estimated to be 3% of fill volume removed (Cook and Dresser, 2003)
[2] Stream crossing failure and associated sedimentation (Hydrology staff report, Cook 2006)

In the Camp Creek watershed, there are roughly 98 miles of road and 94 stream crossings on those roads. An estimated 23,300 yd^3 of potentially eroded fill associated with culvert failures has the risk of impacting the water quality of headwater streams, under the no action alternative. The potential future risk of stream crossing erosion as well as diversion potential is between 23,300 yd^3 to 3,500,000 yd$^{3.}$.

Likewise, in the Lower Middle Klamath watershed area, there are roughly 185 miles of road with 156 stream crossings. There is a risk of an estimated 103,600 yd^3 of eroded fill associated with culvert failures potentially impacting the water quality within this area, and when the potential for stream diversions is included, the potential risk of future erosion and sedimentation is between 103, 700 yd^3 to 5,900,000 yd^3. In the Red Cap Creek watershed, there are 130 miles of road with 145 stream crossings. There is a risk of an estimated 98,600 yd^3 to 4,900,000 yd^3 associated with culvert failures and stream channel diversions potentially impacting the water quality within this area.

In summary, under this alternative there would be no road improvements or road decommissioning. Without treatments, there is the risk of erosion and sedimentation of stream channels associated with storm driven culvert failures and diversions that has the potential to deliver between 300,000 yd^3 to 30,000,000 yd^3 and adversely impact water quality (see Table 3-3).

Table 3-3. Direct sedimentation risks associated with road decommissioning and maintaining roads

Watershed	Alternative 1: No Action			Alternative 2: Proposed Action		Alternative 3	
	Direct Affect Erosion Deco yd^3	Future Risk Range in erosion risk from culvert failures and diversions[1] yd^3		Direct Affect Erosion Deco yd^3	Future Risk in erosion risk from culvert failures[2] yd^3	Direct Affect Erosion Deco yd^3	Future Risk in erosion risk from culvert failures2 yd^3
Blue	0	1, 670	800,000	66	830	66	830
Bluff	0	67,000	14,770,000	1,995	40,600	2,095	40,200
Camp	0	23,400	3,523,000	1,046	17,000	1,046	17,000
Lower Middle Klamath	0	103700	5,904000	1076	90,200	746	94,300
Red Cap	0	98,700	4,898,600	103	97,300	103	97,300
Total	0	**300,000 to 30,000,000**		**4,286**	**245,900**	**4,056**	**249,600**

[1] Diversion potential assumes approximately 50% of culverts would divert during a large storm and erosion and sedimentation amounts could vary between 2 to 100,000 yd^3

[2] Road improvements would significantly reduce or even eliminate the risk of diversion potential. As such, Alternatives 2 and 3 assumes no erosion would occur due to diversion potential.

3.1.4 Alternative 2 (Proposed Action)

Direct and Indirect Effects

With this alternative, 455 miles of road would be kept and maintained on the National Forest System transportation system and 203 miles of road would be decommissioned. Road maintenance and storm-proofing activities as well as road decommissioning activities are expected to reduce the amount of sediment that is delivered to streams from erosion. Project activities are also expected to reduce the risk of mass-wasting events through reducing the risk of stream channel diversion, upgrading undersized culverts, and hardening road surfaces. However, streambanks would be disturbed when culverts and associated fills are upgraded, replaced or removed. This may result in accelerated short-term surface erosion from soil disturbance associated with the proposed road restoration activities [during implementation and/or during first storm event after completion] until vegetation is established at disturbed sites. The direct effectives of these activities would result in short-term impacts to water quality with long-term benefits once the treatment sites have recovered and stabilized.

Table 3-2 displays the amount of fill volume that would be saved associated with road decommissioning as well as the direct effect of erosion and sedimentation amounts following decommissioning and stream restoration activities. In general, erosion and sedimentation amounts following stream crossing removal on the Six Rivers National Forest are relatively small (24 yd^3 on average or 3% of fill volume removed) (Cook and Dresser, in press). Madej (2001) found that most excavated stream crossings in Redwood National Park “produced very little sediment” following treatment (average of about 22 yd^3 per crossing).

Table 3-2 shows by watershed, the estimated direct effects of erosion and sedimentation volumes that could occur from post-treatment channel adjustments as well as the estimated risk of future erosion and sedimentation amounts should these stream crossing restoration activities not occur and culverts were left in place. The potential risk of erosion and sedimentation attributable to storm-driven culvert failures is approximately 13 times higher than the amount of erosion attributable to road decommissioning. The amount of erosion would be several orders of magnitude even higher if erosion rates associated with stream diversion potential were also included (see Table 3-4).

While there is clearly a short-term impact associated with road decommissioning and stream channel restoration, this impact is significantly less than the erosion and sedimentation amounts that could occur when stream crossings fail and divert in large storm events.

Table 3-2 also assess the risk of erosion and sedimentation volumes that could occur on roads that would be kept and maintained on the transportation system, given the likelihood of a large landslide producing storm event. When making road improvements, there is also a slight risk of direct sedimentation affects when installing rolling dips to correct for stream diversion potential or when replacing undersized or aging culverts. The amount of direct sedimentation associated with these activities is minimal and negligible and would significantly reduce the risk of road-related sedimentation impacts in the long-term.

Road improvements such as increasing culvert capacity and correcting culvert diversion potential would significantly reduce the risks of storm-driven erosion and sedimentation from needed roads. The reductions in potential sedimentation from eliminating stream crossing diversion potential (either through road decommissioning or road improvements) are enormous and are illustrated in Table 3-3.

Under Alternative 2, in the Blue Creek watershed, proposed road decommissioning would reduce the potential erosion and sedimentation risks from stream crossing during storm events by half. Approximately 2,209 yd^3 would be saved due to stream crossing removal and 22,169 yd^3 would remain associated with needed roads. There would be a direct effect of approximately 66 yd^3 associated with road decommissioning activities.

In the Bluff Creek watershed 68,750 yd^3 would be removed (approximately 40% of the total stream crossing fill volume within Bluff Creek). The majority of the road decommissioning and stream crossing fill removal within the project area (District) would occur within the Bluff Creek watershed. An estimated 2,000 yd^3 of erosion and sedimentation would result from the road decommissioning but this is anticipated to be a short-term impact that would be greatest after the first winter and decline to minimal amounts within three to five years after treatment when vegetation is re-established. There would be a direct effect of approximately 2,000 yd^3 associated with road decommissioning activities.

In the Camp Creek watershed 34,873 yd^3 would be removed (more than 50% of the total stream crossing fill volume within Camp Creek) and 27, 222 yd^3 of stream crossing fill would remain. An estimated 1,046 yd^3 of erosion and sedimentation would result from the road decommissioning as compared to a potential risk of 13,000 yd^3 should these stream crossings fail in a large storm event.

In the Lower Middle Klamath watersheds 35, 868 yd^3 would be removed through stream crossing restoration (approximately 13% of the total fill volume) and 240, 411 yd^3 would remain. Due to proximity of private land holdings, the risk of wildfire, and fuel treatment opportunities, the majority of the roads within this watershed were considered essential to keep on the transportation system. Roads within this watershed area have the largest potential future risk of culvert failure and sedimentation within the District. Opportunities to upgrade roads to reduce the risk associated with storm-driven road failures would be prioritized within this watershed. There would be a direct effect of approximately 1,080 yd^3 associated with road decommissioning activities.

In the Red Cap watershed 3,420 yd^3 would be removed through stream crossing restoration (approximately 1% of the total fill volume) and 259,500 yd^3 would remain. An estimated 103 yd^3 of erosion and sedimentation would result from the road decommissioning. The majority of stream crossing fill volume are associated with level 3 roads that are critical for access as well as alternative emergency access routes out of Orleans when Highway 96 closes periodically due to storm events.

3.1.5 Alternative 3

Direct and Indirect Effects

For the Blue, Camp and Red Cap Creek watersheds, there are no differences between alternatives 2 and 3 relative to stream crossing fill volume removed and potential erosion and sedimentation. The potential impacts to water quality are the same.

In the Bluff Creek watershed, there are an additional three miles of road decommissioning (12N13D, portion of 12N13H, 12N13H.2, 12N31A) with slight increases in stream crossing fill volume removed (approximately 1000 yd^3). In the Lower Middle Klamath watershed area, approximately 11,000 yd^3 of stream crossing fill would remain as part of the transportation system as compared to Alternative 2. This stream crossing fill is associated with five stream crossings that would remain on the transportation system due to a need for road access for future fuels reductions projects and opportunities (roads 11N18, 11N26A, and 13N14.1) around the Orleans community.

3.1.6 Cumulative Watershed Effects

A cumulative impact results from the incremental effect of an action when combined with other past, present and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. The key steps in a cumulative effects analysis are to identify the beneficial uses of concern, determine the cause-effect relationships of the proposed action on the beneficial uses, and determine the magnitude and significance of the environmental consequences resulting from the proposed action in relation to other past, present and future actions. The significance of effects should be determined based on context and intensity. Factors that would be used to define context and intensity of effects include their magnitude, geographic extent, duration and frequency.

The beneficial uses of concern within the project area are anadromous and resident fish (see Fisheries Section) as well as domestic water sources for the Orleans Community (Crawford Creek) and surrounding local rural residents (tributaries such as Pearch, Cavanaugh, Jo Marine, Aikens, Allen, Slate, Crawford, Cheenitch, Wilson, Rosaleno, Saint Rest’s, Mud, and Donahue Flat Creeks as well as Chimmekanee, Owl, Whiteys and Sawhill Gulches). Within the project area, all main spawning tributaries as well and the tributaries mentioned above fall into one of five 6^{th} field Hydrologic Unit Codes (HUC) assessed in the preceding sections.

The cumulative watershed affects assessment includes all roads within the affected watersheds, with the exception of state, county roads and private roads, which are limited in extent and mostly located along the river corridor of the Klamath River. All reasonably foreseeable future actions were included in the analysis, which includes proposed road decommissioning in Blue Creek on the Smith River National Recreation Area as well as a possible addition of six miles of temporary road associated with the Orleans Community Fuels Reduction (OCFR) project presently under development. Silvicultural and fuels treatments associated with the OCFR project would have minimal short term water quality impacts at the site level, but have a long term reduction in water quality risks.

All watersheds within the project area have experienced in varying degrees, extensive land-use management such as timber harvesting and road building, and are recovering from past and recent storm events. The affected watersheds are considered properly functioning or functioning at risk as defined by the *USDA FS Region 5 Watershed Condition Assessment* (USDA 2000). Although the Klamath River is listed as sediment, nutrient, and temperature impaired under the section 303(d) of the Clean Water Act, none of these tributary watersheds to the Klamath are considered impaired.

Nevertheless, the quality of anadromous habitat and surrounding riparian areas have the potential to be adversely impacted from roads as a result of episodic large flood producing storms. Many of the roads within the project area are in poor condition with actively eroding surfaces and culverts poised for failure in the next moderate storm (10 to 15 year flood storm). A comparison of cumulative watershed effects can be accomplished through assessing the differences in road and culvert densities by alternative and are displayed below in Table 3-4.

Table 3-4. Cumulative watershed effects associated with roads and stream crossings by alternative.

Watershed (6^{th} field HUC)	Watershed Area (sq mi)	Road Miles	Road Density (mi/sq mi)	Number Stream Crossing Culverts	Road Stream Crossing Density (#/sq mi)	CWE Risk Rating**
Alternative 1 (No Action) - Past and Current Road and Stream Crossing Densities						
Blue	125	187.8*	1.50	50	0.40	low
Bluff	74	219.8	2.9	509	6.9	moderate
Camp	43	98.4	2.3	94	2.2	moderate
Lower Middle Klamath	94	184.5	1.9	156	1.7	low
Red Cap	66	130.6	1.9	145	2.2	low
Alternative 2 (Proposed Action)						
Blue	125	168.8*	1.35	41	.33	low
Bluff	74	130.9	1.8	243	3.3	low
Camp	43	52.0	1.2	23	.53	low
Lower Middle Klamath	94	148.7	1.6	114	1.2	low
Red Cap	66	114.3	1.7	139	2.1	low
Alternative 3						
Blue	125	168.8*	1.35	41	.33	low
Bluff	74	127.9	1.7	231	3.1	low
Camp	43	52.0	1.2	23	.53	low
Lower Middle Klamath	94	152.1	1.6	120	1.3	low
Red Cap	66	114.3	1.7	139	2.1	low

*includes roads for the entire watershed (Orleans RD and Smith River NRA)
** road density ratings: >4 mi/sq mi is high watershed disturbance; 2 to 4 mi/sq mi is moderate watershed disturbance; <2 mi/sq mi is low watershed disturbance

Road and culvert densities can be used as indicators of watershed disturbance and help describe past and current watershed conditions and cumulative effects. Limitations associated with using road density include the lack of geographic context. For example, road density does not capture whether or not the bulk of the roads are located on mid to upper hillslopes versus valley bottoms. Roads located in the valley bottoms or mid slopes are generally much more disruptive to watershed processes than ridge top roads. However, road density is a commonly used indicator that is easy to replicate, and can give a generalized overview of the extent of watershed disturbances associated with road building. Road densities greater than five mi/sq mi are considered indicative of very high watershed disturbance levels where cumulative watershed impacts might be a concern. Road densities lower than two mi/sq mile are generally considered indicators of low watershed disturbance.

Similarly, stream-crossing density is a useful indicator describing the extent of hydrologic connectivity of roads within a watershed. Although this indicator is not as commonly used as road density, it is another indicator to describe extent of watershed disturbance. Bluff Creek has triple the stream crossing density of the surrounding watersheds. Reducing the extent of hydrologic connectivity (stream crossing density) in Bluff Creek would significantly reduce the risk of potential cumulative watershed effects associated with storm-driven road failures.

Based on the information displayed in the above table, it is evident that cumulative watershed effects have occurred in the past. However, these past disturbances have not resulted in adverse cumulative watershed effects with the exception of Bluff Creek and to a lesser extent Red Cap and Camp Creek. These watersheds were severely impacted by the 1964 flood and have yet to fully recover relative to sedimentation. These watersheds are considered functioning at risk. Alternatives 2 and 3 would not result in adverse cumulative watershed effects but would instead result in improvements to watershed condition. Alternatives 2 and 3 would result in a lessening of cumulative watershed effects for all watersheds through implementation of road decommissioning and road water quality improvements for remaining roads. There would be minimal short-term impacts (duration, magnitude, and extent) associated with road restoration actions, but these would not result in adverse cumulative watershed effects but rather reduce the potential for long-term adverse cumulative effects. Alternative 1 has the potential of resulting in adverse cumulative watershed effects should a large flood-producing storm result in significant road failures.

3.2 Fisheries

3.2.1 Affected Area and Existing Condition

There are over 20 miles of the Klamath River mainstem extending from near the mouth of Hopkins Creek to approximately the mouth of the Salmon River, within the analysis area of this project. This section of the Klamath River provides spawning and rearing areas for many fish species, including salmon and steelhead, and is the migration corridor for all salmon and steelhead stocks to the upper Klamath Basin. Tributaries to the Klamath River (Blue, Bluff, Slate, Camp, Hopkins, Pearch, Aikens, Red Cap, and Boise creeks) in the analysis area provide the main spawning and rearing habitat for anadromous salmonids. The remaining Klamath watersheds within the project area support resident fish and are important for cool water refugia from the Klamath River during summer months (e.g. Whitmore, Cheenitch, Ullathrone, Crawford, Wilson, Rosalena and Mud Creeks), with use by anadromous salmonids mostly within the lower reach of these drainages.

The information below is summarized from the *Biological Assessment and Biological Evaluation For Threatened, Endangered, Proposed, and Sensitive Fish Species that may be affected by the Orleans Transportation and Road Restoration Project, 2007* (Fish BA) which can be found in the project file.

Threatened, Endangered, and Proposed fish species were identified from the National Marine Fisheries Service (NMFS) List of June 6, 2006, and the Six Rivers National Forest (SRNF) Administrative Unit List provided by the Arcata Fish and Wildlife Office of the U.S. Fish and Wildlife Service (USFWS) dated July 11, 2006. Sensitive fish species were identified from the

USDA Forest Service – Pacific Southwest Region Sensitive Animal Species List dated March 6, 2001.

The Southern Oregon/Northern California Coasts (SONCC) coho salmon (*Oncorhynchus kisutch*) is the only Pacific salmonids listed under the Endangered Species Act (ESA) within the project boundary. Spring Chinook salmon (*O. tshawytscha*) and steelhead trout (*O. mykiss*) are Forest Service sensitive species and may have habitat within the project area or be affected by activities occurring with the project area.

Designated Critical Habitat (CH) for coho salmon encompasses accessible reaches of all rivers (including estuarine areas and tributaries) between the Mattole River in California and the Elk River in Oregon, inclusive (May 5, 1999, 64 FR 24049) and includes accessible reaches found on the Orleans Ranger District of the SRNF. The Proposed Action is within watersheds containing designated CH for SONCC coho salmon.

The existing road network has very little overlap with anadromous habitat with only a total of 2.11 miles (18 separate road segments) with 300 feet of coho habitat with little over one mile comprised of ten separate access roads to the Klamath River. Table 3-5 lists the road segments that are within 300 feet of coho habitat, including those that access the mainstem Klamath River. Within this 300 foot zone only one culvert exists (see Table 3-5). Table 3-6 displays the stream crossings on road segments within ¼ mile of coho habitat

Table 3-5. Forest Service road segments that lie within 300' of coho habitat.

Watershed	Route Number	Road Surface	OML	Description	Proposed Action	Miles w/in 300'
Bluff Creek	*10N06	AGG	3	Bluff Creek-Wright's Ranch River Access	Keep and Maintain	0.04
Mid Klamath Tributaries	10N06.5	NAT	4	Non-system road	Decommission	0.05
	*10N20	AGG/NAT	2	Ullathorne River Access	Upgrade	0.01
	*10N28	NAT	2	Orleans River Access	Upgrade	0.11
	10N74	BIT	3	Mouth of Bluff Creek overlook	Keep and Maintain	0.01
	10N75	AC	3	Aikens Campground-Closed	Decommission	0.02
	*10N76	AGG	3	Aikens Dispersed Rec. Sites and River Access	Keep and Maintain	0.10
	11N05	AC	4	Slate Creek Road	Keep and Maintain	0.24
	11N32	AGG/NAT	1	Ishi Road Access	Keep and Maintain	0.07
	*11N54	NAT	2	Ishi Pishi/Salmon River Access	Keep and Maintain	0.20
	*11N56	NAT	2	Dolans River Access	Keep and Maintain	0.30
	*11N61	NAT	4	Bondo Mine River Access	Keep and Maintain	0.03
	*11N71	NAT	2	Whitmore River Access	Road to Trail	0.05
	*11N72	AGG/NAT	2	Ikes River Access	Upgrade	0.15
	*11N76	NAT	2	Big Bar River Access	Keep and Maintain	0.03

Watershed	Route Number	Road Surface	OML	Description	Proposed Action	Miles w/in 300’
Camp Creek	12N01	AGG	3	Camp Creek	Keep and Maintain	0.60
	In this section of 12N01, the road crosses an intermittent stream (non-fish bearing). A culvert is in place at this location with approximately 29 cyds of fill. The culvert is functioning and will be maintained.					
	12N01	AGG	3	Camp Creek	Keep and Maintain	0.02
	12N01	AGG	3	Camp Creek	Keep and Maintain	0.10
					Total Miles	**2.11**

* River Access

A total of 10 Klamath River access locations are found along the lower-mid Klamath River within the project area (Table 3-5). These spur roads are maintained at operational maintenance level 2 or higher and provide recreation accessibility for swimming, white water kayaking, rafting and fishing. Maintenance along these roads consists of blading native rocks to reshape the roadbed to a condition that facilitates boat and trailer traffic and provides proper drainage. There are no stream crossings with culverts along these roads. This work typically occurs every three years or when conditions warrant, and is generally accomplished by a dozer or back hoe.

A total of 11 stream crossings (totaling 1,963 cubic yards of fill) are found on road segments within a ¼ mile of coho habitat (Table 3-6). These streams are all non-fish bearing and are typically small high gradient streams. Each of these roads are maintained as level 3 or above, and surfaced with aggregate base or asphalt. Most of these roads are main arterial routes that cross or run parallel to mid-Klamath tributaries. Typical road maintenance along these roads includes brushing, slide removal and ditch and culvert clean-out.

Table 3-6. Stream crossings found within ¼ mile of coho habitat along Forest Service Roads.

Road and mile marker of culvert	Stream Type	Fill Volume	Watershed
10N02-6.95	intermittent	618.0	RedCap
10N02-7.14	perennial	62.0	RedCap
10N02-7.91	perennial	124.0	RedCap
10N05-0.21	intermittent	37.0	RedCap
10N05-0.28	intermittent	144.0	RedCap
10N06-3.11	intermittent	35.0	Bluff
11N05-0.30	intermittent	234.0	Slate
11N05-0.38	intermittent	240.0	Slate
11N05-0.49	intermittent	67.0	Slate
11N05-0.51	intermittent	154.0	Slate
12N01-1.00	perennial	248.0	Camp
Total Fill Volume		**1,963 yds**	

Even without the direct overlap of roads on fish habitat, roads are still the leading source of management-related sediment inputs, predominantly associated with mass wasting features such as shallow debris slides and debris torrents. The majority of road-related erosion and sediment delivery are associated with large storm events that trigger culvert failures, stream diversions, and mass wasting such as debris slides and smaller slumps within the roadbed. Roads are a potential liability to water quality and fish habitat, particularly during large storm events when culverts fail and landslides are initiated. Chronic lack of road maintenance can also trigger water quality impacts in the absence of large storm events.

Port-Orford cedar stands provide high ecological diversity and are a critical component to aquatic ecosystem function and stability. These trees provide long term stability to stream banks when growing and are important to pool formation, instream cover and sediment storage when located within the channel

3.2.2 Alternative 1 (No Action)

Direct, Indirect and Cumulative Effects

Under the No Action alternative and the assumptions made under the Water Quality section, direct and indirect impacts could occur to the level that anadromous fish are affected by current road-related erosion and sediment delivery that would be associated with future large storm events. Assuming 50% of the stream channels with diversion potential actually divert in a large storm event, the results indicate that the potential future risk of erosion and sedimentation varies between 300,000 yd^3 to 30,000,000 yd^3. This is a significant risk that could potentially adversely impact water quality and downstream habitat quality for spawning and rearing salmonids.

Bluff Creek has one of the highest miles of anadromous habitat and by far, the highest potential future risk of erosion and sedimentation of salmon and steelhead habitat. The Lower Middle Klamath, Red Cap Creek and Camp Creek follow with varying miles of anadromous habitat and similar potential risk of erosion and sedimentation. The roads within Blue Creek are high up in the watershed and have the lowest future risk of erosion.

No impacts to these watersheds would occur due to management activities such as decommissioning or upgrading, therefore, no short-term management related sediment would impact the anadromous fish.

While annual seasonal closures would continue to occur, actions would not be taken to permanently prevent the spread of POC root disease by decommissioning roads accessing Port-Orford cedar stands, thereby increasing the rate of mortality of this important riparian species. In the short-term, diseased trees would be added to the instream woody debris component; however, replacement riparian species would not provide the same level of structure in the long term.

3.2.3 Alternative 2 (Proposed Action)

Direct, Indirect and Cumulative Effects

The effects of decommissioning and road upgrading/maintenance activities on habitat indicators can be described as maintaining, degrading or restoring habitat indicators at the site level and downstream. Impacts may occur at the project site yet would not be at a level to impact anadromous fish, including Endangered Species Act coho salmon, or their habitats. Storm-proofing and upgrading roads, road maintenance and decommissioning activities that occur within riparian areas or at stream crossings, but not within anadromous habitat occupied by Pacific salmonids would not directly affect Pacific salmonids. The project area has very little overlap of the road network on anadromous habitat; therefore, there is a low likelihood of direct effects occurring to coho, Chinook or steelhead individuals. Maintaining and improving fisheries habitat within lower mid-Klamath tributaries would be accomplished through minimizing potential future risk of sedimentation from roads by maintaining/upgrading remaining roads and decommissioning 203 miles of roads. Efforts to improve habitat conditions for coho salmon may take several years to decades to be realized, however it is clear from looking at the condition of most of the project watersheds for road location and substrate, this project is likely to result in an improvement to watershed condition as roads are decommissioned and upgraded. Although downstream aquatic habitat may experience insignificant amounts of sedimentation for short durations during road maintenance and watershed restoration activities, it is still likely to result in a net reduction of sediment delivered to streams and in the risk of mass-wasting, including the first year after the activity. However, sedimentation, dewatering, chemical contamination, and riparian vegetation alteration resulting from these activities would be localized, short-term in duration and of low intensity. In general, effects resulting from these activities would be insignificant as these actions are of low intensity and all proposed project activities would be implemented in conformance with applicable design features. In the long-term, maintaining/upgrading and decommissioning activities would reduce the risk of salmonid habitat degradation that can result from accelerated sediment delivery to streams.

There is a long-term cumulative benefit to implementing many of the project activities, as the annual and decadal delivery of sediment to streams, as well as runoff risk, is reduced. The retention of Port-Orford cedar within the riparian zone would ensure a long-term supply of important woody debris input. Overall, some of the actions have no cumulative effect on Pacific salmonid habitat (such as activities outside Riparian Reserves) and many of the project activities have beneficial effects at the site, 5th field watershed and Forest scales. Therefore the project activities do not reduce and are expected to improve the quality of stream habitat, and therefore, increase the probability of Pacific salmonids' viability.

3.2.4 Alternative 3

Direct, Indirect and Cumulative Effects

For the Blue, Camp and Red Cap Creek watersheds, there are no differences between Alternatives 2 and 3 relative to stream crossing fill volume removed and potential erosion and sedimentation. The potential impacts to anadromous fish are the same. The minor changes within Bluff Creek and Lower Middle Klamath watersheds would result in little to no difference in impacts to anadromous fish. In the Bluff Creek watershed, the additional three miles of road decommissioning and slight increases in stream crossing fill volume removed would result in little to no differences in impacts to anadromous fish. In the Lower Middle Klamath watershed area, approximately 11,000 yd^3 of stream crossing fill would remain as part of the transportation system as compared to Alternative 2. This stream crossing fill is associated with five stream crossings that would remain on the transportation system due to a need for road access for future fuels reductions projects and opportunities around the Orleans community.

3.3 Recreation and Public Access

3.3.1 Affected Area and Existing Condition

Current recreational uses within the project area include fishing, boating, camping, hiking and hunting. Dispersed camping occurs throughout the project area and is particularly concentrated near the river corridor. There are currently twenty dispersed camping areas, seven vehicle river access sites (boat launches) and five river access trails identified within the project area.

In order to effectively assess potential effects to recreation and public access from roads that are proposed to be decommissioned or kept and maintained, environmental indicators have been identified that would facilitate a comparison of alternatives and the effects of those alternatives. Environmental indicators that would facilitate comparison of effects are:

- Miles of drivable road open to public use.
- Number of dispersed campsites open to public use (via full-sized vehicle).
- Miles of existing motorized trail within the project area open to the motorized user.

There are only minor differences between the alternatives relative to recreation and public access.

3.3.2 Alternative 1 (No Action)

Under this alternative there would be no change with regards to public access for recreational sites or use of public roads. Public access is limited to operation maintenance level roads 2, 3, 4 and 5. Under this alternative, the public has access to 465 miles of level 2 through level 5 roads. Access on many level 2 and 3 roads however, is becoming more difficult due to vegetation encroachment and rock and debris slides, which precludes easy motorized access. Motorized trail use on the Lubbs trail would remain open (3.1 miles). Under the No Action, all non-system roads, including access to dispersed recreation sites (i.e. hunters' camps) would not be authorized under the new Roads Rule.

3.3.3 Alternative 2 (Proposed Action)

Under this alternative, access to the current twenty dispersed camping areas, seven vehicle river access sites (boat launches) and five river access trails would remain the same as in Alternative 1. None of these sites or access would be affected by project implementation. Motorized trail use on the Lubbs trail would remain open (3.1 miles) and would be designated by class to motor vehicles less than or equal to 50 inches (e.g. ATV, motorcycle). In addition, the 0.5 miles of existing non-system roads that access dispersed camping would be designated for motorized use and added to the transportation system. The main difference between alternatives is associated with a reduction in public access on Forest Service roads that varies between watersheds (see Table 3-5). Access on many level 2 and 3 roads however, is becoming more difficult due to vegetation encroachment and rock and debris slides, which precludes easy motorized access.

Table 3-7. Recreation and public access roads open to public use by alternative (in miles)

Watershed	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3
Blue Creek	26.4	12.2	12.2
Bluff Creek	145.0	108.0	104.6
Camp Creek	71	38.5	34.6
Lower Middle Klamath	130.8	115.0	116.4
Red Cap Creek	91.5	89.5	89.5
District Total	**464.7**	**363.2**	**357.3**

Under this alternative, 363 miles of road would remain open to public access. Approximately 78% of the roads accessible under Alternative 1 would remain open for public access under this alternative. The majority of the reduced public access occurs in the Bluff Creek watershed and are associated with reducing level 2 roads and roads that pose a risk in the spread of the POC root disease.

3.3.4 Alternative 3

Under this alternative, the affects to recreation and public access are the similar to Alternative 1 and 2. The exception is that there are 357 miles of road open to public access. Approximately 77% of the roads accessible under Alternative 1 would remain open for public access under this alternative.

3.4 Wildlife

3.4.1 Affected Area and Existing Condition

The affected, or analysis area is defined as all areas where federally listed wildlife species (northern spotted owls, marbled murrelets, including their critical habitat, and bald eagles) as well as Forest Service sensitive wildlife species may be affected directly or indirectly by project implementation, as defined under 50 CFR 402.02. The analysis area may therefore differ for different species.

Designated Critical Habitat for marbled murrelets encompasses the Late Successional Reserves (LSR) within Zone 1 and Zone 2. Critical Habitat designated for the spotted owl occurs in a large block to the north in the Blue Creek watershed, another large block in the Bluff Creek, Slate Creek and Camp Creek watersheds, and a smaller block to the south in headwaters of the Red Cap Creek watershed. Critical Habitat has not been defined for the bald eagle. The following is summarized from the *Biological Assessment and Biological Evaluation for Threatened, Endangered, Proposed, and Sensitive Wildlife Species that may be affected by the Orleans Transportation and Road Restoration Project, December 2006* (Wildlife BA/BE) located in the project file.

In addition to analyzing impacts to threatened, endangered and Forest Service sensitive species, the Forest Service is directed under the National Forest Management Act (NFMA), to “provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives.” (P.L. 94-588, Sec 6 (g) (3) (B)). The 1982 regulations implementing NFMA require that "Fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area." (36 CFR 219.19) Management Indicator Species (MIS) is a concept used by the agency to serve as a barometer for species viability at the Forest level. Population changes of MIS are believed to indicate the effects of management activities.

The Forest Land Management and Resource Plan for the Six Rivers National Forest uses MIS to assess potential effects of project activities on the various habitats and habitat assemblages with which these species are associated. Forty-one fish and wildlife species have been selected as MIS or assemblages for a variety of habitats that are potentially affected by resource management activities on the Forest (LRMP IV-97). Some of the species considered as MIS species are in the Wildlife BA and are addressed below. For the analysis associated with this project, specific MIS were addressed based on the potential of their habitat to occur within the Orleans Transportation and Road Restoration Project area (see Appendix H, *Management Indicator Report*).

Late-successional (old-growth) coniferous forest habitats and other pole, early and mid-mature stands and plantations occur interspersed with and surrounding roads proposed for treatment. Creeks, streams, and ditches with flowing or intermittent water occur alongside some of the roads proposed for treatment, or are channeled under them through bridges, culverts and cross-drains. Vegetation in these areas is typically riparian, and the vegetation growing in the ditches and fill-slope areas that could be disrupted by the proposed actions is generally dense and brushy, and no older that when the roads were originally established in the 1960s.

The project area occurs in areas of Matrix or General Forest, Riparian Reserves and in Late Successional Reserves (LSRs) including 100 acre LSRs. Numerous roads with low administrative need exist within LSRs. In Late Successional Reserves, the management direction is to reduce the density of open roads having a low administrative need in order to lessen the impact to wildlife. Public comments indicated a desire to decommission roads with low administrative needs within LSRs.

The environmental indicators that will facilitate comparison of effects are:

- The number of acres of unsurveyed or occupied suitable marbled murrelet and northern spotted owl nesting habitat potentially affected by the noise and visual disturbance of road decommissioning with heavy equipment during the nesting season.
- The average open road density per section within LSRs, as measured in miles per square mile.

The effects of the proposed action would be assessed for each species listed below, based on the extent of those effects on each given species. So for example, the effects of noise on a species known or suspected to be sensitive to auditory disturbance may extend out up to ¼ mile (or up to 1/2 line-of-sight in the case of bald eagles), from a given road segment proposed for treatment. This area would be described as the "analysis area".

The following federally listed or Forest Service sensitive species are known to, or may, occur in the analysis area, according to historic records, range maps, suitable habitat, current sightings, or formal surveys. The following information is supplied to support the determinations of effects. This is based upon the best available information at this time and the level of likelihood of species occupying territories or habitat where they could be affected by the project. See the *Six Rivers National Forest Species Reference Document* (USDA Forest Service, Six Rivers National Forest, 2006) for species life history information.

The species considered in this document are:

Endangered:

- No wildlife species

Threatened:

- Northern spotted owl (*Strix occidentalis caurina*)
- Bald eagle (*Haliaeetus leucocephalus)*
- Marbled murrelet (*Brachyramphus marmoratus*)

Forest Service Sensitive:

- Southern torrent salamander (*Rhyacotriton variegatus*)
- Foothill yellow-legged frog (*Rana boylii*)
- *Northwestern pond turtle (*Clemmys marmorata marmorata*)
- Northern goshawk (*Accipiter gentilis*)
- Peregrine falcon (*Falco peregrinus*)
- California wolverine (*Gulo gulo luteus*)
- Pacific fisher (*Martes pennanti*)
- American marten (*Martes americana*)
- *Northern red-legged frog (*Rana aurora aurora*)
- *Townsend's big-eared bat (*Corynorhius townsendii*)

Critical Habitat:

- Northern spotted owl, designated January 15, 1992
- Marbled murrelet, designated May 24, 1996

Species (*) Eliminated from Further Analysis due to Lack of Habitat

The project area lies outside the known or expected ranges and/or habitat types of the northern red legged frogs, western pond turtle and Townsend's big-eared bats. Consequently, these species would not be discussed further except in the determinations section.

Management Indicator Species

The Orleans Transportation and Road Restoration Project (OTRRP) will not adversely impact MIS or affect MIS viability. The sizing of culverts may require the removal of moss, grasses, shrubs, and in rare cases sapling trees under eight inches dbh, over areas less than 100 square feet per worksite. Potential impacts to MIS would be minimized through the adherence of LRMP Standards and Guidelines for snags/down woody debris, limited ground disturbance, re-vegetation of disturbed areas, and maintenance of existing live over-story canopy closure (Appendix H).

3.4.2 Alternative 1 (No Action)

There would be no effects to MIS, federally threatened or Forest Service sensitive wildlife species beyond what is already occurring, as a result of implementation of this alternative.

The current average open road density per square mile section within Late Succession densities is 2.38 miles per square mile. This would not change as a result of implementation of this alternative.

The selection of this alternative would not require any Limited Operating Periods to minimize disturbance to any federally threatened wildlife as a result of implementation.

3.4.3 Alternative 2 (Proposed Action)

Analysis for wildlife species are organized below by individual species, including important baseline information. Habitat information is followed by the direct, indirect and cumulative effects of the Proposed Action on the species. This information summarized from the Wildlife BA.

The average open road densities within LSRs under this alternative would be 1.42 miles per square mile.

The maximum number of acres of potential noise and visual disturbance from road decommissioning in proximity to unsurveyed or occupied northern spotted owl nesting habitat during the nesting season under Alternative 2 would be 3,618 acres, as measured using Geographical Information Systems (GIS) analysis.

The maximum number of acres of potential noise and visual disturbance from road decommissioning in proximity to unsurveyed or occupied marbled murrelet nesting habitat during the nesting season under Alternative 2 would be 5,447 acres.

3.4.3.1 *Federally Threatened, Endangered, or Proposed Species*

1. Northern Spotted Owl (*Strix occidentalis caurina*)

A. Habitat Status and Species Information

Under present management direction identified in the Northwest Forest Plan, Six Rivers National Forest Land and Resources Management Plan, there is an 80% or greater likelihood of providing sufficient habitat for a well-distributed population of northern spotted owls on Federal lands over the next 100 years (USDA et al., 1993). This would be met by the application of a network of Late-Successional Reserves (including 100 acre LSRs), and standard and guidelines in matrix lands.

The LSR Network Assessment was conducted to evaluate the current ability of the Northwest Forest Plan's (NFP) system of Late-Successional Reserves (LSR) to conserve and recover populations of northern spotted owls (NSOs) within the Klamath Province. The analysis focused largely on modeling the abundance and distribution of owl habitat within the LSRs (Zabel et al., 2003). This project is located within the Lower Middle Klamath Watershed in an area where the Network Assessment has determined the affected LSRs (RC-304 and RC-305) are providing sufficiently for NSOs, and hence concerns for owls are reduced on the surrounding matrix lands.

The northern spotted owl is associated with mature and older mixed conifer, Douglas-fir forests of the Pacific Northwest. The species was listed as Threatened in July 1990 due to the loss of older forests throughout the Pacific Northwest as a result of timber harvest (Thomas et al, 1990). Critical Habitat has been designated for the northern spotted owl, and occurs in three areas on the Orleans District, in the Blue Creek (CA-20), Bluff/Slate/Camp Creek (CA-24), and Red Cap Creek (CA-30) watersheds.

Locally, spotted owls typically nest in dense, multi-layered late-seral conifer stands showing signs of decadence. Often the stands selected by spotted owls are on the lower third of slopes near flowing water where there are notable accumulations of large down logs, and deformed trees showing evidence of decadence in the stand, providing both prey habitat and nesting structure respectively.

Suitable NSO habitat in the analysis area was identified (based on the definition in the Six Rivers National Forest Species Reference Document) using the SRNF owl habitat layers in GIS. A representative sample of fill slopes were examined and found to be too densely vegetated with vegetation too small to be suitable NSO habitat, even for spotted owl dispersal.

Most of the roads proposed for treatment are within 500 feet of suitable nesting/roosting habitat, which is interspersed with younger or more open stands (see map in Appendix A, Wildlife BA).

The existing or ambient pre-project sound levels are generally affected by the amount of human traffic and activities occurring. These may include larger commercial vehicles, fire-fighting engines, commercial and personal-use firewood gathering, hunting, and other recreational uses. The level of use roughly corresponds to the maintenance level of the road. It is estimated that the existing (ambient) pre-project sound levels within the analysis area(s) may vary from "Natural Ambient" to "Moderate" as described in *Estimating the Effects of Auditory and Visual Disturbance of Northern Spotted Owls and Marbled Murrelets in Northwestern California*, July 26, 2006.

No suitable habitat within the project or analysis area has had recent or still-valid surveys for spotted owls. This species is also a management indicator species (see Appendix H).

B. Direct and Indirect Effects

Water Quality Improvements:

The direct effects of the list of proposed actions, which include stormproofing measures and other upgrades, as well as designating roads to lowered maintenance levels or to motorized trails, would be minimal, because none of these actions would affect any suitable habitat. No vegetation would be removed from suitable nest nesting, roosting, foraging or dispersal habitat.

There is the potential that implementation of some of these activities could result in "high" levels of noise disturbance or visual harassment of breeding northern spotted owls during the year of implementation. However, this potential would be minimized through the use of limited operating periods, as described in the Project Design Features at Section 2.2.4.

There is some potential for indirect effects from possible minor increases in vehicular traffic on roads that have been upgraded to a higher maintenance level or established as a motorized trail. These effects are estimated to be transitory and essentially un-measurable.

Road Decommissioning:

While road decommissioning would not affect any suitable habitat, it has the potential to result in year-of-implementation auditory or visual disturbance to breeding northern spotted owls because; some roads proposed for decommissioning may occur in close proximity (within 500 feet) to unsurveyed suitable nesting habitat; because the work is estimated to result in auditory sound levels of "high"; and the work may take place during the breeding season. It is estimated that up to 3,618 acres, (up to 3,540 acres under Alternative 3) of unsurveyed or occupied suitable nesting habitat could be subjected to noise and visual disturbance during the nesting season.

Road decommissioning and closing of roads (reduction in open road density) would result in long-term indirect beneficial effects to spotted owls through the reduction of vehicular traffic and its associated auditory and visual impacts.

Critical Habitat:

There would be no effects to spotted owl Critical Habitat because none of the primary constituent elements of spotted owl Critical Habitat would be altered by any of the proposed actions.

C. Cumulative Effects

Cumulative effects are those effects on the environment that result in incremental effects of the proposed action when added to the effects of other past, present, or reasonably foreseeable future actions.

The effects of this project would be cumulative with the effects of routine road maintenance ongoing within the affected watersheds. Generally these effects have been minimized to the point that they may affect, but are not likely to adversely affect spotted owls through the use of Limited Operating Periods.

The effects of this project may also be cumulative with the effects of the Orleans Community Fuels Reduction (OCFR) project, which is currently in the planning stages within some of the same watersheds around the town of Orleans. The effects of the OCFR are not known at this time, but are expected not to be likely to adversely affect northern spotted owls.

The effects of past road restoration and decommissioning within the project area are not likely to be cumulative, because they have not occurred within the last 5 years.

The effects from the project may also be cumulative with effects of the Wilder Fire Salvage and Rehabilitation Project (WFSRP). This project salvaged 2.2 acres of fire killed trees (T10N, R5E, Sec. 1), and has authorized the treatment of fire-created fuels on 33 acres and trail restoration along a ridge-top trail. Due to the use of limited operating periods and because the salvage trees were not potential nest trees, the WFSRP has been determined not likely to adversely affect northern spotted owls.

There are ongoing private timber harvests on the Downs Ranch (T11N R5E Sec. 25 and 36, T11 N R6 E Sec. 30), at the Owl Mine (T10N R5E Sec. 2) and on industrial timber lands at T10N R4E Sec. 35 and 35. None of these activities are within ¼ mile of any roads proposed for any project treatments.

There are other private lands in close proximity to roads proposed for decommissioning in T11N R6E Sections 5, 8, 17, and 18, and T10N R6E Sections 19 and 30, and along the western District boundary in Townships 10 and 11 North. It is reasonable to expect some form of future timber harvest, other potential habitat loss or noise disturbance from these lands which might be cumulative with the proposed action.

There are no other known recent or reasonably likely to occur projects that might have effects to northern spotted owls that would be cumulative with the effects of the project.

Because there is potential noise disturbance from road decommissioning using heavy equipment conducted in proximity to unsurveyed suitable nesting habitat where northern spotted owls could be nesting undetected, this project may affect and is likely to adversely affect northern spotted owls.

2. Bald Eagle (*Haliaeetus leucocephalus*)

A. Habitat Status and Species Information

Bald eagles nest, roost, and perch in large trees or snags, generally in areas where they can see a large body of water such as the Klamath River (Lehman, 1979). They typically forage along the Klamath River as well as its major tributaries, often from perches in large trees or snags along the shores.

There is only one known active nest (Waakar) on Chimmekanee Ridge that is within half a mile of any proposed action (including decommissioning road 10N13.1 and 10N13.3) or where the proposed actions are within a bald eagle nest protection zone (Appendix A, Wildlife BA). This pair has been monitored annually and has successfully fledged young in four of the last five years.

Because this pair of bald eagles has chosen to nest near the town of Orleans, and directly above a main county road (Red Cap Road), and agricultural lands, they have become acclimated or habituated to the sights and sounds of heavy vehicular traffic and the typical activities going on in and around the town.

B. Direct and Indirect Effects

The project could potentially have a direct effect the Waakar pair of bald eagles through auditory or visual disturbance, but not through the loss of any habitat elements. However, project design features (Section 2.2.4) have been established that would minimize the potential for adverse effects by limiting the period of operations along the 10N13 road system from January 1 to August 1 (the period of non-operation), unless surveys during season of implementation determine that nesting is not occurring or that young have fledged, after which these seasonal restrictions can be lifted. The project design features for bald eagles would be put into effect for any other bald eagle nest sites that may be found during the 15 year time period of this decision.

While road stormproofing or upgrades may result in some minor increases in vehicular traffic within the Waakar nest protection zone, the indirect effect of decommissioning roads 10N13.1 and 10N13.3 would be a beneficial permanent decrease in any vehicular traffic along these roads.

C. Cumulative Effects

The effects from the project may be cumulative with the effects of the OCFR, which has units proposed for fuels reduction thinning in proximity to the Waakar nest site. The effects of the OCFR are expected to be not likely to adversely affect bald eagles because they would be minimized through the use of appropriate LOPs.

The effects from the project may also be cumulative with effects of the Wilder Fire Salvage and Rehabilitation Project (WFSRP). This project salvaged 2.2 acres of fire killed trees just down slope to the southwest of the Waakar nest, and has authorized the treatment of fire-created fuels on 33 acres around the nest and trail restoration along a ridge-top trail under the nest. Due to the use of limited operating periods and because the salvage trees were not prime perch trees, the WFSRP has been determined not likely to adversely affect bald eagles.

There are ongoing private timber harvests on the Downs Ranch (T11N R5E Sec. 25 and 36, T11 N R6 E Sec. 30), and at the Owl Mine (T10N R5E Sec. 2). None of these activities are within 1/2 mile of any bald eagle nests, but they may be within line-of-sight of the Waakar bald eagle nest.

There are no other known recent or reasonably likely to occur projects that might have effects to bald eagles that would be cumulative with the effects of the project.

Based on these PDFs, and the habituation of the Waakar pair, the proposed actions may affect, but are not likely to adversely affect bald eagles.

3. Marbled Murrelet (*Brachyramphus marmoratus*)

A. Habitat Status and Species Information

Marbled murrelets (MAMU) nest on platforms generally created by large diameter branches in large conifer trees that are close enough to coastal foraging environments for them to adequately supply their young with small marine fish. The project area ranges from approximately 14 miles inland from the coast within Zone 1, to about 35 miles inland, within the Central Study Area of marbled murrelet Zone 2. Portions of the project also occur in MAMU Critical Habitat.

Portions of the project area are within a quarter mile of habitat suitable for marbled murrelet nesting (Appendix A, Wildlife BA)

Protocol surveys for marbled murrelets were conducted in and around four proposed timber sale areas (Jake, Nicker, Stride, and Panther) in Zone 1 of the project area in 1992, which resulted in below-canopy detections (suggesting occupancy) in a thinned, mature, ridge-top stand in Section 18 of T11N, R4E, about 15 miles inland from the coast. Road 11N28, which runs through this stand, is a candidate for decommissioning, but is not a high priority. The 1992 surveys also resulted in a below-canopy detection in upper Notice Creek. A marbled murrelet was also heard flying in this area in 1995. The roads on either side of upper Notice Creek where these detections were made have already been decommissioned. Marbled murrelet surveys were also conducted for the Bluff Creek Road re-route in 1997 and 1998 with no detections.

It is estimated that the existing (ambient) pre-project sound levels within the analysis area may vary from “Natural Ambient” to “Moderate” as described in *Estimating the Effects of Auditory and Visual Disturbance of Northern Spotted Owls and Marbled Murrelets in Northwestern California*, July 26, 2006.

On July 20, 2000, the Six Rivers and Klamath National Forests received a letter, *Technical Assistance on the Final Results of the Status of the Marbled Murrelet in Interior Northwestern California*, from the US Fish and Wildlife Service regarding future consultation within marbled murrelet Zone 2. This letter clarified the implications of negative survey results detailed within the *Status and Distribution of the Marbled Murrelet in Interior Northwestern California: Final Report*, May 18, 2000. Additionally, the FWS letter stated; “…implementation of existing and future projects in this area would not result in harassment of nesting marbled murrelets; therefore, Section 7 consultation relative to disturbance of marbled murrelets would not be necessary”.

While these below-canopy detections infer that these were occupied stands, no nest has been discovered on the Orleans District. The areas mentioned above that have been surveyed to protocol with no detections are considered unoccupied.

B. Direct and Indirect Effects

Water Quality Improvements:

The direct effects of the list of proposed actions described as water quality improvements, which include stormproofing measures and other upgrades, as well as designating roads to lowered maintenance levels or to motorized trails, would be minimal, because none of these actions would affect any suitable habitat.

There is the potential that the implementation of some of these activities could result in “high” noise disturbance or visual harassment of breeding marbled murrelets during the year of implementation. However, this potential would be minimized through the use of limited operating periods, as described in the PDF portions of Section 2.2.4.

There is some potential for indirect effects from possible minor increases in vehicular traffic on roads that have been upgraded to a higher maintenance level or established as a motorized trail. These effects are estimated to be transitory and essentially un-measurable.

Road Decommissioning:

While road decommissioning would not affect any suitable habitat, it has the potential to result in year-of-implementation auditory or visual disturbance to breeding marbled murrelets because; some roads proposed for decommissioning may occur in close proximity to unsurveyed suitable nesting habitat; the work is estimated to result in auditory sound levels of “high”; and the work may take place during the breeding season. This work has the potential to affect up to 5,447 acres of marbled murrelet nesting habitat.

Road decommissioning, which would result in a lowering in open road density, could result in long-term indirect beneficial effects through the reduction of vehicular traffic and its associated auditory impacts.

Critical Habitat:

There would be no effects to marbled murrelet Critical Habitat because none of the primary constituent elements would be altered by any of the proposed actions.

C. Cumulative Effects

Cumulative effects are those effects on the environment that result in incremental effects of the proposed action when added to the effects of other past, present, or reasonably foreseeable future actions.

The effects of the project would be cumulative with the effects of routine road maintenance ongoing within the affected watersheds. Generally these effects have been minimized to the point that they may affect, but are not likely to adversely affect marbled murrelets through the use of Limited Operating Periods.

The effects of the project may also be cumulative with the effects of the Orleans Community Fuels Reduction (OCFR) project which is currently in the planning stages within some of the watersheds affected by the project around the town of Orleans. The effects of the OCFR are not known at this time, but are expected not to be likely to affect marbled murrelets.

The effects of past road restoration and decommissioning within the project area are not likely to be particularly cumulative with the project, because they have not occurred within the last five years.

There are ongoing private timber harvests on the Downs Ranch (T11N R5E Sec. 25 and 36, T11 N R6 E Sec. 30), at the Owl Mine (T10N R5E Sec. 2) and on industrial timberlands at T10N R4E Sec. 35 and 35. None of these activities are within ¼ mile of any roads proposed for any project treatments.

There are other private lands in close proximity to roads proposed for decommissioning in T11N R6E Sections 5, 8, 17, and 18, and along the western District boundary in Townships 10 and 11 North. It is reasonable to expect some form of future timber harvest, other potential habitat loss or noise disturbance from these lands which might be cumulative with the project.

There are no other known recent or reasonably likely to occur projects that might have effects to marbled murrelets that would be cumulative with the effects of the project.

Because there is potential noise and visual disturbance from road restoration conducted in proximity to unsurveyed suitable nesting habitat were marbled murrelets could be nesting undetected, this project may affect and is likely to adversely affect marbled murrelets.

3.4.3.2 *Forest Service Sensitive Species*

1. Southern torrent salamander (*Rhyacotriton variegates*)

A. Habitat Status and Species Information

This species is associated with seeps, small streams, and waterfalls in wet or mesic coastal forested habitats, hence its inclusion in the MIS Bog/Seep/Spring /Wet Meadow Assemblage (Appendix H). Changes to forest canopied and the hydrology of seeps and streams can affect southern torrent salamanders. Although the watercourses flowing under or alongside the roads proposed for treatment are not wet or mesic coastal forests, some do constitute seeps or small streams. It is not known if these areas harbor populations of southern torrent salamanders, because there have never been any specific surveys for them in this analysis area. This is due to the relatively low probability of adverse effects as discussed below.

B. Direct and Indirect Effects

Improvements in water quality around and downstream from the seeps, springs, and creeks, (which may result in short term impacts to salamander habitats), as well as possible direct mortality from heavy equipment during implementation of the project, may impact southern torrent salamanders that may be living in or around these habitats occurring within this analysis area. However, since the implementation of the project would comply with the Aquatic Conservation Strategy, and would avoid impacts to aquatic habitats where possible, these impacts, should they occur, may impact individual southern torrent salamanders, but would not result in a trend towards federal listing or loss of viability.

2. Foothill yellow-legged frog (*Rana boylii*)

A. Habitat Status and Species Information

Foothill yellow-legged frogs are relatively common along the banks of the Klamath River, and other smaller drainages on the Orleans Ranger District. Their preferred aquatic habitats are relatively slow to moderately moving water or pools. Breeding habitats occur in shallow, slow flowing water with at least some pebble and cobble substrate. Pebble/cobble river bars along both riffles and pools, with at least some shading, seems to be preferred by sub-adults and adults.

There are some slower flowing creeks and the other small drainages flowing alongside or under the roads in the project area that may support this taxon. Specific surveys for foothill yellow-legged frogs have not been conducted in the analysis area for this species. This is due to the relatively low probability of adverse effects as discussed below.

B. Direct and Indirect Effects

Although foothill yellow-legged frogs may occur in the slower flowing portions of the drainages in the vicinity of the project area, none of the proposed actions would increase flow velocities, or have any other lasting effects on habitat quality. However, since there may be minor short term impacts to their habitat during the implementation of water quality improvements, plus possible direct mortality from being crushed by heavy equipment, there could be impacts to individual foothill yellow-legged frogs. Since the implementation of the project would comply with the Aquatic Conservation Strategy, and would avoid impacts to aquatic habitats where possible, these impacts, should they occur, may impact individual foothill yellow-legged frogs, but would not result in a trend towards federal listing or loss of viability. Also, it is likely that once the vegetation and hydrology recovers following the project, these sites would once again be suitable habitat.

3. Northern goshawk (*Accipiter gentilis*)

A. Habitat Status and Species Information

Goshawks are known to use mature forest habitats for nesting and foraging. Nesting stands are typically in dense pockets of large trees, often on north-facing, benchy slopes near water. Foraging habitats are often more open to allow for the aerial ambush foraging strategy of the goshawk (Hall 1984). As is similar for spotted owls and marbled murrelets, there appear to be habitats suitable for goshawk nesting and foraging in proximity to the project area, but there have not been any recent surveys for goshawks in this analysis area. This is due to the perceived potential benefits provided by the existing goshawk management areas, and the determination that the proposed actions would not have long term impacts to goshawks as discussed below.

There are seven Goshawk Management Areas within proximity of the project area (Wildlife BA).These management areas were established to provide sufficient nesting habitat for goshawks in the area.

B. Direct and Indirect Effects

There would be no project-related impacts to suitable goshawk habitat.

Noise and human presence generated by the project may disturb northern goshawks during the year of operation if they are nesting undetected in or near roads proposed for treatment.

While there may be minor and essentially un-measurable indirect impacts from possible increases in vehicular traffic following upgrades in maintenance level or designated motorized trails, there would also be indirect benefits to goshawks from the closing and decommissioning of roads.

For the above stated reasons, the project may impact individual northern goshawks, but it would not result in a trend towards federal listing or a loss of viability.

4. Peregrine falcon (*Falco peregrinus*)

A. Habitat Status and Species Information

Peregrine falcons nest on cliffs, often near riparian habitats, and prey almost exclusively on birds. There is one known occupied cliff areas in proximity to the project area (Aikens Creek NI 29). Past monitoring and the fact that this eyrie is close to Highway 96, Aikens Creek and E-Ne-Nuck Campgrounds, as well as a CalTrans slide-waste disposal site suggest that this pair of peregrine falcons has habituated to a relatively high level of noise and human presence, which would be comparable to the proposed hydrologic improvements.

B. Direct and Indirect Effects

While it is known that peregrine falcons nest near and forage over roads proposed for hydrologic upgrades and it is probable that they may forage over or view from their nest roads proposed for decommissioning, none of the treatments would alter the suitability of their foraging habitat.

Since the only peregrine falcons known to nest in proximity to proposed project treatments appear to have habituated to sustained human activity, there should be no impact to peregrine falcons.

5. California wolverine (*Gulo gulo luteus*)

A. Habitat Status and Species Information

The California wolverine is a scarce, solitary, secretive animal that uses mature conifer forests, wet meadows, and montane riparian habitats within large home ranges in Northern California (USDA

SRNF, 2004). Wolverines are known to prefer areas of low human disturbance at higher elevations, and are generally sighted at elevations above 1600 feet (Zeiner et al., 1990). In north coastal areas wolverines have been observed in Douglas-fir and mixed conifer habitats similar to those found in proximity to the project area. There have been no recent wolverine sightings on the Orleans Ranger District, and due to a low likelihood of establishing presence, there have been no surveys done specifically for this project.

B. Direct and Indirect Effects.

No habitat suitable for wolverines would be affected by the project.

While there may be minor and essentially un-measurable indirect disturbance impacts from possible increases in vehicular traffic following upgrades in maintenance level or designated motorized trails, there would also be indirect benefits to wolverines from the reduced disturbance resulting from the closing and decommissioning of roads (reduction in open road density).

Although it would be rare due to their scarcity, California wolverines may occur near the project treatment areas. Since wolverines are known to be highly mobile species, able to avoid disturbance impacts, and since there are large tracts of more suitable habitat in the high elevation wilderness areas north and east of the project area where wolverines are much more likely to occur or be able to escape to, the project would have no impact to California wolverines.

6. Pacific fisher (*Martes pennanti*)

A. Habitat Status and Species Information

Fishers are associated with late seral habitats for their nesting (denning) needs. This need is based on the use of large hollow logs and natural tree cavities (especially in black oaks) that are most abundant in late seral forests (Yaeger 2005). Foraging habitat for fishers is related to prey availability and overhead cover. Fisher foraging and denning habitat exists in proximity to the project area. Zielinski et.al. (1997) summarized surveys for fisher in California between 1989 and 1994. Fishers were primarily detected in two areas of the state: the northern Coast Ranges/Klamath Mountains and the southern Sierra Nevada. Surveys have been conducted and fishers were detected on the Orleans Ranger District, Six Rivers National Forest. Based on results of surveys and presence of suitable habitat, it is assumed that fishers are present in proximity to the project area. This species is also a management indicator species (Appendix H)

B. Direct and Indirect Effects

There would be no project-related impacts to suitable fisher habitat.

Water quality improvements and road decommissioning in areas that contain habitat elements suitable for pacific fisher foraging or denning has the potential to directly impact individuals due to possible disturbance to those that may be breeding undetected near roads being treated during the fisher reproductive season (spring).

While there may be minor and essentially un-measurable indirect impacts from possible increases in vehicular traffic following upgrades in maintenance level or designated motorized trails, there would also be indirect benefits to fishers from the closing and decommissioning of roads which would result in a lowering in the open road density.

Since the proposed project would not impact suitable fisher habitat, and because fishers are known to routinely move their litters to avoid potential threats, this project may impact individual pacific fishers but would not appreciatively diminish the recovery options for this species on the Six Rivers National Forest.

7. American marten (*Martes americana*)

A. Habitat Status and Species Information

Habitat suitability for the marten is believed similar to that for the fisher, and martens have been detected near some of the roads proposed for hydrologic upgrades and decommissioning. This species is a management indicator species (Appendix H)

B. Direct and Indirect Effects

There would be no project-related impacts to suitable marten habitat.

Water quality improvements and road decommissioning in areas that contain habitat elements suitable for American marten foraging or denning has the potential to directly impact individuals due to possible disturbance to those that may be breeding undetected near roads being treated during the marten reproductive season (spring).

While there may be minor and essentially un-measurable indirect impacts from possible increases in vehicular traffic following upgrades in maintenance level or designated motorized trails, there would also be indirect benefits to martens from the closing and decommissioning of roads.

Since the proposed project would not impact suitable marten habitat, this project may impact individual American martens but will not result in a trend towards federal listing or a loss of viability.

Cumulative Effects to Forest Service Sensitive

The Orleans Ranger District is currently in the planning stages of the Orleans Community Fuel Reduction project (OCFR). This project proposes to treat fuels within an approximately 4000 acre area surrounding the town of Orleans. While it is possible that there may be some cumulative impacts to individuals and the late seral habitats and other habitats used by the Forest Service Sensitive Species addressed in this document, it is too early in the planning process to accurately assess what these impacts are, or how they might be cumulative with those of the Orleans Transportation and Road Restoration Project.

Ongoing routine road maintenance may have impacts that could be cumulative with those associated with this project. Generally this work is transitory and of short duration. It may impact individuals of the sensitive species impacted by this project, but is not likely to result in a trend towards Federal Listing or a loss of viability

The effects to Pacific fishers from this project may also be cumulative with effects of the Wilder Fire Salvage and Rehabilitation Project (WFSRP). This project salvaged 2.2 acres of fire killed trees (T10N, R5E, Sec. 1), and has authorized the treatment of fire-created fuels on 33 acres and trail restoration along a ridge-top trail. Due to the use of limited operating periods and because fishers have the ability to move their litters to new dens to avoid disturbance, the WFSRP may impact individual fishers but would not appreciatively diminish the recovery options for this species on the Six Rivers National Forest.

The effects of past road restoration and decommissioning within the project area are not likely to be cumulative, because they have not occurred within the last five years.

There are ongoing private timber harvests on the Downs Ranch (T11N R5E Sec. 25 and 36, T11 N R6 E Sec. 30), at the Owl Mine (T10N R5E Sec. 2) and on industrial timber lands at T10N R4E Sec. 35 and 35. None of these activities are within ¼ mile of any roads proposed for any project treatments.

There are other private lands in close proximity to roads proposed for decommissioning in T11N R6E Sections 5, 8, 17, and 18, and T10N R6E Sections 19 and 30, and along the western District boundary in Townships 10 and 11 North. It is reasonable to expect some form of future timber harvest, other potential habitat loss or noise disturbance from these lands which might be cumulative with the project.

There are no other known recent or reasonably likely to occur projects that might have effects to Forest Service sensitive wildlife species that would be cumulative with the effects of the project.

3.4.4 Alternative 3

The effects to wildlife and Late Successional Reserves under Alternative 3 would be very similar to those under Alternative 2. The differences would be that the resulting average open road densities within LSRs would be very slightly higher at 1.43 miles of road per square mile (vs. 1.42 mi./sq.mi. for Alternative 2).

Similarly, there could be up to 3,540 acres of unsurveyed suitable nesting habitat for northern spotted owls disturbed (vs. 3,618 acres under Alternative 2) and up to 5,380 acres of unsurveyed suitable marbled murrelet nesting habitat that could be subjected to noise or visual disturbance (vs. 5,447 for Alternative 2) during the nesting season.

3.5 Fire and Fuels

3.5.1 Affected Area and Existing Condition

The Orleans Ranger District is characterized by large areas having a moderate to very high fuel hazard and fire risk. This characterization is based on vegetation types and ages, steepness of slopes, south and west-facing aspects, and significant numbers of human and lightning caused wildfires. Due to aggressive fire suppression and prevention efforts, many acres of forested land on the Orleans District now have higher stand densities and much higher accumulations of woody debris than historically existed. These conditions along with longer and warmer summer weather conditions contribute to wildfires burning hotter and consuming more acres than historical wildfires.

Forest roads are an important part of fire and fuel management across the District. During wildfires roads not only provide fire access and access to water sources, they can also act as firebreaks, anchor points, escape routes, and small safety zones. Roads also provide access to fuel management projects, which are designed to reduce live and dead fuel loading, which helps to create more fire resilient forests. Roads do provide access that could increase human caused fires, but roads also decrease initial attack response times, and can act as control/holding lines.

Historical records (1910 – 2005) show that lightning and arson fires have been common on the Orleans District. Of the 950 reported fires in this time period, 271 were lightning ignited and 273 were arson fires. The fire season generally lasts from June to late October. This is a period with little rain and usually high summer temperatures, which dries the fuels, contributing to ease of ignition and higher rates of spread.

Reducing roads has a direct bearing on the ability to fight wildfires and implement fuel reduction projects. However, the utility or importance of any given road for fire risk varies, mainly depending on its strategic location and the density of roads within the general area. Table 3-8 shows the specific criteria that were used to determined roads that have a high, moderate, or low utility relative to fire suppression actions and fuel management opportunities.

Table 3-8. Criteria for prioritizing road access for fire suppression and fuels management

Priority	Criteria
High	• Access to ridges for suppression or ridge fuels projects. • Only one or two access roads into an area. • Access to a water source.
Moderate	• May be one of several roads accessing an area. • Access to a potential fuels project or is within a potential fuels project.
Low	• Small spurs with limited access. • One of many roads into an area, or one of several stacked roads.

In order to display the differences among alternatives between roads that are proposed for decommissioning versus roads proposed to remain on the transportation system, total road miles were assessed by watershed. These road miles are broken down into high, moderate, and low importance relative to fire suppression and fuel management access issues (Table 3-9). Non-system roads were not calculated in this comparison because most are not coded as "drivable" on the roads inventory.

Table 3-9. Fire suppression and fuels management access (road miles) by alternative

	Alternative 1	Alternative 2		Alternative 3	
Watershed	**Proposed to remain on Transportation System (mi)**	**Proposed for Decom (mi)**	**Proposed to remain on Transportation System (mi)**	**Proposed for Decom (mi)**	**Proposed to remain on Transportation System (mi)**
BLUE CREEK					
High	22.2	10.0	12.2	10.0	12.2
Moderate	5.0	5.0		5.0	
Low	3.7	3.7		3.7	
Total	**30.9**	**18.7**	**12.2**	**18.7**	**12.2**
BLUFF CREEK					
High	159.3	41.9	117.4	43.5	115.7
Moderate	26.8	19.1	7.7	19.1	7.7
Low	15.8	11.0	4.8	12.1	3.7
Total	**201.9**	**72**	**129.9**	**74.7**	**127.1**
CAMP CREEK					
High	59.2	24.7	34.5	24.4	34.8
Moderate	19.2	11.4	7.8	11.4	7.8
Low	15.4	5.7	9.7	5.7	9.7
Total	**93.8**	**41.8**	**52**	**41.5**	**52.3**
LOWER MIDDLE KLAMATH					
High	119.4	5.7	113.7	3.3	116.1
Moderate	22.5	5.9	16.6	5.3	17.2
Low	31.9	17.3	14.6	17.3	14.6
Total	**173.8**	**28.9**	**144.9**	**25.9**	**147.9**
RED CAP					
High	97.8	2.1	95.7	2.1	95.7
Moderate	8.4	0.7	7.7	.7	7.7
Low	10.5	4.8	5.7	4.8	5.7
Total	**116.7**	**7.6**	**109.1**	**7.6**	**109.1**
TOTAL DISTRICT	**617.1**	**169**	**448.1**	**168.4**	**448.6**

3.5.2 Alternative 1 (No Action)

Direct, Indirect, and Cumulative Effects

Under this alternative, no roads are proposed to be decommissioned. As such, there would be no Direct, Indirect, or Cumulative impact to fire or fuels management from loss of access.

3.5.3 Alternative 2 (Proposed Action)

Direct and Indirect Effects

Under this alternative, 169 system road miles are proposed to be decommissioned. A direct effect of this proposal would be the reduction of 84 miles of road having a high priority for fire suppression access. The effects of this action are an elevated risk that a land-based fire suppression response would be delayed in the event of a wildfire. The bulk of these roads are located in the Bluff and Camp Creek watersheds and are not located near private residences.

At the same time, 373 miles of roads having a high value for fire suppression access and fuels treatment projects would remain on the transportation system. The majority of these roads are in the Lower Middle Klamath watersheds surrounding the Orleans community, as well as in the Red Cap and Bluff Creek watersheds.

Natural resources and air quality impacts to the community could still be negatively affected by wildfires possibly growing larger due to delayed response time, but by focusing on the retention of strategically placed roads, these impacts should be minimal.

3.5.4 Alternative 3

Direct and Indirect Effects

Under this alternative, the total miles of road to be decommissioned is not different from Alternative 2, however the geographic distribution of those miles is slightly different. The main difference is four miles of road in the Lower Middle Klamath watershed previously proposed for road decommissioning (2.4 system and 1.6 non-system) are now proposed to remain on the transportation system. These roads were reassessed and considered important access for fuel reduction projects and fire suppression access surrounding the Orleans community.

Of those roads proposed to be decommissioned, 83 miles are considered a high priority for fire suppression. The bulk of these roads are located in the Bluff and Camp Creek watersheds and not located near private residences.

At the same time, 375 miles of road having a high value for fire suppression access and fuels treatment projects would remain on the transportation system. The majority of these roads are in the Lower Middle Klamath watersheds surrounding the Orleans community, as well as in the Red Cap and Bluff Creek watersheds.

Natural resources and air quality impacts to the community could still be negatively affected by wildfires possibly growing larger due to delayed response time, but by focusing on the retention of strategically placed roads, these impacts should be minimal.

Cumulative Fire Suppression/Fuel Treatment Access Effects for Alternatives 2 and 3:

Over the past 10 years, approximately 26 miles of District roads have been decommissioned, with the majority of those roads within the Bluff Creek watershed. The majority of these Bluff Creek roads were in the lower 1/3 of the watershed where fire risk is generally lower. With this project, an additional 169 miles of road will be decommissioned, with the majority of the roads also occurring on the lower to mid slope positions in Bluff Creek and Camp Creek where human-caused fire risk is generally lower.

The cumulative effect of this action will be a slightly higher risk of reduced land-based response time for fire suppression efforts in certain watersheds, particularly the Bluff Creek watershed. This is considered a non-significant cumulative effect given that road access on most of all the main ridge tops were maintained in all watersheds throughout the Orleans Ranger District, including the Bluff Creek watershed. An examination of the key fire access routes and fuel management opportunities indicated limited overlap between roads proposed for decommissioning and high priority roads needed for fire suppression access and fuels management activities. The majority of high priority fire and fuel management access roads occur along ridge tops and the bulk of these roads will remain on the District transportation system.

In summary, there are minor differences between Alternatives 2 and 3 relative to the cumulative effect for fire suppression and fuel treatment access. The majority of the District roads miles (i.e. 448 miles under Alternative 2 and 449 miles under Alternative 3) are being maintained on the transportation system and these roads will be very useful for suppression and fuel management actions. Keeping and maintaining roads around the Orleans community would result in a positive cumulative impact on fire suppression access and fuels management opportunities, especially as related to wildfires occurring in and around the community.

3.6 Port-Orford Cedar

Extensive stands of uninfected Port-Orford cedar (POC) exist within the District. These Port-Orford cedar stands provide high ecological diversity and are critical to aquatic ecosystem function and stability. In order to maintain these critical ecological functions, the risk of introducing and spreading Port-Orford cedar root disease must be reduced. Seasonal road closures as well as road decommissioning reduces the risk of spreading the root disease. All roads within Port-Orford cedar habitat were assessed for risk of spread. The methods, assumptions and analysis are summarized in the report titled *Orleans Ranger District Road Analysis Process: A Road-by-Road Risk Assessment of Port-Orford cedar* (Jones 2006). This document describes a road-by-road risk assessment to Port-Orford cedar and rates these roads' potential impacts to Port-Orford cedar if POC root disease is introduced into these stands.

The measures used to compare alternatives are:

- miles of high risk Port-Orford cedar roads to be decommissioned and
- acres of Port-Orford cedar stands no longer at risk of infection from roads (e.g. acres that have a high risk of infection should the disease be spread via road access).

3.6.1 Affected Area and Existing Condition

Port-Orford cedar (*Chamaecyparis lawsoniana*), a member of the Cypress Family, *Cupressaceae,* is found in northwestern California and Oregon. In California it grows mainly in the Coast Ranges, the Siskiyou and Klamath Mountains west of the Klamath River, along with small isolated populations in the Scott Mountains, west of the Sacramento River. There are approximately 41,000 acres of mapped Port-Orford cedar on federal lands (Jimerson, McGee and Jones 1999). Port-Orford cedar is an ecologically, economically, culturally, and socially important tree species. On the Six Rivers National Forest, the species occurs on the Smith River National Recreation Area (SRNRA), Lower Trinity Ranger District and Orleans Ranger Districts. On the Orleans Ranger District there are 9,035 acres, which represent 22% of all mapped Port-Orford-cedar stands within federal lands in California. There are 78 acres of infected Port-Orford cedar stands within the District

Port-Orford cedar can play an important role in riparian ecosystems. Large downed Port-Orford cedar is important in providing habitat complexity for fish and other organisms. Since Port-Orford cedar is highly resistant to decay, it may be expected to have a longer residence time in streams than other associated conifers. Port-Orford cedar provides shade (and thereby maintaining lower stream temperatures), bank stability, and stream structure as downed wood (Hansen et al. 2000b). These factors are key elements of habitat for fish, amphibians, aquatic insects, and other organisms.

Port-Orford cedar is affected by an exotic pathogen, *Phytophthora lateralis,* which causes a root disease that infects and kills Port-Orford cedar. This disease has spread throughout much of Port-Orford cedars' native range. Currently, on the Orleans Ranger District there are two localized infestation sights, around Fish Lake and along Aikens Creek. There are 78 acres infested with POC root disease.

Any activity that involves the use of Forest roads in drainages containing Port-Orford cedar has the potential to spread the pathogen to uninfected drainages (Six Rivers Land and Resource Management Plan (LRMP) Final Environmental Impact Statement IV-16).

Port-Orford cedar risk assessments have been completed to assist Forest Managers in determining how best to reduce the risk of spreading POC root disease. These assessments identified road closures need to be implemented to reduce this risk. These assessments examined the locations of infested and non-infested areas and assigned risk and hazard ratings to the watersheds. It also developed and set priorities of action for the identified non-infested areas. Actions have been implemented to reduce the risk of transport of the root disease from currently infested areas to the identified non-infested areas.

These risk assessments determined that the risk of the root disease being introduced into the non-infested areas from locations already infested would remain high if action is not taken. The infectious spores are carried in mud on the tires and undercarriage of vehicles and transported to non-infested areas, becoming active after very short exposure to wet, rainy and cool conditions. Seasonal road closures were identified as an important measure that could be taken to reduce the risk of spread of POC root disease. Road closures cannot guarantee the root disease will not be introduced into identified non-infested areas, but seasonal road closures have been utilized with success over the last several years. Limiting vehicle access during wet weather does reduce the human risk factor of spreading the disease, since the major source of infection is via mud and dirt carried on vehicles and equipment.

Roads within areas having Port-Orford-cedar stands were assessed. Roads were rated based on risk of transmitting POC root disease and the potential acres of Port-Orford cedar stands at risk. There are 139 miles of roads within the project area that have a high risk of introducing and spreading the root disease. This risk has been reduced over the last 10 years through seasonal road closures of high and moderate risk roads during the rainy season (Appendix E). These road closures have been accomplished by the installation of gates placed at strategic locations to seasonally restrict motorized vehicular access and travel during the wettest times of the year. The current method of closing the gates involves using pins and locks. An alternative to the pins and locks is the welding of the gates with hardened steel braces. This method is only used if the local Search and Rescue group has access to a welder that is capable of opening the welded gates. The advantage of the welded gates is that all access is limited.

Gates are located with safety in mind to provide for safe vehicle turn around. Several gates are utilized to incrementally close an area, allowing gates to be opened progressively as the roads dry. Every attempt is made to minimize the duration of the closures by closing and opening gates as weather and snow melt allows.

3.6.2 Alternative 1 (No Action)

Under this alternative, the risk of spread of POC root disease has been reduced through the seasonal closure of roads during the rainy season (Appendix E). There would be no additional reduction in the current risk of spread of POC root disease associated with roads. There are 137 miles of roads within the project area that have a high risk (without the seasonal closure) of introducing and spreading the root disease. These miles of road would remain under this alternative and have the potential to infect 9,034 acres of Port-Orford cedar. Seasonal closures of these roads by gating would still occur annually, reducing the risk of infecting these acres.

3.6.3 Alternative 2 (Proposed Action)

Direct and Indirect Effects

Since the primary vector for POC root disease is the road network, eliminating unnecessary access to Port-Orford cedar stands would further reduce the risk of introducing the disease. This can be accomplished through road decommissioning. Under Alternative 2, decommissioning 36 miles of proposed high-risk Port-Orford cedar -risk roads would reduce an estimated 4,349 acres of Port-Orford cedar potentially at risk of infection. In other words, 48% of the Port-Orford cedar stands within the Orleans Ranger District would no longer be at risk of introducing or spreading the root disease due to risks from road access. This would result in a substantial reduction in risk to Port-Orford cedar stands.

The remaining roads within Port-Orford cedar stands (83 miles) are proposed to be kept and maintained or upgraded, as these roads are considered essential for access and management. The majority of these roads are in the Bluff Creek watershed. Approximately 28 miles of these roads are in a high-risk category affecting approximately 6,365 acres of Port-Orford cedar stands. The risk of spreading the POC root disease on the remaining roads continues to be reduced through use of seasonal road closures. The same annual seasonal road closures during the rainy season (between October 22 and June 15) on selected roads, as in Alternative 1 would be implemented (Appendix E). These roads would be seasonally closed with the onset of the fall rainy season and remain in place until road surfaces dry out in late spring or early summer. This covers the highest risk period of the year when rain and wet conditions are conducive to spreading spore-laden mud from infected to un-infected areas, minimizing the possibility of human activity spreading the disease.

In summary, under this alternative a total of 83 miles of high-risk road for POC root disease spread would be decommissioned and 4,349 acres of POC stands no longer at risk of infection from roads.

3.6.4 Alternative 3

Direct and Indirect Effects

This alternative is identical to Alternative 2, with the exception o. The only difference between Alternatives 2 and 3 relative to POC root disease risk are changes to two roads: 12N13H.2 and road 12N13H. Under this alternative, the lower portion of road 12N13H would be decommissioned. The non-system road 12N13H.2 that accesses Bluff Creek would be converted to a non-motorized trail. This road has a high risk of introducing the root disease to downstream Port-Orford cedar stands. Since the road is located in the headwaters of Bluff Creek, the introduction and spread of the disease would have the potential to infect all downstream Port-Orford cedar stands adjacent to Bluff Creek. Under this alternative the risks of introducing or spreading the POC root disease is improved from Alternative 2. This alternative would reduce the risk of spread of the disease by at least an additional 330 acres.

In summary, under this alternative a total of 84 miles of high-risk road for POC root disease spread would be decommissioned and 4,679 acres of Port-Orford cedar stands no longer at risk of infection from roads.

Port-Orford cedar root disease and Cumulative Effects

The specific management direction to protect Port-Orford cedar included in the 1995 Six Rivers Land and Resources Management Plan has been implemented in past projects. These practices, which include seasonal road closures, cleaning equipment, sanitation of infected Port-Orford cedar stands, and maintaining, upgrading and decommissioning roads, appear to be slowing the spread POC root disease and have resulted in a moderate to low risk of disease spread. While Agency actions can reduce the rate of disease spread, factors outside of agency control could continue the spread of the disease. *Phytophthera lateralis* is persistent in the soil for several years and can transported by animals, hunters and other vextors, even in areas that have no roads. The cumulative effect of the proposed actions including the implementation of seasonal gates as well as road decommissioning will be to further lower of the risk of spreading the disease. While these actions will not eliminate the risk of spreading the root disease, they will substantially lower the risk beyond efforts currently employed (e.g. annual seasonal road closures).

In the event that the root disease spreads to currently uninfected stands of Port-Orford cedar, there are potentially significant long-term cumulative effects. These effects would vary depending on Port-

Orford cedar's stand density and its proximity to streams and rivers. Short-term effects to stream and river areas from the loss of the Port-Orford cedar tree canopy would be increased water temperatures, decreased bank stability and higher soil erosion rates. There would be massive influxes of large woody debris into stream channels because Port-Orford cedar does not have tap-roots but fibrous intertwining lateral root mats. This would degrade anadromous fish habitat, alter aquatic and riparian ecosystem dynamics. A high percentage of Port-Orford cedar stands are in late seral developments. Disease infestation would reduce habitat for wildlife dependent on old growth Port-Orford cedar plant associations.

Longer term cumulative effects are the replacement of longer lived and decay resistant Port-Orford cedar with early seral species (alder, willow, grass, etc.), which would decrease stream recruitment of large woody debris, a critical component of fish habitat, the potential loss of species diversity associated with several Port-Orford cedar plant communities (aquatic and terrestrial), and the possible elimination of eight plant associations found exclusively in riparian areas. The long term cumulative effects of infecting non-stream side areas would be reduction of species biodiversity, elimination of unique Port-Orford cedar plant associations, loss of wildlife habitat and loss of many old growth stands greater than 500 years old.

In summary, while these are potential long-term consequences should the disease spread to uninfected Port-Orford cedar stands, the actions proposed in the project will substantially reduce the risk of this cumulative effect to aquatic and terrestrial ecosystems from occurring.

3.7 Vegetation Management

3.7.1 Affected Area and Existing Condition

Vegetative conditions within the Orleans Ranger District are highly variable and represent a wide range of ages, densities, species compositions, health risks, and resiliency to potential disturbances. At this time, all artificially regenerated stands are reforested with the appropriate species and numbers of trees to meet the Forest's LRMP objectives. All of the previously regenerated stands are considered "free to grow" and, barring any stand replacing disturbance such as fire, have the potential to develop into the desired future condition for them. Therefore, there is no legal mandate for additional reforestation or stand tending treatments anywhere on the Orleans Ranger District.

Essentially all stands within the District, but especially those younger than 30 years old, could benefit from additional vegetation management treatments to speed the attainment of their desired future conditions. Having drivable road access is a need for some kinds of treatment, e.g. commercial harvesting or prescribed burning, and it is an important cost factor for other treatments such as fuel hazard reduction or pre-commercial thinning using chainsaws.

At this time, most roads other than the main arterial roads, those typically in level 1 and 2 and non-system roads, are in a grown-over or brushed-in state. The costs for most pre-commercial stand tending work and/or fuels treatments already include the additional expense for contractors or employees to walk into the units or to clear the roads of vegetative growth and debris. Most projects that involve commercial harvesting and log haul also typically include costs of doing some road clearing/brushing and other needed maintenance work.

Potential sources of funding for pre-commercial thinning, release, and fuels treatments have been limited on the Six Rivers National Forest. If this trend continues, having road access to non-commercial work sites would be immaterial. For treatments involving the removal of products, thereby requiring drivable road access, product values are often enough to pay for the reconstruction of unmaintained roads to access sale units.

The measurable indicator to describe and analyze this proposal is:

- Miles of road accessing high and medium priority vegetation management opportunities

3.7.2 Alternative 1 (No Action)

Currently there are 332.8 miles of existing system roads that potentially access medium and high priority vegetative treatments. Access would remain similar to that of today with recognition that brush and trees would continue to encroach into the roadways of most spur roads. Also, some of this existing road access would be periodically lost due to culvert or roadbed failures, cut bank failures, and slumps or landslides.

3.7.3 Alternative 2 (Proposed Action)

Direct, Indirect, and Cumulative Effects

Under this alternative there would be 295.6 miles of system roads that could potentially access medium and high priority vegetative treatments. Theoretically, this represents a reduction of about 11% from Alternative 1. However, of the 37.2 miles of roads that “access” priority treatment opportunities and would be taken off the system, 35.4 miles are in level 1 and 2 or are “non system”. Most of these roads are likely non-drivable at this time due to being brushed in or damaged in other ways. Therefore, the direct effects of this alternative are essentially the same as the existing condition. Also, because there is so little funding to conduct pre-commercial work, and because most commercial work can pay to reconstruct unmaintained roadways if needed, there would not be any indirect or cumulative effects.

3.7.4 Alternative 3

Direct, Indirect, and Cumulative Effects

Under this alternative there would be 296.5 miles of system roads that could potentially access medium and high priority vegetative treatments. Theoretically this represents a reduction of about 11% from Alternative 1. However, of the 36.3 miles of roads that “access” priority treatment opportunities and would be taken off the system, 34.5 miles are in level 1 and 2 or are “non system”. Most of these roads are likely non-drivable at this time due to being brushed in or damaged in other ways. Therefore, the direct effects of this alternative are essentially the same as the existing condition. Also, because there is so little funding to conduct pre-commercial work, and because most commercial work can pay to reconstruct unmaintained roadways if needed, there would not be any indirect or cumulative effects.

3.8 Botany/Noxious Weeds

Affected Area and Existing Condition for Botanical Resources

The project area is outside of the range of and would not affect federally listed plant species. There is one documented sensitive plant species, the robust false lupine (*Thermopsis robusta*) that occurs on the margins of the following roads in the project area; 10N51, 11N05, 11N17, 12N12, 13N01and 15N01. Published information on robust false lupine habitat, ecological requirements or level of tolerance for disturbance is scant, hence little is known about the species aside from direct field observations. Observations made by Six Rivers National Forest botanists indicate that plants are generally found growing along roads or trails on cut banks, road edges or fill slopes. Occasionally plants are found growing out of the road-bed, displaying the robust false lupine’s affinity for road and trail related disturbance. For more information see the TES plant biological evaluation in the project record.

Direct and Indirect Effects

Direct effects from vehicular traffic can result in the crushing or removal of individual plants. Speculation regarding the species affinity for roads has centered around the fact that, like many members of the legume family to which it belongs, it is an early seral species and a poor competitor. The possibility has also been raised that both seed scarification and the creation of a loose mineral soil bed by road and trail traffic could be beneficial in seed germination and development. This affinity for roads and trails indicates that keeping or maintaining, upgrading maintenance level, or decommissioning roads and trails would have both negative and beneficial effects on this species, hence the biological evaluation resulted in the determination that the Orleans Transportation and Road Restoration project may effect individuals, but is not likely to result in a trend toward federal listing or loss of viability for the robust false lupine (*Thermopsis robusta*).

Cumulative Effects

The geographic scale for addressing cumulative effects for the robust false lupine is the geograpic range of the species where it is limited to Orleans and Lower Trinity Ranger Districts on Six Rivers National Forest, and Ukonom and Happy Camp Ranger Districts on Klamath National Forest. One occurrence has been recorded for the Hoopa Valley Indian Reservation.

The types of activities (past, present and foreseeable future) that could potentially cumulatively affect the robust false lupine across the geographic scale specified above include road decommissioning, road maintenance activities, paving, road side hazard tree removal, log decking in turn outs, and fire suppression that results in a departure from historic fire return intervals and an increase in competing vegetation. Note that all but the latter of these activities have the potential to both negatively impact adult individuals via crushing and removal, and, additionally to provide positive benefits to the species by providing seed scarification and the creation of a loose mineral soil bed that could aid in seed germination and development. Because of this dual nature of the cumulative effects of past, present and foreseeable future actions it is unlikely that they would cause a loss of viability to the robust false lupine.

Affected Area and Existing Conditions for Noxious Weeds

A noxious weed risk assessment was completed for the proposed action. This assessment focused on roads that are being closed or decommissioned under the proposed action. Noxious weed sites on these roads are given high priority for treatment prior to becoming inaccessible for future treatment and monitoring. Additionally, heavy equipment work associated with decommissioning or closure can spread existing infestations. Based upon inventory and mapping, scotch broom (*Cytisus scoparius*) and yellow star-thistle (*Centaurea solstitialis*) were documented on the following roads proposed for decommissioning (Alternatives 2 and 3) within the project area:

Table 3-10. Weed sites on roads proposed for decommissioning

Road Number	Species	Acreage
10N12	Scotch broom	5.5
11N14	Scotch broom	1.0
11N17A	Yellow star-thistle	0.5
11N21	Scotch broom	0.7
11N37	Scotch broom	0.5
11N44	Scotch broom	1.0
13N02D	Scotch broom	1.0

The assessment determined that the risk of introduction or spread of invasive and noxious weeds as a result of implementing the Orleans Transportation and Road Restoration Project is considered moderate along roads with existing infestations that are proposed for decommissioning. The following measures (see Section 2.2.4) would reduce the risk of weed introduction and spread:

1. Remove and dispose of plants and propagules from roads noted in Table 3-10 above.
2. Inspect and clean equipment and/or gear for the presence of noxious or invasive plant seed before entering the project area.
3. Use certified weed free mulch where mulching is prescribed.

3.8.1 Alternatives 1, Alternative 2 and Alternative 3

Direct, Indirect, and Cumulative Effects

There are no differences between Alternatives 1, 2, and 3 with respect to robust false lupine. The determination was made in the Botanical Biological evaluation that the project may effect individuals, but is not likely to result in a trend toward federal listing or loss of viability for the robust false lupine (*Thermopsis robust*). Because of this dual nature of the cumulative effects of past, present and foreseeable future actions it is unlikely that they would cause a loss of viability to the robust false lupine.

There is a reduction in risk of spread of noxious weeds between Alternative 1 and Alternatives 2, and 3. Roads that are proposed to be decommissioned and that have noxious weeds (see Table 3.10) would be treated to remove the noxious weed populations before the road is decommissioned. These combined actions reduce the risk of noxious weed spreading. There is no difference in risk of spread of noxious weeds between Alternatives 2 and 3.

3.9 Heritage and Cultural Resources

3.9.1 Alternative 1, Alternative 2 and Alternative 3

All alternatives have no adverse effect on heritage and cultural sites since all management actions are confined to previously disturbed areas and roadways as required by the Programmatic Agreement with State Historic Preservation Office (SHPO) and the President's Advisory Council on Historic Preservation (ACHP).

3.10 Economic analysis

Road maintenance funding for Forest Service roads has declined significantly over the past decade and the trend is projected to continue. Assessing the costs associated with maintaining roads as well as decommissioning roads is an important factor in designing a long-term (affordable, manageable, sustainable) transportation system. Although there is an initial large investment associated with road decommissioning, over the long term, decommissioning roads is more cost effective than maintaining roads. Appendix F has the complete economic analysis and comparison of alternatives.

4.0 CONSULTATION AND COORDINATION

Interdisciplinary Members:

Carolyn Cook	Hydrologist, Team Leader
LeRoy Cyr	Fisheries Biologist, Team Leader
David Rutherford	Engineering and Roads Technician
Tony Hacking	Wildlife Biologist
Kathy Barger	Archaeology and Heritage Specialist
Kathy Heffner	Tribal Relations Specialist
Anna Dittmar	Heritage Program Manager
John McRae	Botanist/Noxious Weed Coordinator
Gene Graber	Silviculturist
Bob Hemus	Recreation
Ray McCray	Recreation Planner/OHV Coordinator
Stan Pfister	Fuels Specialist
Jeff Jones	Ecologist/Forester

The Forest Service consulted the following individuals, Federal, state and local agencies, tribes and non-Forest Service persons during the development of this environmental assessment:

Federal, State, and Local Agencies:

North Coast Water Quality Control Board

US Fish and Wildlife Service

National Marine Fisheries Service

Tribes:

Yurok Tribe

Hoopa Tribe

Karuk Tribe

Others:

A description of the public involvement process and results is located in the Project File.

5.0 REFERENCES

Specialist reports were created that support the analysis in this environmental assessment. The following were done in preparation of the Orleans Transportation and Road Restoration Project Environmental Assessment. Information in these reports have been summarized in this EA. The reports are located in the Project File.

Orleans Roads Analysis Process (RAPS)
Hydrology and Water Quality Report
Fisheries Biological Assessment and Biological Evaluation
Wildlife Biological Assessment and Biological Evaluation
TES Plant BE
Noxious weed report
Port-Orford cedar assessment

Literature

Bloom, A.L. 1998. An assessment of road removal and erosion control treatment effectiveness: a comparison of 1997 storm erosion response between treated and untreated roads in Redwood Creek Basin, northwestern California (MS thesis). Arcata, CA: Humboldt State University.

Furniss M.J. T.S., M. Love, S.A. Flanagan. (1997). "Diversion Potential at Road Stream Crossings." USDA, Forest Service San Dimas Technology and Development Center. No.9777-1814.

Furniss, M.J. T.S. Ledwith, M.A. Love, B.C. McFadin, S.A. Flanagan. (1998). "Response of Road-Stream Crossings to Large Flood Events in Washington, Oregon, and Northern California. USDA, Forest Service San Dimas Technology and Development Center. No.9877-1806.

Furniss, M.J., T.D. Roelofs, and C.S. Yee, 1991. Road construction and maintenance. In: Meehan, W.R., ed. Influences of forest and rangeland management. Special Pub. 19. Bethesda, MD: American Fisheries Society: 297-324. Chapter 8.

Hall, P.A. 1984. Characterization of nesting habitat of goshawks (*Accipiter gentilis*) in northwest California. Unpubl. M.S. Thesis, California State University, Humboldt. Arcata, CA. 70pp.

Jimerson, T, J.K. Jones, 2002. A landscape level roads risk assessment of Port-Orford-cedar Plant Associations on the Six Rivers National Forest.

Jimerson, T, J.K. Jones, K.H. McClellan. 2004. Landscape Level Risk Analysis of Port-Orford Cedar Plant Associations In The Elk Valley Area.

Klein, R. 2003. Erosion and Turbidity Monitoring Report – Sanctuary Forest Stream Crossing Excavations in the Upper Mattole River Basin, 2002-2003. Prepared for: Sanctuary Forest, Inc. P.O. Box 166, Whitethorn, CA. 95589.

Ledwith, T. 2000. Road Assessment and Restoration Planning in the Camp and Slate Creek Watersheds of the Klamath River Basin. Final Report. Funded by SB271. Calif. Dept. Fish and Game.

Ledwith, T. 2001. Road Assessment and Restoration Planning in the Red Cap Creek Watershed of the Klamath River Basin. Final Report. Funded by SB271. Calif. Dept. Fish and Game.

Ledwith, T. 2004. Road Assessment and Restoration Planning in the Bluff Creek Watershed of the Klamath River Basin. Final Report. Funded by SB271. Calif. Dept. Fish and Game.

Lehman, R. N. 1979. A survey of selected habitat features of 95 bald eagle nests in California. California Department of Fish and Game. Wildlife Management Branch Admin. Rep. 79-1, Sacramento, CA 23pp.

Lyons, J.K. and R.L. Beschta, 1983. Land use, floods, and channel changes: Upper Middle Fork Willamette River, Oregon. *Water Resources Research* 19(2): 463-471.

Madej, M.A., 2001. Erosion and sediment delivery following removal of forest roads. *Earth Surface Processes and Landforms* 26: 175-190.

National Marine Fisheries Service (NOAA Fisheries). 2001. Water Drafting Specifications, August 2001. Santa Rosa, California

National Marine Fisheries Service (NOAA Fisheries). 1997. Informal Consultation on (1) a BA for Blowdown Removal and Hazard Tree Removal from Campgrounds dated June 3, 1996; (2) a BA for Hazard Tree Removal and Treatment of Fuels Related to Storm Damaged Trees Along Roads dated July 16, 1996. August.

Switaliski, TA, JA Bissonette, TH DeLuca, CH Luce, and MA Majey. 2004. Benefits and impacts of road removal. Front Ecol Environ: 2(1):21-28.

Thomas, J.W., E.D. Forsman, J.B. Lint, E.C. Meslow, B.R. Noon, and J. Verner. 1990. A Conservation Strategy for the Northern Spotted Owl. Report of the Interagency Scientific Committee to address the conservation of the northern spotted owl. Portland, OR. pp. 427

Trombulak, S.C, and C.A. Frissell. 2000. Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities. Conservation Biology, Vol. 14. No.1, pp18-30.

USDA Forest Service 1995. Six Rivers National Forest Land And Resource Management Plan. 200p.

USDA Forest Service 1997. Klamath River Basin Port-Orford-cedar Risk Assessment.

USDA Forest Service 1998. Proposed Implementation Plan: Port-Orford-cedar risk reduction actions for Orleans Ranger District.

USDA Forest Service 1999. Roads Analysis: Informing Decisions about Managing the National Forest Transportation System. Misc. Rep. FS-643. Washington, D.C.: USDA Forest Service. 222p.

USDA Forest Service 2003. OHV Route Designation Guidebook, National Forests in California, USDA Forest Service, Vallejo, CA. 112 p.

USDA Forest Service 2003. Six Rivers National Forest Roads Analysis, Version 1.0. Six Rivers National Forest Eureka, CA. 110 p.

USDA Forest Service 2006. Orleans Roads Analysis and Off-Highway Vehicle Strategy. Six Rivers National Forest. R5-MB-111. March 2006.

USDA Forest Service, 2005. Travel Management: Designated Routes and Areas for Motor Vehicle Use, Final Rule. Federal Register. November 9, 2005.

USDA Forest Service, Draft 2.4, 2000. Rating Watershed Condition: Reconnaissance Level Assessment for the National Forests of the Pacific Southwest Region. USDA Forest Service, Pacific Southwest Region.

USDA, Forest Service, Six Rivers National Forest. 2006. Threatened, Endangered, and Sensitive Species Reference Document for the Six Rivers National Forest, Eureka, California. Unpublished document. November, 2006 version.

USDA, Forest Service, USDI, USFWS, USDC National Oceanic and Atmospheric Administration, NFMS, USDI National Park Service, USDI BLM and EPA. 1993. Forest ecosystem management; an ecological, economic, and social assessment. Report of the Forest Ecosystem Management Assessment Team.

USDA, USDI. 2004. Decision to Clarify Provision Relating to the Aquatic Conservation Strategy, Record of Decision Amending Resource Management Plans for Seven Bureau of Land Management

Districts and Land and Resource Management Plans for Nineteen National Forests Within the Ranger of the Northern Spotted Owl. March.

USDA-FS and USDI- BLM. 1994. Record of Decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl.

USDA-FS, USDC-NOAA Fisheries, USDI-BLM, USDI-FWS. 1995. Streamlining Consultation Procedures. Updated in 1997 and 1999.

USDA-FS. 1995. Land and Resource Management Plan. Six Rivers National Forest, Eureka, California.

USDA-FS. 1991. Forest Service Manual (FSM 2672.42).

USDA-FS. 1992. R5 Forest Service Specifications for Maintenance of Roads. Regional Office, Vallejo, California.

USDA-FS. 2001. Hazard Tree Guidelines. Internal Memo from Forest Supervisors to District Rangers. February 6, 2001.

USDI Fish and Wildlife Service. 2006. Estimating the Effects of Auditory and Visual Disturbance to Northern Spotted Owls and Marbled Murrelets in Northwestern California. July 26, 2006 version. Arcata Fish and Wildlife Office, Arcata California. 12pp.

USDI Fish and Wildlife Service. 2000. Technical assistance on the final results of the status of the marbled murrelet in interior northwestern California (1-14-1997-61.2). Letter signed by B. Halstead and R. Iverson.

Weaver, W.E., D.K. Hagans, and J.H. Popenoe. 1995. “Magnitude and Causes of Gully Erosion in the Lower Redwood Creek Basin, Northwestern California.” In: *Geomorphic Processes and Aquatic Habitat in the Redwood Creek Basin, Northwestern California.* K.M. Nolan, H.M. Kelsey, and D.C. Marron, eds. U.S. Geological Survey Professional Paper 1454.

Yaeger, J. Scott, 2005. Habitat at Fisher Resting Sites in the Klamath Province of Northern California. Unpublished MS Thesis, Humboldt State University, Arcata CA. 64pp.

Zabel, Cynthia J., J.R. Dunk, H.B. Stauffer, L.M. Roberts, B.S. Mulder, A.Wright. 2003. Northern spotted owl habitat models for research and management application in California. Ecological Applications, 13(4), pp. 1027-1040.

Zeiner, David C., W.F. Laudenslayer Jr., K.E. Mayer, M. White editors. 1990. California’s Wildlife, Volume III, Mammals. California Statewide Habitat Relations System. State of California, The Resources Agency, Department of Fish and Game, Sacramento, California. 407pp.

Zielinski, W. J., R. L. Truex, C. V. Ogan, and K. Busse. 1997. Detection surveys for fishers and American martens in California, 1989-1994: summary and interpretations. Pages 372-392 in G. Proulx, H. N. Bryant, and P. M. Woodard, editors. Martes: taxonomy, ecology, techniques and management. Proceedings of the Second International Martes Symposium, Edmonton, Alberta, Canada.

6.0 APPENDICIES

6.1 Appendix A. Alternative 2 - Proposed Action

6.2 Appendix B. Alternative 3

6.3 Appendix C. Maps for Alternative 2 and Alternative 3

6.4 Appendix D. Response to Comments

6.5 Appendix E: Annual-seasonal road closures associated with Port-Orford cedar.

6.6 Appendix F. Economic analysis

6.7 Appendix G. Best Management Practices Implementation

6.8 Appendix H. Management Indicator Species

6.9 Appendix I. Road Maintenance Level Descriptions (FSH 7709.58)

6.1 Appendix A. Alternative 2 - Proposed Action

6.1.1 Table 1. Orleans Transportation and Road Restoration Project - Blue Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action						
			Objective Maintenance Level				Non-motorized trail	Decommission	Treatment Notes
			5 and 4	3	2	1			
12N11	3.48	2					3.48		**Non-motorized trail**
12N11A	0.44	2					0.44		**Non-motorized trail**
12N11B	0.27	2					0.27		**Non-motorized trail**
13N01.100	0.33	NS						0.33	**Decommission**
13N01.102	0.12	NS						0.12	**Decommission**
13N01.51	0.60	NS						0.60	**Decommission**
13N01A.1	0.48	NS						0.48	**Decommission**
13N01E	1.32	2						1.32	**Decommission**
13N01J	1.27	2						1.27	**Decommission**
13N01K	1.32	2					1.32		**Non-motorized trail**
13N01M	0.36	1						0.36	**Decommission**
13N10	2.76	3		2.76					**Keep and Maintain**
13N45	1.79	2						1.79	**Decommission**
13N46	1.87	2						1.87	**Decommission**
13N47	1.60	1						1.60	**Decommission**
13N48	1.09	2						1.09	**Decommission**
13N57	1.12	1						1.12	**Decommission**
13N60	0.50	3		0.50					**Keep and maintain**
14N02	10.10	2			8.90			1.20	**Keep and maintain** to trail head, **Decommission** past junction with 14N02D
14N02A	0.20	1						0.20	**Decommission**
14N02D	1.10	1						1.10	**Decommission**
14N02G	0.19	2						0.19	**Decommission**
TOTAL	**32.31**		**0.00**	**3.26**	**8.90**	**0.00**	**5.51**	**14.64**	

6.1.2 Table 2. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action							Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	
			5 and 4	3	2	1				
10N06	3.60	3		3.60						**Keep and maintain**. Improve road for water quality purposes, replace old and undersized pipes, maintain POC gate, high public use, need also for access for fisheries surveys
10N06.1	0.16	NS		0.16						**Upgrade** and place on transportation system
10N06.2	0.10	NS							0.10	**Decommission**
10N06.5	0.10	NS							0.10	**Decommission**
10N12	3.24	4	2.70						0.54	**Keep and maintain. Decommission** past intersection with 10N51 to end of road due to high risk of POC (approx .5 mi)
10N12.1	0.20	NS							0.20	**Decommission**
10N12.3	1.20	NS							1.20	**Decommission**
10N12.4	0.10	NS							0.10	**Decommission**
10N12.5	0.07	NS							0.07	**Decommission**
10N12A	1.20	2							1.20	**Decommission**
10N12C	0.30	1							0.30	**Decommission**
10N12D	0.55	1							0.55	**Decommission**
10N14	1.70	2			1.70					**Keep and maintain**
10N22	0.75	1							0.75	**Decommission**
10N22A	0.30	1							0.30	**Decommission**
10N27.1	0.30	NS							0.30	**Decommission**
10N27.2	0.20	NS							0.20	**Decommission**
10N27B	0.60	1							0.60	**Decommission**
10N41	2.20	2			2.20					**Keep and maintain**

6.1.2 Table 2. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action							Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	
			5 and 4	3	2	1				
10N42	2.20	2			2.20					**Keep and maintain**
10N43	0.90	2							0.90	**Decommission**
10N43.1	0.30	NS							0.30	**Decommission**
10N43A	0.25	1							0.25	**Decommission**
10N51	1.50	4	1.50							**Keep and maintain**
11N02	3.60	2							3.60	**Decommission**
11N02.1	0.65	NS							0.65	**Decommission**
11N02B	0.18	1							0.18	**Decommission**
11N02B.1	2.5	NS							2.50	**Decommission**
11N04	2.40	2							2.40	**Decommission**
11N04.1	0.15	NS							0.15	**Decommission**
11N04A	0.40	1							0.40	**Decommission**
11N04C	0.85	2							0.85	**Decommission**
11N05	10.60	3		10.60						**Keep and maintain**
11N05M	0.17	1							0.17	**Decommission**
11N10	0.40	2			0.40					**Keep and maintain** road to Onion Lake. Portion of road past lake already decommissioned.
11N10.1	0.15	NS			0.15					**Upgrade** road and place on transportation system as level 2. Road to Onion Lake. Improve condition and reduce water quality concerns
11N15	0.64	1				0.64				**Keep and maintain**
11N15A	0.30	1				0.30				**keep and maintain**
11N15B	0.15	1				0.15				**keep and maintain**
11N15C	0.91	1							0.91	**Decommission**

6.1.2 Table 2. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action							Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	
			5 and 4	3	2	1				
11N16	4.87	2			1.57				3.30	**Keep and maintain** to 11N16P (near Rock Prairie), **improve/**upgrade pipes and diversion on this section. Past 11N16P, **Decommission** approx last 3.3 miles
11N16A	0.27	2							0.27	**Decommission**
11N16B	0.10	1							0.10	**Decommission**
11N16C	0.70	1							0.70	**Decommission**
11N16D	0.26	1				0.26				**Keep and maintain**
11N16E	0.85	1							0.85	**Decommission**
11N16F	0.20	1							0.20	**Decommission**
11N16H	0.95	1							0.95	**Decommission**
11N16J	0.52	1							0.52	**Decommission**
11N16P	0.10	2			0.10					**Keep and maintain**
11N16R	1.07	2			1.07					**Keep and maintain**
11N16S	1.07	1							1.07	**Decommission**
11N17	1.35	2			0.25				1.10	**Keep and maintain** section off of 13NO1, **Decommission** 11N17 from junction with 11N17F north to 11N21
11N17.1	0.25	NS							0.25	**Decommission**
11N17A	0.40	1							0.40	**Decommission**
11N17F	1.50	1				1.50				**Keep and maintain**
11N17F.1	0.30	NS							0.30	**Decommission**
11N17F.2	0.25	NS							0.25	**Decommission**
11N19	3.31	2							3.31	**Decommission**
11N19B	0.55	1							0.55	**Decommission**
11N20	0.16	2							0.16	**Decommission**

6.1.2 Table 2. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action: Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	Treatment Notes
			5 and 4	3	2	1				
11N20A	0.40	1							0.40	**Decommission**
11N20B	0.45	1							0.45	**Decommission**
11N21	7.00	2			2.10				4.90	**Decommission** 11N21 north of intersection of 13N02 and **decommission** portion of 11N21 south of 10N14. Build alternate water source on 11N17F to mitigate loss of water source on 11N21 and gate. **Keep and maintain** remaining portion of 11N21, needs funding, many water quality improvements needed with CMPs and drainage.
11N21.1	0.10	NS							0.10	**Decommission**
11N21.2	0.08	NS							0.08	**Decommission**
11N21.3	0.04	NS							0.04	**Decommission**
11N21B	0.90	1							0.90	**Decommission**
11N21H	0.20	1							0.20	**Decommission**
11N21F	1.00	1							1.00	**Decommission**
11N29	0.50	1							0.50	**Decommission**
11N29A	0.07	1							0.07	**Decommission**
11N35	2.55	2							2.55	**Decommission**
11N35A	1.50	2							1.50	**Decommission**
11N35D	0.30	1							0.30	**Decommission**
11N37	3.20	2							3.20	**Decommission**, provide alternate water source (10N06 maybe better water source)
11N40	2.00	2							2.00	**Decommission**

6.1.2 Table 2. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action							Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	
			5 and 4	3	2	1				
11N40.1	0.10	NS							0.10	**Decommission**
11N40.2	0.26	NS							0.26	**Decommission**
11N47	4.47	2			1.37				3.10	**Keep and maintain** to intersection with 11N47C spur. **Decommission** last 3.1 mi past 11N47C spur
11N47.1	0.07	NS							0.07	**Decommission**
11N47.2	0.20	NS							0.20	**Decommission**
11N47A	0.34	2			0.34					**Keep and maintain**
11N47B	0.31	1				0.31				**Keep and maintain**
11N47C	0.73	1							0.73	**Decommission**
12N03	0.84	1							0.84	**Decommission**
12N08	3.30	2			1.20				2.10	**Keep and maintain** ridge top portion of road (approx 1.2 Mi), **Decommission** remaining 2.1 mi.
12N08A	0.22	1							0.22	**Decommission**
12N10	7.20	3		7.20						**Keep and maintain**, large CIP investment, needs major public safety and water quality improvements
12N10.1	0.20	NS			0.20					**Upgrade** and place on FS road system
12N10.2	0.30	NS							0.30	**Decommission**
12N10.5	0.05	NS							0.05	**Decommission**
12N10.6	0.10	NS							0.10	**Decommission**
12N10.8	0.20	NS							0.20	**Decommission**
12N10.9	0.50	NS							0.50	**Decommission**

6.1.2 Table 2. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action							Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	
			5 and 4	3	2	1				
12N10C	1.05	1				0.45			0.60	**Keep and Maintain** first .45 miles**. Decommission** past rock source
12N10D	0.40	1							0.40	**Decommission**
12N10E	0.18	1							0.18	**Decommission**
12N10F	0.40	1							0.40	**Decommission**
12N10H	0.20	1							0.20	**Decommission**
12N12	1.00	3		1.00						**Keep and maintain**, upgrade cmps where needed
12N12A	0.25	1				0.25				**Keep and maintain**
12N12D	0.10	1				0.10				**Keep and maintain**
12N13	6.80	3		6.80						**Keep and maintain**, upgrade for water quality purposes, replace old and undersized pipes, maintain POC gate, high public use
12N13A	0.90	1							0.90	**Decommission**
12N13A.1	0.45	NS							0.45	**Decommission**
12N13A.2	0.35	NS							0.35	**Decommission**
12N13B	1.38	1				1.38				**Keep and maintain**
12N13B.1	0.25	NS							0.25	**Decommission**
12N13C	1.40	2			1.40					**Keep and maintain**
12N13D	1.53	1				1.53				**Keep and maintain**
12N13E	0.20	1				0.20				**Keep and maintain**
12N13F	1.40	2			0.90				0.50	**Keep and Maintain**. **Decommission** last .5 miles.
12N13G	0.35	1							0.35	**Decommission**

6.1.2 Table 2. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action							Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	
			5 and 4	3	2	1				
12N13H	2.70	1			2.70					**Upgrade** to level 2, acquire CIP funding, improve condition and reduce water quality concerns
12N13H.2	0.25	NS			0.25					**Upgrade** and add to Forest system as level 2
12N13J	1.08	1				1.08				**Keep and maintain**
12N13J.1	0.80	NS							0.80	**Decommission**
12N13K	0.75	1				0.75				**Keep and maintain**
12N13L	0.20	1				0.20				**Keep and maintain**
12N14	3.80	2			3.80					**Keep and maintain**
12N14.3	0.24	NS							0.24	**Decommission**
12N14.4	0.25	NS							0.25	**Decommission**
12N14A	0.68	1							0.68	**Decommission**
12N14B	0.31	1							0.31	**Decommission**
12N14C	0.42	1							0.42	**Decommission**
12N14D	0.80	1							0.80	**Decommission**
12N14E	0.97	1							0.97	**Decommission**
12N14G	0.42	1							0.42	**Decommission**
12N14H	0.25	1							0.25	**Decommission**
12N17	3.30	2			1.50				1.80	**Keep and maintain** 12N17 from junction of 11N47 to junction of 11N15, upgrade and correct water quality concerns on this section; **Decommission** 12N17 approx 1.8 mi past junction with 11N15
12N17A	1.00	1							1.00	**Decommission**
12N17B	0.73	1							0.73	**Decommission**

6.1.2 Table 2. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action							Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	
			5 and 4	3	2	1				
12N17C	0.39	1							0.39	**Decommission**
12N17G	0.12	1							0.12	**Decommission**
12N27	0.73	1				0.73				**Keep and maintain**
12N27A	0.24	1				0.24				**Keep and maintain**
12N30	0.42	1				0.42				**keep and maintain**
12N30H	0.20	1				0.20				**keep and maintain**
12N31	2.87	2			2.87					**Keep and maintain**
12N31A	0.42	1							0.42	Already partly decommissioned; **Decommission** remainder of road
12N31B	0.69	2			0.69					**Keep and maintain**
12N31D	0.64	1							0.64	**Decommission**
12N31E	1.10	2			1.10					**Keep and maintain**
12N31E.2	0.13	NS							0.13	**Decommission**
12N31F	0.25	1				0.25				**Keep and maintain**
12N31G	0.30	1							0.30	**Decommission**
12N32	1.12	1							1.12	**Decommission**
12N34	1.72	1				1.72				**Keep and maintain**
12N34A	0.29	1				0.29				**Keep and maintain**
12N34B	0.50	1				0.50				**Keep and maintain**
12N42	1.10	1				1.10				**Keep and maintain**
12N42.1	1.00	NS							1.00	**Decommission**
12N42A	0.08	1				0.08				**Keep and maintain**
12N43	0.50	1				0.50				**Keep and maintain**
12N44	1.55	1				1.55				**Keep and maintain**
12N44A	0.50	1							0.50	**Decommission**
12N44B	0.34	1				0.34				**Keep and maintain**

6.1.2 Table 2. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action							Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	
			5 and 4	3	2	1				
13N01	36.00	4	36.00							**Keep and maintain**, improve culverts and water quality concerns where needed
13N01.1	0.05	NS							0.05	**Decommission**
13N01.2	0.50	NS							0.50	**Decommission**
13N01.3	0.05	NS							0.05	**Decommission**
13N01.4	0.07	NS							0.07	**Decommission**
13N01.5	0.05	NS							0.05	**Decommission**
13N01.6	1.00	NS							1.00	**Decommission**
13N01.7	0.10	NS							0.10	**Decommission**
13N01.10	0.10	NS							0.10	**Decommission**
13N01A	1.00	1				1.00				**Keep and maintain**
13N01B	1.10	1							1.10	**Decommission**
13N01C	1.20	2			1.20					**Keep and maintain**
13N01F	0.65	2							0.65	**Decommission**
13N01H	1.20	2			1.20					**Keep and maintain**
13N01Q	0.25	1							0.25	**Decommission**
13N01S	1.20	1							1.20	**Decommission**
13N01T	0.45	1							0.45	**Decommission**
13N01V	0.25	1							0.25	**Decommission**
13N01W	0.20	1				0.20				**keep and maintain**
13N02	0.70	2			0.70					**Keep and maintain** .7 mi, already decommissioned from 13N02B to Louse Camp
13N02B	0.20	2			0.20					**Keep and maintain** from junction of 13N02 to 13N02C , remaining portion already decommissioned

6.1.2 Table 2. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action: Objective Maintenance Level 5 and 4	3	2	1	Non-motorized trail	Motorized Trail	Decommission	Treatment Notes
13N02C	1.30	1				1.30				**Decommission**
13N02D	0.60	2							0.60	**Keep and maintain**
13N05	0.66	1				0.66				**Keep and maintain**
13N06	0.21	1				0.21				**Keep and maintain**
13N09	0.25	1				0.25				**Keep and maintain**
13N11	0.63	1				0.63				**Keep and maintain**
13N15	0.50	1				0.50				**Keep and maintain**
13N21	2.41	2			2.41					**Keep and maintain**
13N21A	0.05	1				0.05				**Keep and maintain**
13N21B	0.19	1							0.19	**Decommission**
13N21C	0.60	1							0.60	**Decommission**
13N22	0.90	2			0.90					**Keep and maintain**
13N22A	0.10	1				0.10				**Keep and maintain**
13N23	1.00	1				1.00				**Keep and maintain**
15N01	1.60	5	1.60							**Keep and maintain**
JG502	0.10	NS							0.10	**Decommission**
JG503	0.60	NS							0.60	**Decommission**
JG504	0.04	NS							0.04	**Decommission**
JG505	0.07	NS							0.07	**Decommission**
JM505	1.20	NS							1.20	**Decommission**
MM533	0.08	NS							0.08	**Decommission**
MM534	0.30	NS							0.30	**Decommission**
MM535	0.30	NS							0.30	**Decommission**
JM502	0.04	NS							0.04	**Decommission**
JM513	0.06	NS						0.06		**Motorized trail to dispersed camp (hunters) near Divide Lake -** put on FS trail system; 4X4 OHV jeep access >50" vehicle class or licensed

6.1.2 Table 2. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action							Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	
			5 and 4	3	2	1				
MM521	0.09	NS							0.09	**Decommission**
MM524	0.04	NS							0.04	**Decommission**
MM525	0.04	NS							0.04	**Decommission**
AD002	0.05	NS						0.05		**Motorized trail to dispersed camp (hunters) -** put on FS trail system; 4X4 OHV jeep access >50" vehicle class or licensed
TOTAL	**219.85**		**41.80**	**29.20**	**36.83**	**22.92**	**0.00**	**0.11**	**88.99**	

6.1.3 Table 3. Orleans Transportation and Road Restoration Project - Camp Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action						Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Decommission	
			5 and 4	3	2	1			
11N03	0.20	1				0.20			**Keep and maintain**
11N13	0.88	1				0.88			**Keep and maintain**
11N13A	0.22	1				0.22			**Keep and maintain**
11N14	0.95	2						0.95	**Decommission**
11N23	1.05	1				1.05			**Keep and maintain**
11N24	1.03	1				1.03			**Keep and maintain**
11N30	1.77	2			1.77				**Keep and maintain**
11N30A	0.50	1				0.50			**Keep and maintain**
11N30C	0.51	1				0.51			**Keep and maintain**
11N31	2.00	2			2.00				**Keep and maintain**
11N31A	1.11	1				0.50		0.61	**Decommission**
11N31B	0.57	1				0.57			**Keep and maintain**
11N31C	0.75	1				0.75			**Keep and maintain**
11N38	2.00	2						2.00	**Decommission**

6.1.3 Table 3. Orleans Transportation and Road Restoration Project - Camp Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action						Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Decommission	
			5 and 4	3	2	1			
11N44	1.80	2						1.80	**Decommission**
11N45	5.63	3		5.63					**Keep and maintain**, improve water quality concerns with CIP improvements
11N45A	0.99	1						0.99	**Decommission**
11N50	2.41	2						2.41	**Decommission**
11N50.1	3.80	NS						3.80	**Decommission**
11N55	1.90	2			0.80			1.10	**Keep and maintain** 1.25 miles, **decommission** last .75 miles
11N60	0.75	1				0.75			**Keep and maintain**
12N01	1.39	3		1.39					**Keep and maintain**, improve water quality issues, culverts etc.
12N02	1.47	2			0.40			1.07	**Keep and maintain** until intersection with 12N02B spur, **decommission** last 2 miles
12N02A	0.82	2						0.82	**Decommission**
12N02B	1.09	2			1.09				**Keep and maintain**
12N02C	0.40	1				0.40			**Keep and maintain**
12N04	0.32	2			0.32				**Keep and maintain**
12N04A	0.34	2			0.34				**Keep and maintain**
12N05	2.30	2						2.30	**Decommission**
12N12C	2.95	2						2.95	**Decommission**. Develop alternative water source.
12N12E	0.98	1						0.98	**Decommission**
12N12G	0.18	1						0.18	**Decommission**
12N15	1.23	2			1.23				**Keep and maintain**
12N15A	0.60	1				0.60			**Keep and maintain**

6.1.3 Table 3. Orleans Transportation and Road Restoration Project - Camp Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action: Objective Maintenance Level						Treatment Notes
			5 and 4	3	2	1	Non-motorized trail	Decommission	
12N15B	0.09	1				0.09			**Keep and maintain**
12N16	1.70	2			1.70				**Keep and maintain**
12N16A	0.40	2			0.40				**Keep and maintain**
12N16B	0.45	1				0.45			**Keep and maintain**
12N18	1.30	2						1.30	**Decommission**
12N18A	0.33	1						0.33	**Decommission**
12N19	2.93	2			1.93			1.00	**Keep and maintain** to 0.5 miles past the 12N19A spur; **Decommission** remaining portion
12N19A	0.40	1						0.40	**Decommission**
12N20	5.90	3		4.10				1.80	**Keep and maintain**; improve with road with CIP funding. Decommission remaining road past 12N20H
12N20A	0.23	1						0.23	**Decommission**
12N20C	0.27	1				0.27			**Keep and maintain**
12N20D	0.91	2			0.61			0.30	**Keep and maintain** until junction 12N20J, **Decommission** past J spur
12N20E	0.24	2						0.24	**Decommission**
12N20G	0.74	1				0.54		0.20	**Keep and maintain** until junction w/12N20D, **Decommission** remaining road past D spur
12N20H	2.00	1				2.00			**Keep and maintain**
12N20J	1.30	1						1.30	**Decommission**
12N20K	0.45	1				0.45			**Keep and maintain**
12N23	0.60	2						0.60	**Decommission**
12N23A	0.20	1						0.20	**Decommission**

6.1.3 Table 3. Orleans Transportation and Road Restoration Project - Camp Creek									
			Alternative 2 - Proposed Action						
			Objective Maintenance Level						
Road #	**Length (mi.)**	**Current OML**	**5 and 4**	**3**	**2**	**1**	**Non-motorized trail**	**Decommission**	**Treatment Notes**
12N35	3.00	2			2.20			0.80	**Keep and maintain** until switch before 12N35 A, **Decommission** remaining portion
12N35A	0.40	1						0.40	**Decommission**
12N35B	0.85	2			0.85				**Keep and maintain**
12N36	2.64	2			1.14			1.50	**Keep and maintain** until junction w/12N36A at gate, **Decommission** remaining road past A spur
12N36A	1.33	2						1.33	**Decommission**
12N36B	0.63	2			0.63				**Keep and maintain**
12N36C	0.22	2						0.22	**Decommission**
12N37	1.50	2			0.90			0.60	**Keep and maintain** until junction of 12N37C, **Decommission** remaining road12N37
12N37B	0.62	2			0.62				**Keep and maintain**
12N37B.1	0.39	NS						0.39	**Decommission**
12N37C	0.90	2			0.90				**Keep and maintain**
12N37E	0.90	1						0.90	**Decommission**
12N37E.1	0.37	NS						0.37	**Decommission**
12N37G	0.36	2			0.36				**Keep and maintain**
12N38	1.00	2			0.65			0.35	**Keep and maintain** to water source, **Decommission** past water source
12N38A	0.15	2						0.15	**Decommission**
12N38B	0.14	1						0.14	**Decommission**
12N39	1.80	2			1.00			0.80	**Keep and maintain** until junction of 12N39C, **Decommission** remaining road12N39 including B spur
12N39B	0.64	1						0.64	**Decommission**
12N39C	0.22	2			0.22				**Keep and maintain**

6.1.3 Table 3. Orleans Transportation and Road Restoration Project - Camp Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action						Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Decommission	
			5 and 4	3	2	1			
12N40	3.80	2			2.60			1.20	**Keep and maintain** to intersection with 12N40D; **Decommission** remaining approx. 2 miles
12N40B	1.52	2						1.52	**Decommission**
12N40D	0.40	2			0.40				**Keep and maintain**
12N40F	0.64	2			0.64				**Keep and maintain**
12N40G	1.27	2						1.27	**Decommission**
12N40H	1.52	2						1.52	**Decommission**
12N40J	0.19	2						0.19	**Decommission**
12N46	1.00	1						1.00	**Decommission**
12N46B	0.36	1						0.36	**Decommission**
12N48	0.60	1				0.60			**Keep and maintain**
12N48A	0.08	1				0.08			**Keep and maintain**
12N49	0.64	2			0.64				**Keep and maintain**
12N49A	0.05	1				0.05			**Keep and maintain**
12N50	0.07	1				0.07			**Keep and maintain**
12N50A	0.20	1				0.20			**Keep and maintain**
12N51	0.45	2						0.45	**Decommission**
12N52	0.15	2						0.15	**Decommission**
12N53	0.19	2			0.19				**Keep and maintain**
12N54	0.45	1				0.45			**Keep and maintain**
15N01C	0.83	2			0.83				**Keep and maintain**
15N01F	0.36	1				0.36			**Keep and maintain**
JG501	0.10	NS						0.10	**Decommission**
JG506	0.10	NS						0.10	**Decommission**
JG508	0.06	NS						0.06	**Decommission**
TOTAL	**98.42**		**0.00**	**11.12**	**27.36**	**13.57**	**0.00**	**46.37**	

6.1.4 Table 4. Orleans Transportation and Road Restoration Project - Lower Middle Klamath

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action: Objective Maintenance Level 5 and 4	3	2	1	Non-motorized trail	Decommission	Treatment Notes
10N04	2.90	2			1.30	1.60			**Keep and maintain** road, upgrade 2 culverts, at the intersection of 11N01 block 10N04 and change to OML 1 to terminus, repair POC gate
10N04A	0.30	1						0.30	**Decommission**
10N05C	2.70	2			2.70				**Keep and maintain** road, remove TS gate, need culvert and ditch cleaning
10N05F	0.40	2				0.40			**Downgrade** to OML 1, brush road
10N05G	0.30	2			0.30				**Keep and maintain**
10N05L	0.30	1				0.30			**Keep and maintain**
10N05M	0.80	1				0.80			**Keep and maintain**
10N05N	0.70	1				0.70			**Keep and maintain**
10N07	1.10	2			1.10				**Keep and maintain**
10N08	0.50	1				0.50			**Keep and maintain**
10N09	4.40	2			4.40				**Keep and maintain** road, remove old upper TS gate
10N10	3.80	3		3.80					**Keep and maintain**
10N10B	0.30	1				0.30			**Keep and maintain**
10N10H	0.60	2				0.60			**Downgrade** to OML 1
10N11	0.50	1						0.50	**Decommission**
10N13	4.50	3		3.20	1.30				**Downgrade** from OML 3 to 2 from 10N13A to terminus of 10N13, needs maintenance, upgrade culverts
10N13.1	0.30	NS						0.30	**Decommission**
10N13.2	2.60	NS						2.60	**Decommission**
10N13.3	0.50	NS						0.50	**Decommission**
10N13A	0.60	1						0.60	**Decommission**

6.1.4 Table 4. Orleans Transportation and Road Restoration Project - Lower Middle Klamath

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action						Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Decommission	
			5 and 4	3	2	1			
10N13B	0.40	1				0.40			**Keep and maintain**
10N13C	0.50	1				0.50			**Keep and maintain**
10N13D	0.90	2			0.90				**Keep and maintain**
10N13E	0.10	1				0.10			**Keep and maintain**
10N13F	0.40	2				0.40			**Downgrade** OML 1
10N15	1.40	1				1.40			**Keep and maintain**, install diversion dip
10N15A	0.40	1						0.40	**Decommission**
10N15B	0.20	1				0.20			**Keep and maintain**
10N16	0.60	1				0.60			**Keep and maintain**
10N17	1.60	1						1.60	**Decommission**
10N18	0.90	1			0.90				**Upgrade** to OML 2, keep TS gate-seasonal closure necessary until road surface is adequately rocked. Waterbar entrance.
10N18A	0.20	1				0.20			**Keep and maintain**
10N20	0.20	2		0.20					**Upgrade** to OML 3, needs paving, CIP $, excellent candidate to partner with State for $ to pave upper access
10N25	4.90	2			4.90				**Keep and maintain**
10N27	1.70	2			1.70				**Keep and maintain** (moderate to high road maintenance needed), unplug or replace plugged CMPs
10N27A	0.30	1						0.30	**Decommission**
10N28	0.10	2		0.10					**Upgrade** to OML 3. Needs seasonal maintenance and riprap to armor right bank for treatment facility
10N34	1.00	1				1.00			**Keep and maintain** road, high risk of spread of POC root disease, maintain POC gate to protect POC stands, Yurok access

6.1.4 Table 4. Orleans Transportation and Road Restoration Project - Lower Middle Klamath

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action: Objective Maintenance Level 5 and 4	3	2	1	Non-motorized trail	Decommission	Treatment Notes
10N34.1	0.30	NS						0.30	Decommission
10N34A	0.40	1				0.40			**Keep and maintain**
10N41	2.60	2			1.20			1.40	**Keep and maintain**; needs substantial road maintenance work. **Decommission** portion of road from intersection of 10N34 to terminus, remove gate and block road to protect POC stands
10N41A	0.40	1						0.40	**Decommission**
10N41B	0.20	1						0.20	**Decommission**
10N45	3.60	2			0.80			2.80	**Keep and maintain** road, **decommission** portion of road from the junction of 10N46 to terminus (currently inpassable)
10N45A	0.20	2			0.20				**Keep and maintain**
10N46	0.60	2			0.60				**Keep and maintain**, road needs to be assessed for culvert upgrades and slump repairs
10N47A	1.50	2			1.30	0.20			**Keep and maintain** as OML 2 to Trail Creek, **Downgrade** to OML 1 to terminus
10N47B	0.30	2				0.30			**Downgrade** to OML 1
10N47D	0.30	1				0.30			**Keep and maintain**
10N47E	0.40	1				0.40			**Keep and maintain**
10N47F	0.30	1				0.30			**Keep and maintain**
10N47W	0.30	1				0.30			**Keep and maintain**
10N70	0.20	4	0.20						**Keep and maintain**, keep campground gates, needs paving, possible CIP $
10N72	0.40	3		0.40					**Keep and maintain**
10N74	0.20	3		0.20					**Keep and maintain**

6.1.4 Table 4. Orleans Transportation and Road Restoration Project - Lower Middle Klamath

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action						Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Decommission	
			5 and 4	3	2	1			
10N75	1.00	3		0.80				0.20	**Keep and maintain**, **decommission** portion within Aikens Campground
10N76	0.40	3		0.40					**Keep and maintain**
11N01	2.60	2				2.60			**Downgrade** to OML 1
11N01B	0.20	1						0.20	**Decommission**
11N01C	0.30	1				0.30			**keep and maintain**
11N05	12.40	4	12.40						**Keep and maintain**, needs CIP funding, avoid sensitive plant populations, culvert upgrades
11N05A	1.20	2				1.20			**Keep and maintain** portion of road to rockpit, **Downgrade** to OML 1 from rock pit to terminus
11N05D	0.30	2				0.30			**Downgrade** to OML 1
11N05E	0.30	1				0.30			**Keep and maintain**
11N05F	0.30	2				0.30			**Downgrade** to OML 1
11N05K	0.70	1				0.70			**Keep and maintain**
11N05L	0.50	1				0.50			**Keep and maintain**
11N05N	0.30	1				0.30			**Keep and maintain**
11N06	0.60	2			0.60				**Keep and maintain**, needs CIP funding
11N06A	0.30	2			0.30				**Keep and maintain**, needs CIP funding
11N08	1.70	2			1.70				**Keep and maintain**, ditch and cuvert cleanup
11N11	3.10	4	3.10						**Keep and maintain**, routine maintenance in upper segment needs CIP funding
11N12	2.50	2			2.50				**Keep and maintain**
11N12A	0.20	1				0.20			**Keep and maintain**
11N12B	0.30	1				0.30			**keep and maintain**

6.1.4 Table 4. Orleans Transportation and Road Restoration Project - Lower Middle Klamath

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action						Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Decommission	
			5 and 4	3	2	1			
11N16G	0.90	1				0.90			**Keep and maintain**
11N18	2.10	2						2.10	**Decommission**
11N18A	1.00	1						1.00	**Decommission**
11N26	1.20	2			1.20				**Keep and maintain**
11N26A	0.30	1						0.30	**Decommission**
11N28	1.00	1						1.00	**Decommission**, place barrier at start of road, high risk of spread of POC root disease
11N32	0.30	1				0.30			**Keep and maintain**
11N33	0.20	1				0.20			**Keep and maintain**
11N34	0.20	1				0.20			**Keep and maintain**
11N36	5.10	2			5.10				**Keep and maintain**
11N36A	1.30	2						1.30	**Decommission**
11N36B	1.20	1						1.20	**Decommission**
11N36C	0.50	1				0.50			**Keep and maintain**
11N36D	0.10	1						0.10	**Decommission**
11N36E	0.20	1						0.20	**Decommission**
11N36G	0.20	1				0.20			**Keep and maintain**
11N36T	0.10	1						0.10	**Decommission**
11N39	1.80	1						1.80	**Decommission**, place barrier at start of road, high risk of spread of POC root disease
11N41	0.30	1				0.30			**Keep and maintain**
11N42	2.00	2			1.30			0.70	**Keep and maintain**, **decommission** portion from intersection of 11N52, pull culvert and block access at Forest boundary, high risk of spread of POC disease

6.1.4 Table 4. Orleans Transportation and Road Restoration Project - Lower Middle Klamath									
			Alternative 2 - Proposed Action						
			Objective Maintenance Level				Non-motorized trail	Decommission	
Road #	Length (mi.)	Current OML	5 and 4	3	2	1			Treatment Notes
11N42A	0.50	1				0.50			**Keep and maintain**
11N45	5.60	3		5.60					**Keep and maintain**
11N46	3.40	2			0.10			3.30	**Keep and maintain** to tanker fill,upgrade culvert(s). **Decommission** from tanker fill to terminus
11N46.1	0.10	NS						0.10	**Decommission**
11N46A	0.70	1						0.70	**Decommission**
11N46B	0.20	1						0.20	**Decommission**
11N48	3.10	2			2.60	0.50			**Keep and maintain**, **downgrade** to OML 1 @ MP 2.6
11N48A	0.60	1				0.60			**Keep and maintain**
11N48E	0.20	1				0.20			**Keep and maintain**
11N49	2.80	1						2.80	**Decommission**, place barrier at start of road, high risk of spread of POC root disease
11N52	0.50	1				0.50			**Keep and maintain**
11N52A	0.20	1				0.20			**Keep and maintain**
11N53	0.30	1				0.30			**Keep and maintain**
11N54	0.20	2		0.20					**Upgrade** to OML 3
11N56	0.50	3		0.50					**Keep and maintain**, needs rock or paving, CIP funding
11N59	0.60	1				0.60			**Keep and maintain**
11N59A	0.30	1				0.30			**Keep and maintain**, pull culvert pipe @ MP 0.2 and create low water crossing
11N60	0.70	1			0.70				**Upgrade** to level 2, prvt property access, keep TS gate
11N61	0.30	3		0.30					**Keep and maintain**, keep recreation gate, needs rock or paving, CIP $

6.1.4 Table 4. Orleans Transportation and Road Restoration Project - Lower Middle Klamath

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action						Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Decommission	
			5 and 4	3	2	1			
11N62	0.30	4	0.30						**Keep and maintain**, keep both campground gates
11N65	1.30	2			1.30				**Keep and maintain**
11N65A	0.70	1						0.70	**Decommission**
11N65B	0.30	1				0.30			**Keep and maintain**
11N65C	0.40	1				0.40			**Keep and maintain**
11N70	0.50	4	0.50						**Keep and maintain**
11N71	0.10	2					0.10		Convert road to **Non-motorized trail**
11N72	0.30	2		0.30					**Upgrade** to OML 3, needs rocking
11N73	0.10	2						0.10	**Decommission**, public safety concerns
11N76	0.20	2			0.20				**Keep and maintain**
12N12	14.50	3		14.50					**Keep and maintain**, needs CIP funding, culvert(s) need to be improved
12N12B	0.30	2			0.30				**Keep and maintain**
12N12E	0.80	1				0.80			**Keep and maintain**, improve stream crossing, keep TS gate
12N12F	1.10	1				1.10			**Keep and maintain**
12N12G	0.20	1				0.20			**Keep and maintain**
12N12J	0.50	1				0.50			**keep and maintain**
13N01	19.00	4	19.00						**Keep and maintain**, needs CIP $, culvert cleaning, ditch cleaning
13N01.14	0.40	NS						0.40	**Decommission**
13N01.15	0.10	NS				0.10			**Upgrade** and add to system, emergency Tribal access
13N01.16	0.60	NS						0.60	**Decommission**
13N01.17	0.80	NS						0.80	**Decommission**
13N01.18	0.80	NS				0.80			**Upgrade** and add to system, emergency Tribal access

6.1.4 Table 4. Orleans Transportation and Road Restoration Project - Lower Middle Klamath

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action: Objective Maintenance Level 5 and 4	3	2	1	Non-motorized trail	Decommission	Treatment Notes
13N01.19	0.70	NS						0.70	**Decommission**
13N01.20	0.30	NS						0.30	**Decommission**
13N01N	0.40	1						0.40	**Keep and maintain**, needs culvert cleaning, ditch cleaning
13N01R	0.80	1						0.80	**Decommission**
13N04	0.50	1						0.50	**Decommission**
13N07	1.60	1				1.00		0.60	**Keep and maintain** 1 mile, **Decommission** last 0.6 miles, block access at end of road, high risk of spread of POC root disease
13N14	2.40	1			2.40				**Upgrade** to OML 2, needs CIP funding, improve culvert and other maintenance
13N14.1	0.50	NS						0.50	**Decommission**
13N18	2.00	3		2.00					**Keep and maintain**, needs improvements and CIP funding
13N18.1	0.50	NS						0.50	**Decommission**
13N18A	0.40	1			0.40				**Upgrade** to OML 2
13N18B	0.60	1				0.60			**Keep and maintain**
13N18C	0.50	2				0.50			**Downgrade** to OML 1, block road 200' from intersection
13N18D	0.40	1				0.40			**Keep and maintain**
15N01	2.00	5	2.00						**Keep and maintain**, needs CMP improvements
15N01.1	0.40	NS						0.40	**Decommission**
MM531	0.02	NS						0.02	**Decommission**

6.1.4 Table 4. Orleans Transportation and Road Restoration Project - Lower Middle Klamath									
			Alternative 2 - Proposed Action						
			Objective Maintenance Level						
Road #	**Length (mi.)**	**Current OML**	**5 and 4**	**3**	**2**	**1**	**Non-motorized trail**	**Decommission**	**Treatment Notes**
MM582	0.10	NS			0.10				**Upgrade** and add to system, Dolans Bar river access
MM583	0.10	NS		0.10					**Upgrade** and add to system, Dolans Bar river access
MM584	0.10	NS		0.10					**Upgrade** and add to system, Dolans Bar river access
MM593	0.10	NS			0.10				**Upgrade** and add to system, access to Le Perron Flat, dispearsed recreational use
JG601	0.10	NS						0.10	**Decommission**
JG602	0.20	NS			0.20				**Upgrade** and add to system. Day use and interpretative area, Bluff Creek overlook
JG507	0.10	NS						0.10	**Decommission**
MM539	0.08	NS						0.08	**Decommission**
MM592	0.05	NS						0.05	**Decommission**
MM594	0.09	NS						0.09	**Decommission**
MM591	0.10	NS			0.10				**Upgrade** and add to system; part of 10N25 Orleans Mnt Lookout.
TOTAL	**184.54**		**37.50**	**32.70**	**44.80**	**32.20**	**0.10**	**37.24**	

6.1.5 Table 5. Orleans Transportation and Road Restoration Project - Red Cap Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action: Objective Maintenance Level 5 and 4	3	2	1	Motorized Trail	Non-motorized trail	Decommission	Treatment Notes
09N31	3.17	2			3.17					**Keep and maintain**
09N31A	0.89	1				0.89				**Keep and maintain**
09N31B	0.72	1				0.72				**Keep and maintain**
09N31C	0.27	1				0.27				**Keep and maintain**
09N31D	1.93	1				1.93				**Keep and maintain**
09N31E	1.18	1							1.18	**Decommission**
09N31G	0.16	1				0.16				**Keep and maintain**
09N31H	0.79	1				0.79				**Keep and maintain**
09N31J	0.69	1				0.69				**Keep and maintain**
09N32	2.35	2			2.35					**Keep and maintain**
09N32A	0.65	1				0.65				**Keep and maintain**
09N32B	0.32	1				0.32				**Keep and maintain**
09N32C	1.00	1							1.00	**Decommission**
09N32D	0.87	1				0.87				**Keep and maintain**
10N01	16.80	3		16.80						**Keep and maintain,** improve road through culvert and water quality investments; CIP funding
10N01.1	2.28	NS							2.28	**Decommission**
10N01.1A	0.45	NS							0.45	**Decommission**
10N01.2	0.10	NS							0.10	**Decommission**
10N01.2A	0.40	NS							0.40	**Decommission**
10N01.3	0.12	NS							0.12	**Decommission**
10N01.4	0.08	NS							0.08	**Decommission**
10N01.5	0.20	NS							0.20	**Decommission**
10N01.6	0.18	NS							0.18	**Decommission**

6.1.5 *Table 5. Orleans Transportation and Road Restoration Project - Red Cap Creek*

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action							Treatment Notes
			Objective Maintenance Level				Motorized Trail	Non-motorized trail	Decommission	
			5 and 4	3	2	1				
10N01.7	0.14	NS					0.14			**Motorized trail to dispersed (hunter) camps - put on FS trail system; 4X4 OHV jeep access >50" vehicle class and licensed**
10N01A	0.22	1				0.22				**Keep and maintain**
10N01C	0.86	2			0.86					**Keep and maintain**
10N01C.1	0.18	NS							0.18	**Decommission**
10N01D	0.62	1				0.62				**Keep and maintain**
10N01F	0.24	1				0.24				**Keep and maintain**
10N02	14.24	3		14.24						**Keep and maintain,** improve road through culvert and water quality investments; CIP funding
10N02.2	0.11	NS			0.11					**Upgrade** and add to FS system roads
10N02C	0.77	1				0.77				**Keep and maintain**
10N02F	1.49	1				1.49				**Keep and maintain**
10N02G	0.47	1				0.47				**Keep and maintain**
10N02H	1.03	1				1.03				**Keep and maintain**
10N02L	0.73	1							0.73	**Decommission**
10N02P	1.05	1				1.05				**Keep and maintain**
10N02P.1	0.25	NS							0.25	**Decommission**
10N03	8.75	3		8.75						**Keep and maintain,** improve road through culvert and water quality investments; CIP funding
10N03.1	1.34	NS							1.34	**Decommission**

6.1.5 Table 5. Orleans Transportation and Road Restoration Project - Red Cap Creek

			Alternative 2 - Proposed Action							
			Objective Maintenance Level							
Road #	**Length (mi.)**	**Current OML**	**5 and 4**	**3**	**2**	**1**	**Motorized Trail**	**Non-motorized trail**	**Decommission**	**Treatment Notes**
10N03.2	0.58	NS						0.58		**Non-Motorized trail**
10N03.3	0.07	NS							0.07	**Decommission**
10N03.4	0.14	NS							0.14	**Decommission**
10N03B	1.50	2			1.50					**Keep and maintain**
10N05	10.01	3		10.01						**Keep and maintain,** improve road through culvert and water quality investments; CIP funding
10N05A	2.65	1							2.65	**Decommission**
10N05D	0.75	1				0.75				**Keep and maintain**
10N05D.1	0.29	NS							0.29	**Decommission**
10N05E	1.92	2			1.03				0.89	**Keep and maintain** first 1.03 miles, **Decommission** remaining road
10N05J	0.86	2			0.86					**Keep and maintain**
10N05M	0.85	1				0.85				**Keep and maintain**
10N09	4.40	2			4.40					**Keep and maintain**
10N09.1	0.22	NS							0.22	**Decommission**
10N09B	0.31	1				0.31				**Keep and maintain**
10N09D	0.17	1				0.17				**Keep and maintain**
10N10	2.75	3		2.75						**Keep and maintain**
10N10A	2.96	2			2.96					**Keep and maintain**
10N10A.1	0.30	NS				0.30				**Upgrade** and add to FS system roads
10N10A.2	0.25	NS				0.25				**Upgrade** and add to FS system roads
10N10G	0.61	1				0.61				**Keep and maintain**
10N35	3.30	2			3.30					**Keep and maintain**

6.1.5 Table 5. Orleans Transportation and Road Restoration Project - Red Cap Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action: Objective Maintenance Level 5 and 4	3	2	1	Motorized Trail	Non-motorized trail	Decommission	Treatment Notes
10N35A	1.58	1				1.58				**Keep and maintain**
10N35A.1	0.12	NS							0.12	**Decommission**
10N35A.2	0.22	NS							0.22	**Decommission**
10N35B	1.23	1				1.23				**Keep and maintain**
10N35C	0.30	1				0.30				**Keep and maintain**
10N37	2.10	2			1.43				0.67	**Keep and maintain** first 1.4 miles, **Decommission** remaining road
10N37.1	0.25	NS							0.25	**Decommission**
10N37A	2.70	2			2.16				0.54	**Keep and maintain** first 2.2 miles, **Decommission** remaining road
10N37A.1	0.51	NS							0.51	**Decommission**
10N37A.2	0.18	NS							0.18	**Decommission**
10N37A.3	0.25	NS							0.25	**Decommission**
10N40	1.46	2			1.46					**Keep and maintain**
10N40A	1.48	2			1.48					**Keep and maintain**
10N40B	0.33	2			0.33					**Keep and maintain**
10N40C	0.21	2			0.21					**Keep and maintain**
10N40D	0.16	1				0.16				**Keep and maintain**
10N47	4.60	3		4.60						**Keep and maintain**
10N47.1	0.13	NS							0.13	**Decommission**
10N47C	0.36	1				0.36				**Keep and maintain**
10N47Z	0.77	1				0.77				**Keep and maintain**
10N50	1.41	2			1.41					**Keep and maintain**
10N50A	0.18	1				0.18				**Keep and maintain**
10N50B	0.21	2			0.21					**Keep and maintain**
10N71	1.86	1				1.86				**Keep and maintain**

6.1.5 Table 5. Orleans Transportation and Road Restoration Project - Red Cap Creek

Road #	Length (mi.)	Current OML	Alternative 2 - Proposed Action: Objective Maintenance Level 5 and 4	3	2	1	Motorized Trail	Non-motorized trail	Decommission	Treatment Notes
10N71A	0.31	1				0.31				**Keep and maintain**
10N71B	0.29	1				0.29				**Keep and maintain**
MM597	0.40	NS						0.40		**Non-Motorized trail to Schnable Diggings**
JM510	0.24	NS					0.24			**Motorized trail to dispersed (hunter) camps - put on FS trail system:** off of 9N31 E Packsaddle ridge.
JM511	0.10	NS							0.10	**Decommission**
MM595	0.06	NS					0.06			**Motorized trail to dispersed (hunter) camps - put on FS trail system; 4X4 OHV jeep access >50" vehicle use and licensed**
MM596	0.10	NS							0.10	**Decommission**
6E55 (Lubbs Trail)	3.10	trail					3.10			**Keep and maintain**, redefine as a trail for use by motorized vehicles $\leq$ 50 inches, needs trail improvements and treat fuel loads remaining from Megram Fire dozer fireline construction.
TOTAL	**130.16**		**0.00**	**57.15**	**29.23**	**23.45**	**3.54**	**0.98**	**15.82**	

6.2 Appendix B. Alternative 3

6.2.1 Table 6. Orleans Transportation and Road Restoration Project - Blue Creek

Road #	Length (mi.)	Current OML	Alternative 3: Objective Maintenance Level 5 and 4	3	2	1	Non-motorized trail	Decommission	Treatment Notes
12N11	3.48	2					3.48		**Non-motorized trail**
12N11A	0.44	2					0.44		**Non-motorized trail**
12N11B	0.27	2					0.27		**Non-motorized trail**
13N01.100	0.33	NS						0.33	**Decommission**
13N01.102	0.12	NS						0.12	**Decommission**
13N01.51	0.60	NS						0.60	**Decommission**
13N01A.1	0.48	NS						0.48	**Decommission**
13N01E	1.32	2						1.32	**Decommission**
13N01J	1.27	2						1.27	**Decommission**
13N01K	1.32	2					1.32		**Non-motorized trail**
13N01M	0.36	1						0.36	**Decommission**
13N10	2.76	3		2.76					**Keep and Maintain**
13N45	1.79	2						1.79	**Decommission**
13N46	1.87	2						1.87	**Decommission**
13N47	1.60	1						1.60	**Decommission**
13N48	1.09	2						1.09	**Decommission**
13N57	1.12	1						1.12	**Decommission**
13N60	0.50	3		0.50					**Keep and maintain**
14N02	10.10	2			8.90			1.20	**Keep and maintain** to trail head, **Decommission** past junction with 14N02D
14N02A	0.20	1						0.20	**Decommission**
14N02D	1.10	1						1.10	**Decommission**
14N02G	0.19	2						0.19	**Decommission**
TOTAL	**32.31**		**0.00**	**3.26**	**8.90**	**0.00**	**5.51**	**14.64**	

6.2.2 Table 7. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 3							Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	
			5 and 4	3	2	1				
10N06	3.60	3		3.60						**Keep and maintain**. Improve road for water quality purposes, replace old and undersized pipes, maintain POC gate, high public use, need also for access for fisheries surveys
10N06.1	0.16	NS		0.16						**Upgrade** and place on transportation system
10N06.2	0.10	NS							0.10	**Decommission**
10N06.5	0.10	NS							0.10	**Decommission**
10N12	3.24	4	2.70						0.54	**Keep and maintain. Decommission** past intersection with 10N51 to end of road due to high risk of POC (approx .5 mi)
10N12.1	0.20	NS							0.20	**Decommission**
10N12.3	1.20	NS							1.20	**Decommission**
10N12.4	0.10	NS							0.10	**Decommission**
10N12.5	0.07	NS							0.07	**Decommission**
10N12A	1.20	2							1.20	**Decommission**
10N12C	0.30	1							0.30	**Decommission**
10N12D	0.55	1							0.55	**Decommission**
10N14	1.70	2			1.70					**Keep and maintain**
10N22	0.75	1							0.75	**Decommission**
10N22A	0.30	1							0.30	**Decommission**
10N27.1	0.30	NS							0.30	**Decommission**
10N27.2	0.20	NS							0.20	**Decommission**
10N27B	0.60	1							0.60	**Decommission**
10N41	2.20	2			2.20					**Keep and maintain**
10N42	2.20	2			2.20					**Keep and maintain**

6.2.2 Table 7. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 3							Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	
			5 and 4	3	2	1				
10N43	0.90	2							0.90	**Decommission**
10N43.1	0.30	NS							0.30	**Decommission**
10N43A	0.25	1							0.25	**Decommission**
10N51	1.50	4	1.50							**Keep and maintain**
11N02	3.60	2							3.60	**Decommission**
11N02.1	0.65	NS							0.65	**Decommission**
11N02B	0.18	1							0.18	**Decommission**
11N02B.1	2.5	NS							2.50	**Decommission**
11N04	2.40	2							2.40	**Decommission**
11N04.1	0.15	NS							0.15	**Decommission**
11N04A	0.40	1							0.40	**Decommission**
11N04C	0.85	2							0.85	**Decommission**
11N05	10.60	3		10.60						**Keep and maintain**
11N05M	0.17	1							0.17	**Decommission**
11N10	0.40	2			0.40					**Keep and maintain** road to Onion Lake. Portion of road past lake already decommissioned.
11N10.1	0.15	NS			0.15					**Upgrade** road and place on transportation system as level 2. Road to Onion Lake. Improve condition and reduce water quality concerns
11N15	0.64	1				0.64				**Keep and maintain**
11N15A	0.30	1				0.30				**keep and maintain**
11N15B	0.15	1				0.15				**keep and maintain**
11N15C	0.91	1							0.91	**Decommission**

6.2.2 Table 7. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 3							Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	
			5 and 4	3	2	1				
11N16	4.87	2			1.57				3.30	**Keep and maintain** to 11N16P (near Rock Prairie), **improve/**upgrade pipes and diversion on this section. Past 11N16P, **Decommission** approx last 3.3 miles
11N16A	0.27	2							0.27	**Decommission**
11N16B	0.10	1							0.10	**Decommission**
11N16C	0.70	1							0.70	**Decommission**
11N16D	0.26	1				0.26				**Keep and maintain**
11N16E	0.85	1							0.85	**Decommission**
11N16F	0.20	1							0.20	**Decommission**
11N16H	0.95	1							0.95	**Decommission**
11N16J	0.52	1							0.52	**Decommission**
11N16P	0.10	2			0.10					**Keep and maintain**
11N16R	1.07	2			1.07					**Keep and maintain**
11N16S	1.07	1							1.07	**Decommission**
11N17	1.35	2			0.25				1.10	**Keep and maintain** section off of 13NO1, **Decommission** 11N17 from junction with 11N17F north to 11N21
11N17.1	0.25	NS							0.25	**Decommission**
11N17A	0.40	1							0.40	**Decommission**
11N17F	1.50	1				1.50				**Keep and maintain**
11N17F.1	0.30	NS							0.30	**Decommission**
11N17F.2	0.25	NS							0.25	**Decommission**
11N19	3.31	2							3.31	**Decommission**
11N19B	0.55	1							0.55	**Decommission**
11N20	0.16	2							0.16	**Decommission**

6.2.2 Table 7. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 3: Objective Maintenance Level 5 and 4	3	2	1	Non-motorized trail	Motorized Trail	Decommission	Treatment Notes
11N20A	0.40	1							0.40	**Decommission**
11N20B	0.45	1							0.45	**Decommission**
11N21	7.00	2			2.10				4.90	**Decommission** 11N21 north of intersection of 13N02 and **decommission** portion of 11N21 south of 10N14. Build alternate water source on 11N17F to mitigate loss of water source on 11N21 and gate. **Keep and maintain** remaining portion of 11N21, needs funding, many water quality improvements needed with CMPs and drainage.
11N21.1	0.10	NS							0.10	**Decommission**
11N21.2	0.08	NS							0.08	**Decommission**
11N21.3	0.04	NS							0.04	**Decommission**
11N21B	0.90	1							0.90	**Decommission**
11N21H	0.20	1							0.20	**Decommission**
11N21F	1.00	1							1.00	**Decommission**
11N29	0.50	1							0.50	**Decommission**
11N29A	0.07	1							0.07	**Decommission**
11N35	2.55	2							2.55	**Decommission**
11N35A	1.50	2							1.50	**Decommission**
11N35D	0.30	1							0.30	**Decommission**
11N37	3.20	2							3.20	**Decommission**, provide alternate water source (10N06 maybe better water source)
11N40	2.00	2							2.00	**Decommission**
11N40.1	0.10	NS							0.10	**Decommission**
11N40.2	0.26	NS							0.26	**Decommission**

6.2.2 Table 7. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 3							Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	
			5 and 4	3	2	1				
11N47	4.47	2			1.37				3.10	**Keep and maintain** to intersection with 11N47C spur. **Decommission** last 3.1 mi past 11N47C spur
11N47.1	0.07	NS							0.07	**Decommission**
11N47.2	0.20	NS							0.20	**Decommission**
11N47A	0.34	2			0.34					**Keep and maintain**
11N47B	0.31	1				0.31				**Keep and maintain**
11N47C	0.73	1							0.73	**Decommission**
12N03	0.84	1							0.84	**Decommission**
12N08	3.30	2			1.20				2.10	**Keep and maintain** ridge top portion of road (approx 1.2 Mi), **Decommission** remaining 2.1 mi.
12N08A	0.22	1							0.22	**Decommission**
12N10	7.20	3		7.20						**Keep and maintain**, large CIP investment, needs major public safety and water quality improvements
12N10.1	0.20	NS			0.20					**Upgrade** and place on FS road system
12N10.2	0.30	NS							0.30	**Decommission**
12N10.5	0.05	NS							0.05	**Decommission**
12N10.6	0.10	NS							0.10	**Decommission**
12N10.8	0.20	NS							0.20	**Decommission**
12N10.9	0.50	NS							0.50	**Decommission**
12N10C	1.05	1				0.45			0.60	**Keep and Maintain** first .45 miles**.** **Decommission** past rock source
12N10D	0.40	1							0.40	**Decommission**

6.2.2 Table 7. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 3							Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	
			5 and 4	3	2	1				
12N10E	0.18	1							0.18	**Decommission**
12N10F	0.40	1							0.40	**Decommission**
12N10H	0.20	1							0.20	**Decommission**
12N12	1.00	3		1.00						**Keep and maintain**, upgrade cmps where needed
12N12A	0.25	1				0.25				**Keep and maintain**
12N12D	0.10	1				0.10				**Keep and maintain**
12N13	6.80	3		6.80						**Keep and maintain**, upgrade for water quality purposes, replace old and undersized pipes, maintain POC gate, high public use
12N13A	0.90	1							0.90	**Decommission**
12N13A.1	0.45	NS							0.45	**Decommission**
12N13A.2	0.35	NS							0.35	**Decommission**
12N13B	1.38	1				1.38				**Keep and maintain**
12N13B.1	0.25	NS							0.25	**Decommission**
12N13C	1.40	2			1.40					**Keep and maintain**
12N13D	1.53	1							1.53	**Decommission**
12N13E	0.20	1				0.20				**Keep and maintain**
12N13F	1.40	2			0.90				0.50	**Keep and Maintain**. **Decommission** last .5 miles.
12N13G	0.35	1							0.35	**Decommission**
12N13H	2.70	1			1.94				0.76	**Upgrade** to level 2, acquire CIP funding, improve condition and reduce water quality concerns, **Decommission** last 0.76 miles of road, high POC risk concerns
12N13H.2	0.25	NS					0.25			**Non-motorized trail**

6.2.2 Table 7. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 3							Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	
			5 and 4	3	2	1				
12N13J	1.08	1				1.08				**Keep and maintain**
12N13J.1	0.80	NS							0.80	**Decommission**
12N13K	0.75	1				0.75				**Keep and maintain**
12N13L	0.20	1				0.20				**Keep and maintain**
12N14	3.80	2			3.80					**Keep and maintain**
12N14.3	0.24	NS							0.24	**Decommission**
12N14.4	0.25	NS							0.25	**Decommission**
12N14A	0.68	1							0.68	**Decommission**
12N14B	0.31	1							0.31	**Decommission**
12N14C	0.42	1							0.42	**Decommission**
12N14D	0.80	1							0.80	**Decommission**
12N14E	0.97	1							0.97	**Decommission**
12N14G	0.42	1							0.42	**Decommission**
12N14H	0.25	1							0.25	**Decommission**
12N17	3.30	2			1.50				1.80	**Keep and maintain** 12N17 from junction of 11N47 to junction of 11N15, upgrade and correct water quality concerns on this section; **Decommission** 12N17 approx 1.8 mi past junction with 11N15
12N17A	1.00	1							1.00	**Decommission**
12N17B	0.73	1							0.73	**Decommission**
12N17C	0.39	1							0.39	**Decommission**
12N17G	0.12	1							0.12	**Decommission**
12N27	0.73	1				0.73				**Keep and maintain**
12N27A	0.24	1				0.24				**Keep and maintain**
12N30	0.42	1				0.42				**keep and maintain**
12N30H	0.20	1				0.20				**keep and maintain**

6.2.2 Table 7. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 3							Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	
			5 and 4	3	2	1				
12N31	2.87	2			2.87					**Keep and maintain**
12N31A	0.42	1				0.42				**Keep and maintain** to 12N31F, remaining.16 miles already decommissioned
12N31B	0.69	2				0.69				**Downgrade to level 1**
12N31D	0.64	1				0.64				**Keep and maintain**
12N31E	1.10	2			1.10					**Keep and maintain**
12N31E.2	0.13	NS							0.13	**Decommission**
12N31F	0.25	1				0.25				**Keep and maintain**
12N31G	0.30	1							0.30	**Decommission**
12N32	1.12	1							1.12	**Decommission**
12N34	1.72	1				1.72				**Keep and maintain**
12N34A	0.29	1				0.29				**Keep and maintain**
12N34B	0.50	1				0.50				**Keep and maintain**
12N42	1.10	1				1.10				**Keep and maintain**
12N42.1	1.00	NS							1.00	**Decommission**
12N42A	0.08	1				0.08				**Keep and maintain**
12N43	0.50	1				0.50				**Keep and maintain**
12N44	1.55	1				1.55				**Keep and maintain**
12N44A	0.50	1							0.50	**Decommission**
12N44B	0.34	1				0.34				**Keep and maintain**
13N01	36.00	4	34.50						1.50	**Upgrade old road access section over Aikens Creek slide (1 mi)**, **Keep and maintain** remaining road; improve culverts and water quality concerns where needed. **Decommission** 1.5 miles of road damaged by 2005/2006 New Years storm
13N01.1	0.05	NS							0.05	**Decommission**

6.2.2 Table 7. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 3: Objective Maintenance Level				Alternative 3: Non-motorized trail	Alternative 3: Motorized Trail	Alternative 3: Decommission	Treatment Notes
			5 and 4	3	2	1				
13N01.2	0.50	NS							0.50	**Decommission**
13N01.3	0.05	NS							0.05	**Decommission**
13N01.4	0.07	NS							0.07	**Decommission**
13N01.5	0.05	NS							0.05	**Decommission**
13N01.6	1.00	NS							1.00	**Decommission**
13N01.7	0.10	NS							0.10	**Decommission**
13N01.10	0.10	NS							0.10	**Decommission**
13N01A	1.00	1				1.00				**Keep and maintain**
13N01B	1.10	1							1.10	**Decommission**
13N01C	1.20	2			1.20					**Keep and maintain**
13N01F	0.65	2							0.65	**Decommission**
13N01H	1.20	2			1.20					**Keep and maintain**
13N01Q	0.25	1							0.25	**Decommission**
13N01S	1.20	1							1.20	**Decommission**
13N01T	0.45	1							0.45	**Decommission**
13N01V	0.25	1							0.25	**Decommission**
13N01W	0.20	1				0.20				**keep and maintain**
13N02	0.70	2			0.70					**Keep and maintain** .7 mi, already decommissioned from 13N02B to Louse Camp
13N02B	0.20	2			0.20					**Keep and maintain** from junction of 13N02 to 13N02C , remaining portion aleady decommissioned
13N02C	1.30	1				1.30				**Decommission**
13N02D	0.60	2							0.60	**Keep and maintain**
13N05	0.66	1				0.66				**Keep and maintain**

6.2.2 Table 7. Orleans Transportation and Road Restoration Project - Bluff Creek

Road #	Length (mi.)	Current OML	Alternative 3							Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Motorized Trail	Decommission	
			5 and 4	3	2	1				
13N06	0.21	1				0.21				**Keep and maintain**
13N09	0.25	1				0.25				**Keep and maintain**
13N11	0.63	1				0.63				**Keep and maintain**
13N15	0.50	1				0.50				**Keep and maintain**
13N21	2.41	2			2.41					**Keep and maintain**
13N21A	0.05	1				0.05				**Keep and maintain**
13N21B	0.19	1							0.19	**Decommission**
13N21C	0.60	1							0.60	**Decommission**
13N22	0.90	2			0.90					**Keep and maintain**
13N22A	0.10	1				0.10				**Keep and maintain**
13N23	1.00	1				1.00				**Keep and maintain**
15N01	1.60	5	1.60							**Keep and maintain**
JG502	0.10	NS							0.10	**Decommission**
JG503	0.60	NS							0.60	**Decommission**
JG504	0.04	NS							0.04	**Decommission**
JG505	0.07	NS							0.07	**Decommission**
JM505	1.20	NS							1.20	**Decommission**
MM533	0.08	NS							0.08	**Decommission**
MM534	0.30	NS							0.30	**Decommission**
MM535	0.30	NS							0.30	**Decommission**
JM502	0.04	NS							0.04	**Decommission**
JM513	0.06	NS						0.06		**Motorized trail to dispersed camp (hunters) near Divide Lake -** put on FS trail system; 4X4 OHV jeep access >50" vehicle class or licensed
MM521	0.09	NS							0.09	**Decommission**
MM524	0.04	NS							0.04	**Decommission**

6.2.2 Table 7. Orleans Transportation and Road Restoration Project - Bluff Creek

			Alternative 3							
			Objective Maintenance Level							
Road #	**Length (mi.)**	**Current OML**	**5 and 4**	**3**	**2**	**1**	**Non-motorized trail**	**Motorized Trail**	**Decommission**	**Treatment Notes**
MM525	0.04	NS							0.04	**Decommission**
AD002	0.05	NS						0.05		**Motorized trail to dispersed camp (hunters) -** put on FS trail system; 4X4 OHV jeep access >50" vehicle class or licensed trail
TOTAL	**219.85**		**40.30**	**29.36**	**34.97**	**23.14**	**0.25**	**0.11**	**91.72**	

6.2.3 Table 8. Orleans Transportation and Road Restoration Project - Camp Creek

			Alternative 3						
			Objective Maintenance Level						
Road #	**Length (mi.)**	**Current OML**	**5 and 4**	**3**	**2**	**1**	**Non-motorized trail**	**Decommission**	**Treatment Notes**
11N03	0.20	1				0.20			**Keep and maintain**
11N13	0.88	1				0.88			**Keep and maintain**
11N13A	0.22	1				0.22			**Keep and maintain**
11N14	0.95	2						0.95	**Decommission**
11N23	1.05	1				1.05			**Keep and maintain**
11N24	1.03	1				1.03			**Keep and maintain**
11N30	1.77	2			1.77				**Keep and maintain**
11N30A	0.50	1				0.50			**Keep and maintain**
11N30C	0.51	1				0.51			**Keep and maintain**
11N31	2.00	2			2.00				**Keep and maintain**
11N31A	1.11	1				0.50		0.61	**Decommission**
11N31B	0.57	1				0.57			**Keep and maintain**
11N31C	0.75	1				0.75			**Keep and maintain**
11N38	2.00	2						2.00	**Decommission**

6.2.3 Table 8. Orleans Transportation and Road Restoration Project - Camp Creek									
			Alternative 3						
			Objective Maintenance Level				**Non-motorized trail**		
Road #	**Length (mi.)**	**Current OML**	**5 and 4**	**3**	**2**	**1**		**Decommission**	**Treatment Notes**
11N44	1.80	2						1.80	**Decommission**
11N45	5.63	3		5.63					**Keep and maintain**, improve water quality concerns with CIP improvements
11N45A	0.99	1						0.99	**Decommission**
11N50	2.41	2						2.41	**Decommission**
11N50.1	3.80	NS						3.80	**Decommission**
11N55	1.90	2			0.80			1.10	**Keep and maintain** 1.25 miles, **decommission** last .75 miles
11N60	0.75	1				0.75			**Keep and maintain**
12N01	1.39	3		1.39					**Keep and maintain**, improve water quality issues, culverts etc.
12N02	1.47	2			0.40			1.07	**Keep and maintain** until intersection with 12N02B spur, **decommission** last 2 miles
12N02A	0.82	2						0.82	**Decommission**
12N02B	1.09	2			1.09				**Keep and maintain**
12N02C	0.40	1				0.40			**Keep and maintain**
12N04	0.32	2				0.32			**Downgrade to Level 1**
12N04A	0.34	2				0.34			**Downgrade to Level 1**
12N05	2.30	2						2.30	**Decommission**
12N12C	2.95	2						2.95	**Decommission**. Develop alternative water source.
12N12E	0.98	1						0.98	**Decommission**
12N12G	0.18	1						0.18	**Decommission**
12N15	1.23	2			1.23				**Keep and maintain**
12N15A	0.60	1				0.60			**Keep and maintain**
12N15B	0.09	1				0.09			**Keep and maintain**

6.2.3 Table 8. Orleans Transportation and Road Restoration Project - Camp Creek									
			Alternative 3						
			Objective Maintenance Level						
Road #	Length (mi.)	Current OML	5 and 4	3	2	1	Non-motorized trail	Decommission	Treatment Notes
12N16	1.70	2			1.70				**Keep and maintain**
12N16A	0.40	2			0.40				**Keep and maintain**
12N16B	0.45	1				0.45			**Keep and maintain**
12N18	1.30	2						1.30	**Decommission**
12N18A	0.33	1						0.33	**Decommission**
12N19	2.93	2			2.27			0.66	**Keep and maintain** to 0.5 miles past the 12N19A spur out to knoll; **Decommission** remaining portion
12N19A	0.40	1						0.40	**Decommission**
12N20	5.90	3		4.10				1.80	**Keep and maintain**; improve with road with CIP funding. Decommission remaining road past 12N20H
12N20A	0.23	1						0.23	**Decommission**
12N20C	0.27	1				0.27			**Keep and maintain**
12N20D	0.91	2			0.61			0.30	**Keep and maintain** until junction 12N20J, **Decommission** past J spur
12N20E	0.24	2						0.24	**Decommission**
12N20G	0.74	1				0.54		0.20	**Keep and maintain** until junction w/12N20D, **Decommission** remaining road pastD spur
12N20H	2.00	1				2.00			**Keep and maintain**
12N20J	1.30	1						1.30	**Decommission**
12N20K	0.45	1				0.45			**Keep and maintain**
12N23	0.60	2						0.60	**Decommission**
12N23A	0.20	1						0.20	**Decommission**
12N35	3.00	2			2.20			0.80	**Keep and maintain** until switch before 12N35 A, **Decommission** remaining portion

6.2.3 Table 8. Orleans Transportation and Road Restoration Project - Camp Creek

Road #	Length (mi.)	Current OML	Alternative 3 Objective Maintenance Level 5 and 4	3	2	1	Non-motorized trail	Decommission	Treatment Notes
12N35A	0.40	1						0.40	**Decommission**
12N35B	0.85	2				0.85			**Downgrade to Level 1**
12N36	2.64	2			1.14			1.50	**Keep and maintain** until junction w/12N36A at gate, **Decommission** remaining road past A spur
12N36A	1.33	2						1.33	**Decommission**
12N36B	0.63	2				0.63			**Downgrade to Level 1**
12N36C	0.22	2						0.22	**Decommission**
12N37	1.50	2			0.90			0.60	**Keep and maintain** until junction of 12N37C, **Decommission** remaining road12N37
12N37B	0.62	2			0.62				**Keep and maintain**
12N37B.1	0.39	NS						0.39	**Decommission**
12N37C	0.90	2			0.90				**Keep and maintain**
12N37E	0.90	1						0.90	**Decommission**
12N37E.1	0.37	NS						0.37	**Decommission**
12N37G	0.36	2				0.36			**Downgrade to Level 1**
12N38	1.00	2			0.65			0.35	**Keep and maintain** to water source, **Decommission** past water source
12N38A	0.15	2						0.15	**Decommission**
12N38B	0.14	1						0.14	**Decommission**
12N39	1.80	2			1.00			0.80	**Keep and maintain** until junction of 12N39C, **Decommission** remaining road12N39 including B spur
12N39B	0.64	1						0.64	**Decommission**
12N39C	0.22	2				0.22			**Downgrade to Level 1**

6.2.3 Table 8. Orleans Transportation and Road Restoration Project - Camp Creek

Road #	Length (mi.)	Current OML	Alternative 3						Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Decommission	
			5 and 4	3	2	1			
12N40	3.80	2			2.60			1.20	**Keep and maintain** to intersection with 12N40D; **Decommission** remaining approx. 2 miles
12N40B	1.52	2						1.52	**Decommission**
12N40D	0.40	2			0.40				**Keep and maintain**
12N40F	0.64	2				0.64			**Downgrade to Level 1**
12N40G	1.27	2						1.27	**Decommission**
12N40H	1.52	2						1.52	**Decommission**
12N40J	0.19	2						0.19	**Decommission**
12N46	1.00	1						1.00	**Decommission**
12N46B	0.36	1						0.36	**Decommission**
12N48	0.60	1				0.60			**Keep and maintain**
12N48A	0.08	1				0.08			**Keep and maintain**
12N49	0.64	2				0.64			**Downgrade to Level 1**
12N49A	0.05	1				0.05			**Keep and maintain**
12N50	0.07	1				0.07			**Keep and maintain**
12N50A	0.20	1				0.20			**Keep and maintain**
12N51	0.45	2						0.45	**Decommission**
12N52	0.15	2						0.15	**Decommission**
12N53	0.19	2				0.19			**Downgrade to Level 1**
12N54	0.45	1				0.45			**Keep and maintain**
15N01C	0.83	2			0.83				**Keep and maintain**
15N01F	0.36	1				0.36			**Keep and maintain**
JG501	0.10	NS						0.10	**Decommission**
JG506	0.10	NS						0.10	**Decommission**
JG508	0.06	NS						0.06	**Decommission**
TOTAL	**98.42**		**0.00**	**11.12**	**23.51**	**17.76**	**0.00**	**46.03**	

6.2.4 Table 9. Orleans Transportation and Road Restoration Project - Lower Middle Klamath

Road #	Length (mi.)	Current OML	Alternative 3: Objective Maintenance Level 5 and 4	3	2	1	Non-motorized trail	Decommission	Treatment Notes
10N04	2.90	2			1.30	1.60			**Keep and maintain** road, upgrade 2 culverts, at the intersection of 11N01 block 10N04 and change to OML 1 to terminus, repair POC gate
10N04A	0.30	1						0.30	**Decommission**
10N05C	2.70	2			2.70				**Keep and maintain** road, remove TS gate, need culvert and ditch cleaning
10N05F	0.40	2				0.40			**Downgrade** to OML 1, brush road
10N05G	0.30	2			0.30				**Keep and maintain**
10N05L	0.30	1				0.30			**Keep and maintain**
10N05M	0.80	1				0.80			**Keep and maintain**
10N05N	0.70	1				0.70			**Keep and maintain**
10N07	1.10	2			1.10				**Keep and maintain**
10N08	0.50	1				0.50			**Keep and maintain**
10N09	4.40	2			4.40				**Keep and maintain** road, remove old upper TS gate
10N10	3.80	3		3.80					**Keep and maintain**
10N10B	0.30	1				0.30			**Keep and maintain**
10N10H	0.60	2				0.60			**Downgrade** to OML 1
10N11	0.50	1						0.50	**Decommission**
10N13	4.50	3		4.5					**Keep and maintain**, needs maintenance, upgrade culverts
10N13.1	0.30	NS						0.30	**Decommission**
10N13.2	2.60	NS						2.60	**Decommission**
10N13.3	0.50	NS				0.50			**Upgrade** to OML 1
10N13.4	0.50	NS						0.5	**Decommission**
10N13A	0.60	1				0.60			**Keep and maintain**

6.2.4 Table 9. Orleans Transportation and Road Restoration Project - Lower Middle Klamath

Road #	Length (mi.)	Current OML	Alternative 3 Objective Maintenance Level 5 and 4	3	2	1	Non-motorized trail	Decommission	Treatment Notes
10N13B	0.40	1				0.40			**Keep and maintain**
10N13C	0.50	1				0.50			**Keep and maintain**
10N13D	0.90	2			0.90				**Keep and maintain**
10N13E	0.10	1				0.10			**Keep and maintain**
10N13F	0.40	2			0.40				**Keep and maintain**
10N15	1.40	1				1.40			**Keep and maintain**, install diversion dip
10N15A	0.40	1						0.40	**Decommission**
10N15B	0.20	1				0.20			**Keep and maintain**
10N16	0.60	1				0.60			**Keep and maintain**
10N17	1.60	1						1.60	**Decommission**
10N18	0.90	1			0.90				**Upgrade** to OML 2, keep TS gate- seasonal closure necessary until road surface is adequately rocked and entrance is waterbared.
10N18A	0.20	1				0.20			**Keep and maintain**
10N20	0.20	2		0.20					**Upgrade** to OML 3, needs paving, CIP $, excellent candidate to partner with State for $ to pave upper access
10N25	4.90	2			4.90				**Keep and maintain**
10N27	1.70	2			1.70				**Keep and maintain** (moderate to high road maintenance needed), unplug or replace plugged CMPs
10N27A	0.30	1						0.30	**Decommission**
10N28	0.10	2		0.10					**Upgrade** to OML 3. Needs seasonal maintenance and riprap to armor right bank for treatment facility
10N34	1.00	1				1.00			**Keep and maintain** road, high risk of spread of POC root disease, maintain POC gate to protect POC stands, Yurok access

6.2.4 Table 9. Orleans Transportation and Road Restoration Project - Lower Middle Klamath

Road #	Length (mi.)	Current OML	Alternative 3						Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Decommission	
			5 and 4	3	2	1			
10N34.1	0.30	NS						0.30	Decommission
10N34A	0.40	1				0.40			**Keep and maintain**
10N41	2.60	2			1.20			1.40	**Keep and maintain**; needs substantial road maintenance work. **Decommission** portion of road from intersection of 10N34 to terminus, remove gate and block road to protect POC stands
10N41A	0.40	1						0.40	**Decommission**
10N41B	0.20	1						0.20	**Decommission**
10N45	3.60	2			0.80			2.80	**Keep and maintain** road, **decommission** portion of road from the junction of 10N46 to terminus (currently inpassable)
10N45A	0.20	2			0.20				**Keep and maintain**
10N46	0.60	2			0.60				**Keep and maintain**, road needs to be assessed for culvert upgrades and slump repairs
10N47A	1.50	2			1.30	0.20			**Keep and maintain** as OML 2 to Trail Creek, **Downgrade** to OML 1 to terminus
10N47B	0.30	2				0.30			**Downgrade** to OML 1
10N47D	0.30	1				0.30			**Keep and maintain**
10N47E	0.40	1				0.40			**Keep and maintain**
10N47F	0.30	1				0.30			**Keep and maintain**
10N47W	0.30	1				0.30			**Keep and maintain**
10N70	0.20	4	0.20						**Keep and maintain**, keep campground gates, needs paving, possible CIP $
10N72	0.40	3		0.40					**Keep and maintain**
10N74	0.20	3		0.20					**Keep and maintain**

6.2.4 Table 9. Orleans Transportation and Road Restoration Project - Lower Middle Klamath										
			Alternative 3							
			Objective Maintenance Level				**Non-motorized trail**	**Decommission**	
Road #	**Length (mi.)**	**Current OML**	**5 and 4**	**3**	**2**	**1**			**Treatment Notes**
10N75	1.00	3		0.80				0.20	**Keep and maintain**, **decommission** portion within Aikens Campground
10N76	0.40	3		0.40					**Keep and maintain**
11N01	2.60	2				2.60			**Downgrade** to OML 1
11N01B	0.20	1						0.20	**Decommission**
11N01C	0.30	1				0.30			**keep and maintain**
11N05	12.40	4	12.40						**Keep and maintain**, needs CIP funding, avoid sensitive plant populations, culvert upgrades
11N05A	1.20	2				1.20			**Keep and maintain** portion of road to rockpit, **Downgrade** to OML 1 from rock pit to terminus
11N05D	0.30	2				0.30			**Downgrade** to OML 1
11N05E	0.30	1				0.30			**Keep and maintain**
11N05F	0.30	2				0.30			**Downgrade** to OML 1
11N05K	0.70	1				0.70			**Keep and maintain**
11N05L	0.50	1				0.50			**Keep and maintain**
11N05N	0.30	1				0.30			**Keep and maintain**
11N06	0.60	2			0.60				**Keep and maintain**, needs CIP funding
11N06A	0.30	2			0.30				**Keep and maintain**, needs CIP funding
11N08	1.70	2			1.70				**Keep and maintain**, ditch and cuvert cleanup
11N11	3.10	4	3.10						**Keep and maintain**, routine maintenance in upper segment needs CIP funding
11N12	2.50	2			2.50				**Keep and maintain**
11N12A	0.20	1				0.20			**Keep and maintain**
11N12B	0.30	1				0.30			**keep and maintain**
11N12C*	1.42	1			1.42				**Upgrade old 13N14 route to a level 2 and**

6.2.4 Table 9. Orleans Transportation and Road Restoration Project - Lower Middle Klamath

Road #	Length (mi.)	Current OML	Alternative 3						Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Decommission	
			5 and 4	3	2	1			
									rename road as 11N12C
11N16G	0.90	1				0.90			**Keep and maintain**
11N18	2.10	2			2.10				**Keep and maintain**
11N18A	1.00	1						1.00	**Decommission**
11N26	1.20	2			1.20				**Keep and maintain**
11N26A	0.30	1				0.30			**Keep and maintain**
11N28	1.00	1						1.00	**Decommission**, place barrier at start of road, high risk of spread of POC root disease
11N32	0.30	1				0.30			**Keep and maintain**
11N33	0.20	1				0.20			**Keep and maintain**
11N34	0.20	1				0.20			**Keep and maintain**
11N36	5.10	2			5.10				**Keep and maintain**
11N36A	1.30	2						1.30	**Decommission**
11N36B	1.20	1						1.20	**Decommission**
11N36C	0.50	1				0.50			**Keep and maintain**
11N36D	0.10	1						0.10	**Decommission**
11N36E	0.20	1						0.20	**Decommission**
11N36G	0.20	1				0.20			**Keep and maintain**
11N36T	0.10	1						0.10	**Decommission**
11N39	1.80	1						1.80	**Decommission**, place barrier at start of road, high risk of spread of POC root disease
11N41	0.30	1				0.30			**Keep and maintain**

6.2.4 Table 9. Orleans Transportation and Road Restoration Project - Lower Middle Klamath

Road #	Length (mi.)	Current OML	Alternative 3						Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Decommission	
			5 and 4	3	2	1			
11N42	2.00	2			1.30			0.70	**Keep and maintain**, **decommission** portion from intersection of 11N52, pull culvert and block access at Forest boundary, high risk of spread of POC disease
11N42A	0.50	1				0.50			**Keep and maintain**
11N45	5.60	3		5.60					**Keep and maintain**
11N46	3.40	2			0.10			3.30	**Keep and maintain** to tanker fill,upgrade culvert(s). **Decommission** from tanker fill to terminus
11N46.1	0.10	NS						0.10	**Decommission**
11N46A	0.70	1						0.70	**Decommission**
11N46B	0.20	1						0.20	**Decommission**
11N48	3.10	2			2.60	0.50			**Keep and maintain**, **downgrade** to OML 1 @ MP 2.6
11N48A	0.60	1				0.60			**Keep and maintain**
11N48E	0.20	1				0.20			**Keep and maintain**
11N49	2.80	1						2.80	**Decommission**, place barrier at start of road, high risk of spread of POC root disease
11N52	0.50	1				0.50			**Keep and maintain**
11N52A	0.20	1				0.20			**Keep and maintain**
11N53	0.30	1				0.30			**Keep and maintain**
11N54	0.20	2		0.20					**Upgrade** to OML 3
11N56	0.50	3		0.50					**Keep and maintain**, needs rock or paving, CIP funding
11N59	0.60	1				0.60			**Keep and maintain**

6.2.4 Table 9. Orleans Transportation and Road Restoration Project - Lower Middle Klamath

Road #	Length (mi.)	Current OML	Alternative 3						Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Decommission	
			5 and 4	3	2	1			
11N59A	0.30	1				0.30			**Keep and maintain**, pull culvert pipe @ MP 0.2 and create low water crossing
11N60	0.70	1				0.70			**Keep and maintain** prvt property access, keep TS gate
11N61	0.30	3		0.30					**Keep and maintain**, keep recreation gate, needs rock or paving, CIP $
11N62	0.30	4	0.30						**Keep and maintain**, keep both campground gates
11N65	1.30	2			1.30				**Keep and maintain**
11N65A	0.70	1						0.70	**Decommission**
11N65B	0.30	1				0.30			**Keep and maintain**
11N65C	0.40	1				0.40			**Keep and maintain**
11N70	0.50	4	0.50						**Keep and maintain**
11N71	0.10	2					0.10		Convert road to **Non-motorized trail**
11N72	0.30	2		0.30					**Upgrade** to OML 3, needs rocking
11N73	0.10	2						0.10	**Decommission**, public safety concerns
11N76	0.20	2			0.20				**Keep and maintain**
12N12	14.50	3		14.50					**Keep and maintain**, needs CIP funding, culvert(s) need to be improved
12N12B	0.30	2			0.30				**Keep and maintain**
12N12E	0.80	1				0.80			**Keep and maintain**, improve stream crossing, keep TS gate
12N12F	1.10	1				1.10			**Keep and maintain**
12N12G	0.20	1				0.20			**Keep and maintain**
12N12J	0.50	1				0.50			**keep and maintain**
13N01	19.00	4	19.00						**Keep and maintain**, needs CIP $, culvert cleaning, ditch cleaning
13N01.14	0.40	NS						0.40	**Decommission**

6.2.4 Table 9. Orleans Transportation and Road Restoration Project - Lower Middle Klamath

Road #	Length (mi.)	Current OML	Alternative 3						Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Decommission	
			5 and 4	3	2	1			
13N01.15	0.10	NS				0.10			**Upgrade** and add to system, emergency Tribal access
13N01.16	0.60	NS						0.60	**Decommission**
13N01.17	0.80	NS						0.80	**Decommission**
13N01.18	0.80	NS				0.80			**Upgrade** and add to system, emergency Tribal access
13N01.19	0.70	NS						0.70	**Decommission**
13N01.20	0.30	NS						0.30	**Decommission**
13N01N	0.40	1						0.40	**Keep and maintain**, needs culvert cleaning, ditch cleaning
13N01R	0.80	1						0.80	**Decommission**
13N04	0.50	1						0.50	**Decommission**
13N07	1.60	1				1.00		0.60	**Keep and maintain** 1 mile, **Decommission** last 0.6 miles, block access at end of road, high risk of spread of POC root disease
13N14*	0.56	2		0.56					**Upgrade** to OML 3, needs CIP funding, improve culvert and other maintenance
13N14E	0.50	NS				0.50			**Upgrade** to OML 1
13N18	2.00	3		2.00					**Keep and maintain**, needs improvements and CIP funding
13N18.1	0.50	NS				0.50			**Upgrade** to OML 1
13N18A	0.40	1			0.40				**Upgrade** to OML 2
13N18B	0.60	1				0.60			**Keep and maintain**
13N18C	0.50	2				0.50			**Downgrade** to OML 1, block road 200' from intersection
13N18D	0.40	1				0.40			**Keep and maintain**

6.2.4 Table 9. Orleans Transportation and Road Restoration Project - Lower Middle Klamath

Road #	Length (mi.)	Current OML	Alternative 3						Treatment Notes
			Objective Maintenance Level				Non-motorized trail	Decommission	
			5 and 4	3	2	1			
15N01	2.00	5	2.00						**Keep and maintain**, needs CMP improvements
15N01.1	0.40	NS						0.40	**Decommission**
MM531	0.02	NS						0.02	**Decommission**
MM582	0.10	NS		0.10					**Upgrade** and add to system, Dolans Bar river access
MM583	0.10	NS		0.10					**Upgrade** and add to system, Dolans Bar river access
MM584	0.10	NS		0.10					**Upgrade** and add to system, Dolans Bar river access
MM593	0.10	NS			0.10				**Upgrade** and add to system, access to Le Perron Flat, dispearsed recreational use
JG601	0.10	NS						0.10	**Decommission**
JG602	0.20	NS			0.20				**Upgrade** and add to system. Day use and interpretative area, Bluff Creek overlook
JG507	0.10	NS				0.10			**Upgrade** and add to system. Access to Progeny Site behind gate.
MM539	0.08	NS						0.08	**Decommission**
MM592	0.05	NS						0.05	**Decommission**
MM594	0.09	NS						0.09	**Decommission**
MM591	0.10	NS			0.10				**Upgrade** and add to system; part of 10N25 Orleans Mnt Lookout.
TOTAL	**185.04**		**37.50**	**34.3**	**44.6**	**34.9**	**0.10**	**33.64**	

***note - 13N14 was reconfigured into several smaller roads with new road names for better database tracking purposes. Portions of the old 13N14 have been renamed as 11N12C and 13N14E.**

6.2.5 Table 10. Orleans Transportation and Road Restoration Project - Red Cap Creek

Road #	Length (mi.)	Current OML	Alternative 3							Treatment Notes
			Objective Maintenance Level				Motorized Trail	Non-motorized trail	Decommission	
			5 and 4	3	2	1				
09N31	3.17	2			3.17					**Keep and maintain**
09N31A	0.89	1				0.89				**Keep and maintain**
09N31B	0.72	1				0.72				**Keep and maintain**
09N31C	0.27	1				0.27				**Keep and maintain**
09N31D	1.93	1				1.93				**Keep and maintain**
09N31E	1.18	1							1.18	**Decommission**
09N31G	0.16	1				0.16				**Keep and maintain**
09N31H	0.79	1				0.79				**Keep and maintain**
09N31J	0.69	1				0.69				**Keep and maintain**
09N32	2.35	2			2.35					**Keep and maintain**
09N32A	0.65	1				0.65				**Keep and maintain**
09N32B	0.32	1				0.32				**Keep and maintain**
09N32C	1.00	1							1.00	**Decommission**
09N32D	0.87	1				0.87				**Keep and maintain**
10N01	16.80	3		16.80						**Keep and maintain,** improve road through culvert and water quality investments; CIP funding
10N01.1	2.28	NS							2.28	**Decommission**
10N01.1A	0.45	NS							0.45	**Decommission**
10N01.2	0.10	NS							0.10	**Decommission**
10N01.2A	0.40	NS							0.40	**Decommission**
10N01.3	0.12	NS							0.12	**Decommission**
10N01.4	0.08	NS							0.08	**Decommission**
10N01.5	0.20	NS							0.20	**Decommission**
10N01.6	0.18	NS							0.18	**Decommission**

6.2.5 Table 10. Orleans Transportation and Road Restoration Project - Red Cap Creek

Road #	Length (mi.)	Current OML	Alternative 3							Treatment Notes
			Objective Maintenance Level				Motorized Trail	Non-motorized trail	Decommission	
			5 and 4	3	2	1				
10N01.7	0.14	NS					0.14			**Motorized trail to dispersed (hunter) camps - put on FS trail system; 4X4 OHV jeep access >50" trail**
10N01A	0.22	1				0.22				**Keep and maintain**
10N01C	0.86	2			0.86					**Keep and maintain**
10N01C.1	0.18	NS							0.18	**Decommission**
10N01D	0.62	1				0.62				**Keep and maintain**
10N01F	0.24	1				0.24				**Keep and maintain**
10N02	14.24	3		14.24						**Keep and maintain,** improve road through culvert and water quality investments; CIP funding
10N02.2	0.11	NS			0.11					**Upgrade** and add to FS system roads
10N02C	0.77	1				0.77				**Keep and maintain**
10N02F	1.49	1				1.49				**Keep and maintain**
10N02G	0.47	1				0.47				**Keep and maintain**
10N02H	1.03	1				1.03				**Keep and maintain**
10N02L	0.73	1							0.73	**Decommission**
10N02P	1.05	1				1.05				**Keep and maintain**
10N02P.1	0.25	NS							0.25	**Decommission**

6.2.5 Table 10. Orleans Transportation and Road Restoration Project - Red Cap Creek

Road #	Length (mi.)	Current OML	Alternative 3							Treatment Notes
			Objective Maintenance Level				Motorized Trail	Non-motorized trail	Decommission	
			5 and 4	3	2	1				
10N03	8.75	3		8.75						**Keep and maintain,** improve road through culvert and water quality investments; CIP funding
10N03.1	1.34	NS							1.34	**Decommission**
10N03.2	0.58	NS						0.58		**Non-Motorized trail**
10N03.3	0.07	NS							0.07	**Decommission**
10N03.4	0.14	NS							0.14	**Decommission**
10N03B	1.50	2			1.50					**Keep and maintain**
10N05	10.01	3		10.01						**Keep and maintain,** improve road through culvert and water quality investments; CIP funding
10N05A	2.65	1							2.65	**Decommission**
10N05D	0.75	1				0.75				**Keep and maintain**
10N05D.1	0.29	NS							0.29	**Decommission**
10N05E	1.92	2			1.03				0.89	**Keep and maintain** first 1.03 miles, **Decommission** remaining road
10N05J	0.86	2			0.86					**Keep and maintain**
10N05M	0.85	1				0.85				**Keep and maintain**
10N09	4.40	2			4.40					**Keep and maintain**
10N09.1	0.22	NS							0.22	**Decommission**
10N09B	0.31	1				0.31				**Keep and maintain**
10N09D	0.17	1				0.17				**Keep and maintain**

6.2.5 Table 10. Orleans Transportation and Road Restoration Project - Red Cap Creek

Road #	Length (mi.)	Current OML	Alternative 3							Treatment Notes
			Objective Maintenance Level				Motorized Trail	Non-motorized trail	Decommission	
			5 and 4	3	2	1				
10N10	2.75	3		2.75						**Keep and maintain**
10N10A	2.96	2			2.96					**Keep and maintain**
10N10A.1	0.30	NS				0.30				**Upgrade** and add to FS system roads
10N10A.2	0.25	NS				0.25				**Upgrade** and add to FS system roads
10N10G	0.61	1				0.61				**Keep and maintain**
10N35	3.30	2			3.30					**Keep and maintain**
10N35A	1.58	1				1.58				**Keep and maintain**
10N35A.1	0.12	NS							0.12	**Decommission**
10N35A.2	0.22	NS							0.22	**Decommission**
10N35B	1.23	1				1.23				**Keep and maintain**
10N35C	0.30	1				0.30				**Keep and maintain**
10N37	2.10	2			1.43				0.67	**Keep and maintain** first 1.4 miles, **Decommission** remaining road
10N37.1	0.25	NS							0.25	**Decommission**
10N37A	2.70	2			2.16				0.54	**Keep and maintain** first 2.2 miles, **Decommission** remaining road
10N37A.1	0.51	NS							0.51	**Decommission**
10N37A.2	0.18	NS							0.18	**Decommission**
10N37A.3	0.25	NS							0.25	**Decommission**
10N40	1.46	2			1.46					**Keep and maintain**
10N40A	1.48	2			1.48					**Keep and maintain**
10N40B	0.33	2			0.33					**Keep and maintain**

6.2.5 Table 10. Orleans Transportation and Road Restoration Project - Red Cap Creek

Road #	Length (mi.)	Current OML	Alternative 3							Treatment Notes
			Objective Maintenance Level				Motorized Trail	Non-motorized trail	Decommission	
			5 and 4	3	2	1				
10N40C	0.21	2			0.21					**Keep and maintain**
10N40D	0.16	1				0.16				**Keep and maintain**
10N47	4.60	3		4.60						**Keep and maintain**
10N47.1	0.13	NS							0.13	**Decommission**
10N47C	0.36	1				0.36				**Decommission**
10N47Z	0.77	1				0.77				**Keep and maintain**
10N50	1.41	2			1.41					**Keep and maintain**
10N50A	0.18	1				0.18				**Keep and maintain**
10N50B	0.21	2			0.21					**Keep and maintain**
10N71	1.86	1				1.86				**Keep and maintain**
10N71A	0.31	1				0.31				**Keep and maintain**
10N71B	0.29	1				0.29				**Keep and maintain**
MM597	0.40	NS						0.40		**Non-Motorized trail to Schnable Diggings**
JM510	0.24	NS					0.24			**Motorized trail to dispersed (hunter) camps - put on FS trail system:** off of 9N31 E Packsaddle ridge.
JM511	0.10	NS							0.10	**Decommission**
MM595	0.06	NS					0.06			**Motorized trail to dispersed (hunter) camps - put on FS trail system; 4X4 OHV jeep access >50"** vehicle class or licensed
MM596	0.10	NS							0.10	**Decommission**

6.2.5 Table 10. Orleans Transportation and Road Restoration Project - Red Cap Creek

Road #	Length (mi.)	Current OML	Alternative 3: Objective Maintenance Level 5 and 4	Alternative 3: Objective Maintenance Level 3	Alternative 3: Objective Maintenance Level 2	Alternative 3: Objective Maintenance Level 1	Alternative 3: Motorized Trail	Alternative 3: Non-motorized trail	Alternative 3: Decommission	Treatment Notes
6E55 (Lubbs Trail)	3.10	trail					3.10			**Keep and maintain**, redefine as a trail for use by motorized vehicles ≤ 50 inches, needs trail improvements and treat fuel loads remaining from Megram Fire dozer fireline construction.
TOTAL	**130.16**		**0.00**	**57.15**	**29.23**	**23.45**	**3.54**	**0.98**	**15.82**	

6.3 Appendix C. Maps for Alternative 1, Alternative 2 and Alternative 3

These three maps are located in pocket at the back of this document.

6.4 Appendix D. Response to Comments

Scoping Comments for Orleans Transportation and Road Restoration Project

A scoping letter, dated May 11, 2006, was sent to interested and potentially affected parties. Comments were received from 4 groups as part of the scoping process for the Orleans Transportation and Road Restoration Project. All comments expressed support for the project, however 3 of the letters from environmental groups expressed an interest in decommissioning more miles of road and one group expressed modification of some roads to be decommissioned. The comments received were from the following people and are numbered for tracking:

1. George Sexton, Klamath Siskiyou Wildlands Center, Ashland, OR; letter and email and Scott Greacen, Environmental Protection Information Center, Garberville, CA; letter and email.
2. Tim McKay, North Coast Environmental Center, Arcata, CA; letter and email
3. Ryan Hensen, California Wilderness Coalition, Redding, CA; letter and email
4. Will Harling, Mid Klamath Watershed Council, Orleans, CA; letter and email
5. Kenny Peugh, Orleans CA Resident; letter
6. Kimberly Baker, Klamath Forest Alliance, Orleans CA; letter
7. George and Frances Alderson, Baltimore, MD; letter
8. Kathyrn Wild, Wild By Nature, Orleans, CA; letter
9. Ken Becker, Talent, OR; letter
10. Tim Ream; email letter
11. Patricia Mersman, Cave Junction, OR; email letter
12. Saundra Whitten, Cave Junction, OR; email letter
13. Jay Lininger, Ashland, OR; email letter
14. John Bricker, email
15. Judith Schlacter, Eugene, OR, email letter
16. Blythe Reis, Orleans CA Resident; letter
17. Todd Salberg, Orleans CA Resident; letter
18. Robinsons, Phoenix, OR, letter
19. Angela Allgier, Orleans CA Resident; letter

20-25. email form letter
26-43. email form letter

The following table shows how each comment was handled. The first column includes the comments made. Many comments are paraphrased and similar comments combined. The second column indicated the source(s) of the comment. Letter numbers are as indicated above. Comments in each letter were numbered to aid in tracking. The third column shows the response to each comment. Comments are categorized as alternatives, concerns that appropriate procedures be followed, other concerns, and questions.

Disposition of Comments Received During Public Scoping				
Source #	**Comment Source**	**Comment Statement**	**Resource/ Activity Category**	**Disposition**
1-4, 6-16, 18-43	1/1a; 2/1; 3/1; 4/1, 4/2, 6/15, 11/1 etc	Support the effort to reduce road maintenance costs, protect and restore aquatic and terrestrial ecosystems and reduce the spread of Port Orford cedar root disease through road decommissioning	Project Design	Comment: These issues are addressed in the Purpose and Need for action in the Environmental Assessment (EA).
5, 17	5/1; 17/1, 17/2, 17/13	I have serious reservations about the assessment and oppose the proposed reduction in the transportation infrastructure on the district…scoping and community outreach efforts were inadequate for the size and complexity of the project…concerned about the potential of the analysis in setting future management direction for the district transportation system … failure to evaluate a range of alternatives has produced a skewed project that focuses on eliminating roads through decommissioning	Project Design	Comment: The extent of public involvement will be documented in the environmental assessment. A range of alternatives assessing the environmental and socio-economic impacts of treatments ranging from decommissioning roads to keeping and maintaining roads and upgrading roads will be conducted within the environmental assessment.
1,3	1/1	Comments on the Draft Orleans RAP pertaining to the Trombulack and Frissell paper were ignored. Roads have negative effects on biotic integrity in both terrestrial and aquatic ecosystems	Water Quality/Wildlife	Comment: Affects of road on terrestrial and aquatic ecosystems will be addressed in the environmental assessment. Impacts to terrestrial and aquatic ecosystems and the species that rely on them are discussed in the wildlife and fisheries biological assessments prepared for this EA. Trombulack and Frissell paper discussed, among other impacts, effects of road density on wildlife. These impacts, among others raised by Trombulack and Frissell, are addressed in this EA.
1,3, 7, 8, 9, 12, 13, 15, 18,20-43	1/2; 7/1; 8/1; 9/1, 11/2; 12/2; 13/1; 15/2, 18/2	Reinstate the previously recommended 40 miles of road decommission that were in the draft Orleans RAP proposal	Project Design	The 40 miles of road decommissioning proposed in the draft Orleans RAP were re-assessed in this EA to determine risks versus need for these roads. Of the original 40 miles of road decommissioning proposed in the draft Orleans RAP, specific changes were made on selective roads and are incorporated in Alternative 3. Specific changes on selective roads were made by reducing level 2 roads to level 1 roads which effectively reduces open road densities for wildlife concerns.
1,3	1/3	The Orleans RAP or public scoping does not clearly explain why the 40 miles of previously recommended road decommissioning were removed from the Proposed Action, since LRMP guidance states that existing permanent roads not necessary for	Project Design	Comment: The 40 miles of road that were previously proposed to be decommissioned in the draft Orleans RAP were not included in the final Orleans RAP or the Proposed Action for the EA. The reason the 40 miles were not included for road decommissioning is that none of these roads had

Disposition of Comments Received During Public Scoping

Source #	Comment Source	Comment Statement	Resource/ Activity Category	Disposition
		administrative, recreation, resource protection, commercial or public access should be closed after all project work has been completed. Orleans RAP indicates that these roads are not necessary for the purposes listed in the LRMP.		water quality concerns since they were short, mid-slope to ridge-top roads with no culverts, erosion, or stability concerns. Neither did these roads pose a risk for spread of POC root disease. While these roads were rated as having a low management need, the low management need does not mean absolutely no need. Roads that pose no resource risk and have little maintenance costs are useful for access in the event wildfire. All alternatives will meet the intent of the LRMP.
1,3, 7, 10, 11	1/4; 6/2; 7/2; 10/2,	By reducing the proposed road decommissioning in Key Watersheds, the agency is ignoring the intent of the Forest LRMP and public input that calls for reduced road densities in Key Watershed for salmonids recovery	Water Quality/Fisheries	Comment: Water quality and fisheries effects for roads proposed for decommissioning and roads proposed to be maintained will be assessed. The 40 miles of roads originally proposed for decommissioning in the draft Orleans RAP proposal which were later modified to keep and maintain are not a water quality concern since they are ridge top roads with no culverts and do not have sedimentation risk. Alternatives 2 and 3 both meet the intent of reducing road densities in Key Watersheds for the purposes of salmonids recovery.
1, 3, 6, 9, 11,15	1/5, 6/3; 9/2; 11/3; 15/2	Follow the LRMP direction for Late Successional Reserves as well as the LSRA. The LRMP states that within LSRs, minimize the mileage of open roads. Roads not providing primary travel access should be closed. Reinstate the proposed road decommissioning of un-needed level 1 and 2 roads in the LSRs ..choosing priority fire suppression routes as well as allowing fires to burn in LSRs should be considered.	Project Design/Wildlife	Both Alternatives 2 and 3 reduce the open road density in LSRs. The Forest LRMP guidance recommends reducing mileage of open roads in LSRs. This can be accomplished through closing a road or decommissioning a road. One of the main objectives and potential treatments within LSRs is to protect areas from catastrophic fire loss and fuel treatments are high on list of future treatments. Low risk roads are ideal access points to accomplish these objectives (6-2 through 6-4).
1, 3, 6	1/6; 6/7	There is no indication in either the Orleans Roads Analysis or the scoping notice for this project (or in any other Forest Service document) that the roads initially proposed for decommissioning in the Blue Creek, Bluff Creek, Camp Creek and Red Cap Creek watersheds are needed for fire suppression activities. The 40+ miles of road that have already been dropped from your road decommissioning report are not viable access roads and are primarily short spurs, duplicative, in poor	Project Design/Fire and Fuels	Comment: Roads having a low need for fire or fuels will be considered for road decommissioning. The bulk of the 40+ miles of road on primarily ridge top roads that are not a water quality risk and are closed to public access. However, a road rated as having a low management need for fire suppression does not mean that there is no need. Roads that pose no resource risk and have little maintenance costs are useful for access in the event wildfire.

Disposition of Comments Received During Public Scoping				
Source #	**Comment Source**	**Comment Statement**	**Resource/ Activity Category**	**Disposition**
		condition or are on steep sideslopes and hence are not necessary for fire suppression (or fire management activities)		
1, 3, 6	1/7; 6/6	Wildfire frequency and seasonality are related to road density…that most human caused fires are located near roads. Increased attention to data of this kind is needed to adequately assess the extent of the impact of roads on wildfires	Fire/Fuels	Comment: Impacts of roads on access for wildfire will be assessed.
1,3	1/8	POC root disease is a significant and serious issue relevant to this project. By precluding needed road decommissioning prior to NEPA scoping (20+ miles in the Blue and Bluff Creek) the Forest Service is biasing the outcome of the NEPA document and neglecting needed protections for POC.	Port-Orford cedar root disease	Comment: The environmental assessment will evaluate the risk or spread of POC root disease through road upgrades, seasonal closures, maintenance, and decommissioning. The 20+ miles of road that were not listed for decommissioning do not pose a threat to the spread of the POC root disease.
4, 6	4/6; 6/11	The importance of stemming the spread of Port Orford Cedar root disease cannot be overstated. We fully support the decommissioning of the roads in the Bluff Creek drainage associated with this risk.	Port-Orford cedar root disease	Comment: The environmental assessment will evaluate the risk or spread of POC root disease through road upgrades, seasonal closures, maintenance, and decommissioning.
1,3,6, 12, 16	1/9, 6/1; 12/1, 16/2	The lack of maintenance on Level 1 and 2 roads throughout the District may result in severe chronic sediment production, increases in peak flows and in periodic blowouts and culvert failures. The forthcoming EA for this project must analyze and disclose the impacts of keeping and maintaining roads that were previously identified for decommissioning on streamcourses that are designated as "sediment impaired" under the Clean Water Act and the Basin Plan.	Water Quality	Comment: The environmental assessment will evaluate the risk to water quality from roads that are proposed to be decommissioned and roads that are proposed to be maintained.
1,3	1/10	The forthcoming EA must analyze and disclose the widespread current use of OHVs on allegedly closed Level 1 roads. The EA must be explicit in disclosing the relative effectiveness of gating or berming vs road decommissioning on OHV use and affected resources such as POC and sediment production.	Recreation/ Water Quality/POC	Comment: Assessing current OHV use on level 1 roads is outside of the scope of the project. The environmental assess will assess road closure/decommissioning treatments on OHV use, POC, and sediment production.
1,3	1/11	Barricades don't mitigate the edge effects and microclimatic changes that roads produce….negative impacts of roads to wildlife habitat are not limited to the road prism – there is a zone of influence that extends	Wildlife	Comment: The effects of roads on wildlife habitat will be assessed based on the effects to those species-of-concern addressed in the EA and the BE/BA.

Disposition of Comments Received During Public Scoping

Source #	Comment Source	Comment Statement	Resource/ Activity Category	Disposition
		into the adjacent habitat..even narrow forest roads fragment habitat and exert negative effects on the quality of habitat for forest interior species.		
1,3, 7, 9	1/12; 7/3; 9/3	The preferred alternatives OHV route system should follow the guidance provided by Executive Order 11644(1072) and 11989 (1977) The roads remaining in the system after the proposed decommissioning are plenty for off-highway vehicles.	Recreation/OHV	Comments: All pertinent laws and regulations pertaining to OHV use and roads will be followed.
1, 3, 6,	1/13; 6/12;	The EA must evaluate the impacts of ORV use on the full range of resources present in the area, including wildlife habitat, wilderness quality lands, non-motorized recreation, water quality, scenic quality and other uses.	All areas	Comment: The known extent of ORV use will be analyzed in the assessment. All roads (system and non-system) will be assessed relative to their potential to influence wildlife habitat, wilderness quality lands, non-motorized recreation, water quality, scenic quality and other uses.
1,3	1/14	The following types of routes should be closed in the preferred alternative: all illegally created user routes; routes that cause damage to riparian habitats or scenic river corridors; routes within inventoried roadless areas; routes that cause damage to habitat for endangers and threatened species; duplicate routes, routes in areas currently being considered for wilderness designation	Project Design: all areas	Comment: The assessment will disclose the effect on all these areas of concern. There are no roads within the project vicinity within inventoried roadless areas or in areas within in wilderness areas or in the recently expanded wilderness areas.
1,3	1/15	It is crucial that the Forest Service consider the environmental impacts of re-opening level 1 roads for ORV use. These impacts must be fully disclosed in the forthcoming NEPA document.	Recreation	Comment: This is not applicable to the analysis since level 1 road are not open to the public for ORV use. Level 1 roads will not be re-opened for public use.
1,3, 4, 6, 16	1/16; 4/1; 16/1	Studies in the Klamath Mountains have shown that roads are a primary contributor of sediment into stream courses and have contributed to the habitat destruction of salmon and steelhead. Excessive road densities are known to directly affect water quality and aquatic values. Direct and significant relationships between road density and fine sediment have established the link between forest management practices and channel sediment characteristics.	Water Quality	Comment: The environmental analysis will assess the effect of roads on water quality.
1,3	1/17	Recent studies demonstrate that even trails have an impact on wildlife	Wildlife	Comment: The effects of motorized trail on wildlife will be assessed. An analysis of the effects of non-motorized trails is outside the scope of this analysis
1, 3, 6	1/18; 6/13	In addition to avoiding route designation in special	Wildlife	Comment: Effects to wildlife will be assessed. The effects to

Disposition of Comments Received During Public Scoping

Source #	Comment Source	Comment Statement	Resource/ Activity Category	Disposition
		habitats, the plan must provide for protecting certain species to ensure that biological diversity is protected…management indicator species must receive species-specific attention. The EA must carefully evaluate problems with habitat fragmentation and the need for maintaining connectivity		Management Indicator Species will be based on effects to their Habitat Assemblages.
2	2/2	The environmental assessment should explicitly evaluate the project's nexus to the Clean Water Act, Porter-Cologne Act and the state and federal endangered species laws. The project must discuss the relationship to the Mid-Klamath TMDL.	Water Quality	Comment: The environmental assessment will assess how it meets all relevant state and federal water quality laws, including the pending Mid-Klamath TMDL.
2, 4, 6, 10	2/3; 4/2; 6/10; 10/1, 10/2	We are very concerned that the agency will not have the necessary funding to adequately maintain 455 miles of road within the project area. With the decline in timber harvesting, funding has not been available to complete annual basic road maintenance. This has set the stage for disastrous road failures during flood events such as the one we experienced last New Year's Eve. If the funding to maintain these roads is not forthcoming, specifically how will the Forest Service meet its Clean Water Act obligations? Please discuss this in your environmental analysis.	Water Quality/ Road maintenance funding	Comment: Congress allocates funding for road maintenance. If insufficient funds are available to maintain roads or decommission roads, it is likely that during large storm events, the intent of the Clean Water Act will not be met if/when roads fail due to lack of maintenance.
4, 6	4/3; 6/8	Public access to the National Forests is critical for spiritual, cultural, recreational, and economic reasons. Every effort must be made to keep access open to Tribal Trust resources or property for Karuk Tribal members and the community.	Access Issues	Comment: Access and management of known cultural uses and gathering areas was considered as part of the analysis and proposal. Tribal consultation with Yurok, Karuk, and Hoopa tribes identified areas of concern and those areas were incorporated into the project design.
4	4/4	Many residents worry that decommissioning roads will cut off access to fire fighters during an emergency. Roads that are located along ridges and do not cross perennial or larger intermittent streams should be considered for maintenance or upgrade if they have not failed.	Fire and Fuels	Comment: The effects of road decommissioning on fire fighting will be assessed.
4	4/5	…most of the roads planned for decommissioning are short spurs or one of several roads into an area and thus are not likely to seriously affect fire-fighting efforts. Existing road or crossing failure, along with brush	Fire and Fuels	Comment: The effects of road decommission on fire and fuels will be assessed. Treating fuels before road decommissioning is outside the scope of the analysis.

Disposition of Comments Received During Public Scoping				
Source #	**Comment Source**	**Comment Statement**	**Resource/ Activity Category**	**Disposition**
		encroachment or downed trees already have blocked off many of these roads for fire access. We propose that every effort be made to instigate needed fuels reduction treatments before decommissioning in areas that are slated to become less accessible.		
4, 6	4/7; 6/10	Noxious weeds are not mentioned in the public scoping letter. The presence of invasive weeds in affected areas should be critically evaluated before decommissioning.	Noxious/invasive weeds	Comment: Noxious weeds will be part of the analysis in the environmental assessment.
4	4/8	We are concerned that the RAP be thoroughly incorporated into the planning process for the currently proposed Orleans Community Fuels Reduction Project… We feel every effort should be made to use existing roads rather than building any new roads.	Project Design	Comment: The proposed action for the Orleans Transportation and Road Restoration Project is and will continue to be coordinated with the planning process for the Orleans Community Fuels project.
4	4/9	Roads 10N13.2, 11N26A, and JG507 are in the footprint of the OCFRFH Project currently proposed. We understand that 10N13.2 has a blowout and is not passable in portions. Is this road scheduled for reopening as part of the OCFRFH project?	Project Design	Comment: Roads needed for the OCFP project will be kept and maintained and are assessed in Alternative 3.
4	4/10	Roads 11N49, 11N18, 12N31D, and part of 12N12C appear to be ridge roads and may not be the best use of decommissioning monies. These roads may be the access routes for future fuel reduction treatments, if they do not have existing failures.	Project Design	In Alternative 3, roads 11N18, 12N31D and 12N12C are proposed to be kept and maintained for future fuel reduction treatments and fire suppression needs.
5, 17	5/2, 17/4	I question the landscape scale approach the analysis used. Road resource damage is caused by fine scale attributes like culvert size, road configuration and drainage features.	Project Design	Comment: The most appropriate scale to evaluate any given road is to assess it in the context of the larger transportation network. Larger connections and access needs are more easily understood. In addition, there needs to be sufficient site-specific information to adequately evaluate road treatments on a road segment basis. Both of these analysis scales were taken into consideration in developing the action alternatives. Site-specific road condition information is in the project file and available upon request.
5, 17	5/3, 17/10, 17/11	The focus should be on mitigating road related resource impacts, not on eliminating roads. The Orleans RAP focused on identifying roads for decommissioning at the expense of alternative solutions.	Project Design	Comment: Funding for road maintenance, road upgrading and road decommissioning is limited and will be used as it becomes available. One of the main purposes and needs for action is to bring the current transportation system more in line with current and projected road maintenance funding capabilities, while still providing a balance between public and

Disposition of Comments Received During Public Scoping				
Source #	**Comment Source**	**Comment Statement**	**Resource/ Activity Category**	**Disposition**
		The focus must be on good stewardship, not on one size fits all administrative solutions.		administrative access needs and reducing road-related resource risks and impacts. The focus of the proposed action was not on road decommissioning because the proposed action clearly maintains the bulk of the district roads and proposes road upgrading where needed. A range of alternative will be assessed in the environmental analysis and site-specific road segment treatments proposed.
5	5/4	There was no economic analysis completed for this project proposal and economics was not a factor in the analysis…this requirement pertains to economics in addition to fish and wildlife…removing 200 miles of road will result in substantial if not significant impacts to the community…there needs to be an analysis of the impacts that will occur across the entire planning horizon.	Economic Analysis	Comment: The environmental assessment will conduct an economic impact analysis covering the projected costs over the planning horizon. See Appendix F of this EA.
5	5/5	The analysis did not identify funding sources for road decommissioning and road improvements identified for implementation. If funding for routine road maintenance is not available how can additional costs associated with decommissioning be justified?	Economic Analysis	Comment: Funding for road maintenance and improvements primarily comes from Congressionally appropriated dollars and is limited. Funding sources for road decommissioning primarily comes from outside grant sources (non Forest Service) and is also limited. Funding road maintenance for needed roads is equally as important as funding road decommissioning of unneeded roads. Both road treatments are necessary to bring the existing transportations system in line with current and project budgets for the purposes of public safety and reduced resource risk.
5	5/6	Vegetation management concerns were incorrectly addressed in the (RAP) analysis.	Vegetation Management	Comment: All plantations potentially impacted by proposed road decommissioning were assessed and determined to be compliant with NFMA requirements. Proposed road decommissioning would not eliminate the potential for future plantation management activities.
5, 17	5/7, 17/9	Removing vegetation and equipment operations on stabilized fill slopes is likely to create additional sediment, often more than would occur if the road system were left untreated. Road decommissioning can have negative hydrologic effects that far outweigh the benefit realized by closing the road…on some roads, no action would cause fewer	Water Quality	Comment: The sedimentation risks associated with road decommissioning as well as keeping and maintaining roads will be assessed in the environmental analysis. Roads proposed for decommissioning that do not have water quality concerns will not be treated or disturbed.

Disposition of Comments Received During Public Scoping				
Source #	Comment Source	Comment Statement	Resource/ Activity Category	Disposition
		resource impacts than decommissioning.		
5	5/8	Stands within LSRs need active management in order to promote structural characteristics needed by old growth dependent species. Removing the road systems that provides access into LSR stands will eliminate the ability to implement stand treatments in these stands	Wildlife/Veg Mgt	Comment: Silvicultural opportunities to promote Late-seral structural characteristics within LSRs was one of the criteria used to rate the need to retain, upgrade or decommission roads
5	5/9	Bear damage is increasing as a problem in numerous drainages. It does not appear that this was taken into account in the analysis. What about other potential insect and disease outbreaks, how will decommissioning and road abandonment affect the ability to address these issues.	Wildlife/Veg Mgt	Comment: The need to maintain road access to stands in order to mitigate bear damage was not used as a selection criteria because Timber Stand Improvement practices to increase growth in conifer plantations has been shown to promote bear damage. Mortality caused by bear activity is creating desirable structural diversity within the LSR land allocation and also is accomplishing some much needed thinning of conifers. Within LSRs, scattered mortality from bear, insects, and diseases is actually desirable for creating future structural diversity and certain habitat characteristics. If a serious forest health issue, or significant enhancement opportunity, were to develop in the future, nothing would prohibit the reconstruction and use of abandoned or decommissioned roads.
5	5/10	The analysis discusses the current backlog of road maintenance on the forest and cites a lack of funding as a key reason to decommission or abandon road systems. How will road maintenance on forest service system roads be funded in the future? Will continuing lack of maintenance require additional road closures in the future? How much funding is diverted from the roads budget for overhead administrative salaries?	Economic analysis	Comment: Road maintenance funding is allocated each year by Congress. It is unknown in any given year how much funding will be available for road maintenance. The trend in recent years is for declining road maintenance funding and that trend is expected to continue. Projecting future additional road closures beyond this environmental assessment is outside the scope of analysis. Assessing administrative overhead costs of implementing the District road maintenance program is also outside the scope of analysis.
5	5/11	What criteria were used to determine the roads that would be decommissioned in spite of the high rating for fire/fuels. Specific roads illustrating this concern include 11N37, 11N35A, 12N13G and 12N14E.	Project Design	Comment: The relative benefits of keeping a road with a high rating for fire/fuels were qualitatively assessed against the risks to water quality and risk of spread of POC disease as well as other factors (see Orleans RAP for criteria). Each road was assessed individually on a case by case basis. Roads 11N37, 11N35A, 12N13G and 12N14E were reassessed by the analysis team. Roads 11N37 have high POC risk and water quality issues and are proposed to be decommissioned. However roads12N13G and 12N14E were reassessed and

Disposition of Comments Received During Public Scoping

Source #	Comment Source	Comment Statement	Resource/ Activity Category	Disposition
				are proposed to be kept on the transportation system in Alternative 3.
5, 6, 19	5/12; 6/8; 19	Was cultural resource management using understory burning considered as a factor in the analysis? Will decommissioning roads affect potential management of hazel, beargrass, or other collection areas? Public access to the National Forests is critical for spiritual, cultural, and recreational reasons. Every effort should be made to provide access to Tribal Trust resources or property and roads with heritage resource for Karuk Tribal members.	Project Design/ Cultural use	Comment: Access and management of known cultural uses and gathering areas was considered as part of the analysis and proposal. Tribal consultation with Yurok, Karuk, and Hoopa tribes identified areas of concern and those areas were incorporated into the project design.
5, 17	5/13, 17/1	The public scoping and community participation in the RAP were inadequate for a project as large and complex as this RAP.	Project Design	Comment: Two public meetings were held during the RAP process and widespread scoping for the environmental analysis was conducted. All box holders within the Orleans, Somes Bar, and Weitchepec communities were notified and solicited for project input.
5	5/14	The project creates a grab bag of roads for later decommissioning without really identifying or prioritizing road segments using sound criteria.	Project Design	Comment: Criteria were developed to facilitate comparing risk versus need for each road. In conducting the risk versus need assessment, individual road segments were assessed as appropriate. The proposed action and alternatives clearly indicate site-specific road treatments including portions of road that will be kept and maintained and portions of road that will be decommissioned. Roads with highest water quality risks will have a higher priority for decommissioning than roads that have low water quality risks.
5, 17	5/15; 17/6, 17/12	Congress needs to be informed of the lack of maintenance funding and the Forest Service needs to adequately fund maintenance of road systems needed for forest management activities Failure to maintain adequate funding created the current maintenance backlog, making the Forest Service responsible for the watershed effects that result from that backlog.	Economic Analysis	Comment: Congress has been apprised of the current road maintenance backlog. Funding for road maintenance comes from Congress. The Forest Service implements the funding allocated by Congress. Without adequate funding for roads, road conditions will deteriorate and potential for resource damage will continue.
5	5/16	The proposed action will result in substantial if not significant impacts to forest, riparian and wildlife resources on the district. The economic and social impacts to the local community will be significant. The proposal will reduce future management opportunities	Project Design	Comment: Potential impacts to forest, riparian and wildlife resources will be assessed in the analysis. An economic analysis will be included in the environmental assessment. Future management opportunities associated with the proposed action were assessed and compared to direction

Disposition of Comments Received During Public Scoping				
Source #	Comment Source	Comment Statement	Resource/ Activity Category	Disposition
		and squander past investments made in the road system.		provided from the Forest Land Management Plan. The proposed action is consistent with Forest Plan direction.
5, 17	5/17, 17/3, 17/4	The methodology used in the analysis is inadequate for identifying and prioritizing future road systems…. …the process was based on subjective criteria to rank roads and relied on inventory data that is 2-5 years …you should direct your staff to design an analysis that identifies where road resource damage is occurring and priorize sites for repair, mitigation, or decommissioning using well thought out criteria. ….mitigating road resource damage requires site specific evaluations to design effective treatments…conduct onsite evaluations that focus on mitigating road related watershed impacts	Project Design	Comment: The Orleans RAP process followed the National Forest Service guidance for conducting Roads Analysis (USDA Forest Service 1999. Roads Analysis: Informing Decisions about Managing the National Forest Transportation System. Misc. Rep FS-643). The criteria used to rank roads had elements that were subjective; however they were consistent and transparent to the public. The road inventory data to determine road condition was detailed and site specific (e.g. GPS of culvert location, fill volume, condition, diversion potential etc) and considered current and relevant. This information is available in the project file. The road condition information is state of the art and comparable road data sets are unlikely to be found on most National Forests elsewhere. Upon completion of the environmental analysis, road treatments will be prioritized and implemented as funding permits.
6, 18	6/17, 18/1	KFA deeply appreciates the amount of fieldwork and data collection that went into compiling the Orleans RAP. Thank you for the large-scale color map that was included. The layout of the strategy was well documented. We compliment the Forest Service on the thoughtful analysis of the impacts and public purposes of the road system in the Orleans Ranger District.	Project Design.	Comment: Thank you.
17	17/5	The Orleans RAP violates the spirit if not the legal requirements for NEPA analysis	NEPA	Comment: The Orleans RAP is not a NEPA or decision document. The public scoping notice of May 11, 2006 inviting public input on the Orleans Transportation and Road Restoration Project was the initiation of the NEPA process.
17	17/7, 17/8	The proposed actions developed through the RAP will have positive and negative impacts on watershed resources, fish and wildlife habitat, and vegetation resources. Decision on future management actions should be based on an analysis that weighs these positive and negative impacts using measurable criteria…that maximize watershed and wildlife benefit at	Project Analysis/Economic Analysis	Comment: Potential resource benefits and impacts on watershed resources, fish and wildlife habitat, and vegetation resources will be assessed in the environmental analysis using measurable indicators and criteria. Economic analysis will be included.

Disposition of Comments Received During Public Scoping				
Source #	**Comment Source**	**Comment Statement**	**Resource/ Activity Category**	**Disposition**
		the lowest environmental and economic cost.		
6	6/14	6E55 known as Lubbs Saddle trail, has already suffered damage because of subsequent OHV trail use. It is also adjacent to one of the few Orleans roadless areas. Future NEPA must disclose impacts of motorized vehicles to wildlife disturbance and habitat fragmentation…encourage changing this trail to a foot trail	Project Design/Recreation	Comment: This analysis disclose impacts to wildlife and other forest resources from OHV use.
6	6/16	Not all roads proposed for decommissioning will need to be cleared with heavy equipment because some roads (without culverts) are already decommissioning themselves.	Project Design	Comment: Roads proposed for decommissioning that do not have water quality concerns will not be treated or disturbed with heavy equipment.

6.5 Appendix E: Annual-seasonal road closures associated with Port-Orford cedar.

1. Forest Road 10N04 (Laural Road);
2. Forest Road 10N06 (Wright's Ranch Road);
3. Forest Road 10N11 (Slate Road);
4. Forest Road 10N12 (Fish Lake Road) and spurs 10N12A and 10N12C;
5. Forest Road 10N14 (Serpentine Road);
6. Forest Road 10N22 (Serpent Road);
7. Forest Road 10N27 (Burrill Peak Road) and spurs 10N27A and 10N27B;
8. Forest Road 10N34 (Border Road) and spur 10N34A;
9. Forest Road 10N41 (Dry Lake Road) and spurs 10N41A and 10N41B;
10. Forest Road 10N42 (Border Road);
11. Forest Road 10N43 (Lower Serpentine Road);
12. Forest Road 10N51 (Fish Lake Loop Road);
13. Forest Road 11N01 (Shoshone Road);
14. Forest Road 11N02 (Big Bend Road);
15. Forest Road 11N04 (Custer Road) and spurs 11N04A and 11N04C;
16. Forest Road 11N15 (Mine Road) and spurs 11N15A, 11N15B and 11N15C;
17. Forest Road 11N16 (Rock Prairie Road) and spurs 11N16A, 11N16B, 11N16C, 11N16D, 11N16E, 11N16F, 11N16G, 11N16H, 11N16J, and 11N16R;
18. Forest Road 11N17 (Big Foot Road) and spurs 11N17A and 11N17F;
19. Forest Road 11N19 (Fish Creek Road) and spur 11N19B;
20. Forest Road 11N20 (Rock Road);
21. Forest Road 11N21 (Bee Creek Road) and spurs 11N21B, 11N21F and 11N21H;
22. Forest Road 11N28 (Squeaky Road);
23. Forest Road 11N35 (Slide Creek Road) and spurs 11N35A and 11N35D;
24. Forest Road 11N37 (North Wrights Ranch Road);
25. Forest Road 11N39 (Scallion Road);
26. Forest Road 11N40 (Borrow Pit Road);
27. Forest Road 11N42 (Monks Road);
28. Forest Road 11N44 (Aquarius Road);
29. Forest Road 11N47 (Mosquito Road) and spur 11N47A;
30. Forest Road 11N49 (Cedar Springs Road);
31. Forest Road 12N05 (Kemp Road);
32. Forest Road 12N08 (Blue Meadow Road) and spur 12N08A;
33. Forest Road 12N11 (Soapstone Road) and spurs 12N11A and 12N11B;
34. Forest Road 12N12C (Cedar Camp Road Spur);
35. Forest Road 12N17 (Dans Creek Road) and spurs 12N17A, 12N17B, 12N17C, and 12N17G;
36. Forest Road 12N36C (Tributary Catsup Creek Road Spur);
37. Forest Road 12N39 (Tributary Camp Creek Road) and spurs 12N39B and 12N39C;
38. Forest Road 12N44 (Tributary Deer Lick Road) and spurs 12N44A and 12N44B;
39. Forest Road 12N49A (Teneyck Road Spur);
40. Forest Road 12N51 (Sisky Ridge Road);
41. Forest Road 13N01 (Bluff Creek Road) from the gate at milepost 5.5 to the gate at mile marker 12.5 and spurs 13N01J and 13N01S;
42. Forest Road 13N02 (Chappell Road) and spurs 13N02C and 13N02D;
43. Forest Road 13N17 (Flint Valley Road);
44. Forest Road 14N02D (Nickowitz Peak Road Spur);
45. Forest Road 14N03 (Elk Valley Road);
46. Forest Road 14N17 (Cedar Camp Road);
47. Forest Road 14N21 (Dillon Road) from the gate at its intersection with Forest Road 15N01 (Gasquet-Orleans Road) to the gate near its intersection with Forest Road 13N35 (Meadow Road);
48. Forest Road 14N31 (Siskon Rd).

6.6 Appendix F. Economic analysis

Road maintenance funding for Forest Service roads has declined significantly over the past decade and the trend is projected to continue. Assessing the costs associated with maintaining roads as well as decommissioning roads is an important factor in designing a long-term (affordable, manageable, sustainable) transportation system.

Road Maintenance Costs:
Maintenance costs associated with National Forest system roads varying depending on their Objective Maintenance Level (OML e.g. OML 1 through 5) with Level 1 roads receiving the least maintenance funding due to infrequent need or use and Level 4 or 5 roads receiving the most maintenance funding associated with key arterial routes throughout the Forest. Due to declining budgets, there is a backlog of road maintenance on most roads (vegetation encroachment, falling debris, culvert and ditch cleaning etc) that is necessary for accesses and health and safety. Costs associated with this backlog vary by OML. In addition to the maintenance backlog, there are annual maintenance costs that vary by OML. Table 1 summarizes the typical costs per mile of road for both deferred road maintenance, annual maintenance, and capital investments needed for NFS roads. The 2006 costs per mile of road by OML level listed in Table 1 were used to estimate the cost of maintaining roads within the Orleans Ranger District over the next 15-year period. These future costs estimates are shown in Table 2. The costs of keeping and maintaining roads listed in Table 2 are an underestimate because storm damage is not included nor is inflation. Table 1 illustrates that by 2021 the cost of maintaining a given road is almost double due to inflation.

Table 1. Six Rivers National Forest Cost Per Mile Deferred and Annual Maintenance (Mtc)

Objective Maintenance Level	Miles	Work Type	2006 Cost/Mile	2021 Cost/Mile
1	135.410	Annual Mtc (once every 5 years)	$459.85	$828.16
		Deferred Mtc	$3,784.77	$6,816.13
2	247.190	Annual Mtc	$1,064.98	$1,917.96
		Deferred Mtc	$40,047.00	$72,122.05
3	97.703	Annual Mtc	$1,029.30	$1,853.70
		Capitol Improvements	$1,056.77	$1,903.17
		Deferred Mtc	$17,319.00	$31,190.40
4	17.579	Annual Mtc	$705.45	$1,270.47
		Capitol Improvements	$248.92	$448.29
		Deferred Mtc	$47,740.04	$85,976.71
5	29.650	Annual Mtc	$506.43	$912.05
		Capitol Improvements	$105.25	$189.55
		Deferred Mtc	$17,210.59	$30,995.16

1) Mtc level 1 costs for 2006 are an average of Klamath and Mendocino.
2) Miles do not include Ukonom.
3) Inflation rate between 2006 and 2021 is assumed to be 4% per year.

Table 2 shows the estimated costs of maintaining roads within the Orleans District by alternative. Over the next 15 years, Alternative 3 has the least cost, averaging approximately $1,000,000 per year. Based on past maintenance funding, the Orleans District receives on average between $10,000 to $25,000 per year. These funds are clearly insufficient to maintain the existing road network. The bulk of the future road maintenance funding will have to originate from project work (future timber or fuels projects) or from grants. Traditionally, the bulk of the maintenance funding originated from Timber Sale receipts. With the decline in timber sales, the funding for maintaining roads has also significantly declined.

Table 2 - Cost ($) of keeping roads by watershed and District over the next 15 years

Watershed	Alternative 1	Alternative 2	Alternative 3
Blue	$1,478,221	$608,820	$429,157
Bluff	$7,813,524	$5,561,925	$5,482,544
Camp	$3,802,449	$1,978,829	$1,781,480
LMK	$6,823,566	$4,406,991	$4,528,819
Red Cap	$3,813,601	$3,690,677	$3,690,677
Total District	$23,731,361	$16,247,242	$15,912,677

*costs include annual maintenance, deferred maintenance and capitol improvements over the next 15 years (assuming no inflation)

Road Decommissioning and Storm-proofing Costs:

The costs associated with road decommissioning vary considerably. Roads that have no culverts, ditches or stability concerns require no investment to decommission other than the installation of a dirt barricade. Roads having numerous culverts with large fills are significantly more costly. Road decommissioning costs are estimated based on the amount of stream crossing fill removed. Based on past road decommissioning records, approximately $15 per cubic yard of fill is a good estimate of the investment need to decommission a road having culverts. Table 3 shows by watershed and alternative the estimated cost of decommissioning roads with culverts versus the cost of keeping and maintaining those roads over the next 15 years. While there is a significant upfront investment associated with decommissioning a road, the long-term costs of maintaining the road are greater. These costs apply only to roads with culverts because there are little to no costs associated with decommissioning low risk roads (e.g. no culverts).

Table 3. Cost comparison of proposed road decommissioning versus keeping and maintaining the roads over next 15 years

Watershed	Alternative 2		Alternative 3	
	Road Deco	Keep & Maintain	Road Deco	Keep & Maintain
Blue	$33,135	$32,696	$33,135	$32,696
Bluff	$1,031,250	$2,556,997	$1,047,675	$2,772,238
Camp	$523,095	$1,826,176	$523,095	$1,826,176
LMK	$537,870	$838,522	$373,140	$700,055
Red Cap	$51,360	$180,688	$51,360	$180,688
Total Cost	$2,176,710	$5,435,079	$2,028,405	$5,511,853

There are also costs associated with storm proofing needed roads through upgrading culverts to meet the 100 year flood and correcting diversion potential. Costs associated with correcting diversion potential is approximately $2000 per stream crossing. This investment is not part of regular road maintenance but is an enormous preventative investment in reducing potential sedimentation risks associate with road-related storm or flood damage.

Funding for road decommissioning or road storm proofing is limited and mostly originates from outside grant sources. Funding for maintaining roads is also limited. Supplemental funding to maintain NFS roads through projects or grants is essential if the transportation network is to remain functional, accessible, and safe.

6.7 Appendix G. Best Management Practices Implementation

Best Management Practices (BMP) are used for water quality management on National Forest System lands within the State of California. Below is a summary statement for each of the BMPs applicable to this project.

Practice 1.14 – Special Erosion Prevention Measures on Disturbed Land

Where appropriate special erosion prevention measures include the spreading of slash, straw, or, by agreement, some other treatment.

Practice 1.19 – Streamcourse and Aquatic Protection

The interdisciplinary team doing the environmental analysis identifies the streamcourses requiring protection and the protection requirements.

Practice 2.2 – Erosion Control Plan

A general plan for erosion control be developed that will set forth erosion control measures and discuss mitigation required by operator. Operations cannot begin until the Forest Service has given written approval of the plan.

Practice 2.5 – Road Slope Stabilization Construction Practices

Stabilization methods will be designed to minimize erosion from road slopes and slope failure along roads. Methods will be identified during the environmental analysis and included in the project plan. The measures should be completed prior to the first winter rains.

Practice 2.6 – Dispersion of Subsurface Drainage from Cut and Fill Slopes

Subsurface drainage from cut and fill slopes will be provided where it is identified that subsurface moisture saturation is expected. Collected water will be dispersed in an area capable of withstanding increased flows.

Practice 2.7 – Control of Road Drainage

If there is a need identified in the project planning process, measures will be developed to minimize the erosive effects of water concentrated by road drainage features. Measures include such controls as construction properly spaced cross drains, water bars or rolling dips, energy dissipaters, aprons, downspouts, debris racks, and armoring of ditches.

Practice 2.11 – Control of Sidecast Material during Construction and Maintenance

The Timber Sale Contract includes clause B6.62 that addresses temporary road maintenance specifications. This includes slide and slump repair, surface blading, and side casting during road maintenance. Generally, sidecasting of material will be avoided in areas where it can adversely impact water quality.

Practice 2.12 – Servicing and Refueling of Equipment

A Spill Prevention, Containment and Counter Measures Plan is required if the volume of fuel exceeds 660 gallons in a single container, or if total storage a site exceeds 1,320 gallons. Incorporation of BMPs into Timber Sale Contract Provisions is as follows: B6.34 and C6.341.

Practice 2.21 – Water Source Development Consistent with Water Quality Protection

Water source development is normally needed to supply water for road construction and maintenance, dust control, and fire control. At no time will downstream water flow be reduced to a level that will be detrimental to aquatic resources, fish passage, or other established uses.

Practice 2.22 – Maintenance of Roads

Roads will be maintained in a manner that provides for water quality protection by minimizing rutting, failures, sidecasting, and blockage of drainage facilities. The Purchaser and the Forest Service will agree to an Annual Road Maintenance Plan that outlines responsibilities and timing of maintenance. This will be done before the beginning of the operating season.

Practice 2.23 – Road Surface Treatment to Prevent Loss of Material

Measures will be taken to minimize loss of road material when the need for such action is identified.

Practice 2.24 – Traffic Control during Wet Periods

Roads that must be used during wet periods should have a stable surface and sufficient drainage provided to allow such use while at the same time maintaining water quality. Where wet season field operations are planned, roads may need to be upgraded or use restricted. The Six Rivers National Forest Wet Weather/Winter Operations Standards will be a part of the operations.

Practice 2.25 – Snow Removal Controls to Avoid Resource Damage

When roads are used in the winter, snow removal will be done in a manner to protect roads and adjacent resources. Snow berms will be removed where they result in concentration of snowmelt runoff on the road. The Purchaser and the Forest Service will agree to measures prior to snow removal activities. Incorporation of BMPs into Timber Sale Contract Provisions is as follows: C5.414.

Practice 5.6 –Soil Moisture Limitations for Mechanical Equipment Operations

The Contract shall require winter shutdown whenever the Forest Service determines that the soil moisture or physical conditions have become unsuitable for equipment operation on any area. The Six Rivers National Forest Wet Weather/Winter Operations Standards will apply to all projects.

6.8 Appendix H. Management Indicator Species

Orleans Transportation and Road Restoration Project

Under the National Forest Management Act (NFMA), the Forest Service is directed to "provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives." (P.L. 94-588, Sec 6 (g) (3) (B)). The 1982 regulations implementing NFMA require that "Fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area." (36 CFR 219.19) Management Indicator Species (MIS) is a concept used by the agency to serve as a barometer for species viability at the Forest level. Population changes of MIS are believed to indicate the effects of management activities.

The Forest Land Management and Resource Plan for the Six Rivers National Forest uses MIS to assess potential effects of project activities on the various habitats and habitat assemblages with which these species are associated. Forty-one fish and wildlife species have been selected as MIS or assemblages for a variety of habitats that are potentially affected by resource management activities on the Forest (LRMP IV-97). For the analysis associated with this project, specific MIS were addressed based on the potential of their habitat to occur within the Orleans Transportation and Road Restoration Project area.

Table 1 lists the MIS and assemblages occurring on the Six Rivers National Forest (LRMP IV-97), and those known or thought to occur within the project area based on habitat suitability, survey results, or incidental sighting records. Habitat suitability evaluations were made using the California Wildlife Habitat Relationships System, Version 7.0 software, developed by the California Department of Fish and Game, and the experience of journey-level biologists.

Table 1. Management Indicator Species and Habitat Assemblages – Six Rivers National Forest

MIS Species and Habitat Assemblages	Habitat is Affected by the Project	Habitat is in or adjacent to the project areas, but is not directly or indirectly affected by the project	Habitat is not in or adjacent to the project area and is not directly affected by the project
Individual Species			
Northern Spotted Owl		Habitat is adjacent to the project area, but will only be subjected to noise (see Wildlife BA)	
Pileated woodpecker		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
Black Bear		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
American marten		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
Pacific Fisher		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
Black-tailed deer	Suitable habitat - No adverse effects		

MIS Species and Habitat Assemblages	Habitat is Affected by the Project	Habitat is in or adjacent to the project areas, but is not directly or indirectly affected by the project	Habitat is not in or adjacent to the project area and is not directly affected by the project
Bog/Seep/Spring/Wet Meadow Assemblage			
Southern torrent salamander	Suitable habitat – Short term impacts to habitats (see Wildlife BA)		
Marsh/ Lake/ Pond/ Assemblage			
California red-legged frog			No suitable habitat present in project area
Western pond turtle			No suitable habitat present in project area
Wood duck			No suitable habitat present in project area
River/Stream/Creek Assemblage			
Cutthroat trout			No suitable habitat present in project area
Steelhead/rainbow trout	Suitable habitat – Short term impacts to habitats (see Fish BA)		
Tailed frog	Suitable habitat – Short term impacts to habitats		
Summer steelhead	Suitable habitat – Short term impacts to habitats (see Fish BA)		
Common merganser			No suitable habitat present in project area
Ruffed grouse	Suitable habitat – Short term impacts to habitats		
Winter wren	Suitable habitat – Short term impacts to habitats		
American dipper	Suitable habitat - No adverse effects		
Yellow-breasted chat	Suitable habitat – Short term impacts to habitats		
Tanoak/Madrone Assemblage			
Hammond's Flycatcher		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
Western Tanager		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
Black-headed grosbeak		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
Snag Assemblage			
Flammulated Owl		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
Western screech owl		Habitat is adjacent to the project area, but will not be	

MIS Species and Habitat Assemblages	Habitat is Affected by the Project	Habitat is in or adjacent to the project areas, but is not directly or indirectly affected by the project	Habitat is not in or adjacent to the project area and is not directly affected by the project
		directly or indirectly affected (only noise)	
Red-breasted sapsucker		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
Downy woodpecker		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
Hairy woodpecker		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
White-headed woodpecker		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
Vaux's swift		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
Brown creeper		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
Western bluebird		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
Douglas squirrel		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
Down Woody Debris Assemblage			
Arboreal salamander	Suitable habitat - No adverse effects		
Clouded salamander	Suitable habitat - No adverse effects		
Blue grouse	Suitable habitat - No adverse effects		
Dusky-footed wood rat	Suitable habitat - No adverse effects		
Western fence lizard	Suitable habitat - No adverse effects		
Black Oak/White Oak Assemblage			
Acorn woodpecker		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
Scrub jay		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	
Lazuli bunting		Habitat is adjacent to the project area, but will not be	

MIS Species and Habitat Assemblages	Habitat is Affected by the Project	Habitat is in or adjacent to the project areas, but is not directly or indirectly affected by the project	Habitat is not in or adjacent to the project area and is not directly affected by the project
		directly or indirectly affected (only noise)	
Western gray squirrel		Habitat is adjacent to the project area, but will not be directly or indirectly affected (only noise)	

Summary: Impacts to MIS

The Orleans Transportation and Road Restoration Project (OTRRP) will not adversely impact MIS or affect MIS viability. The sizing of culverts may require the removal of moss, grasses, shrubs, and in rare cases sapling trees under eight inches dbh, over areas less than 100 square feet per worksite. Potential impacts to MIS would be minimized through the adherence of LRMP Standards and Guidelines for snags/down woody debris, limited ground disturbance, re-vegetation of disturbed areas, and maintenance of existing live over-story canopy closure.

Direct and Indirect Effects

There will be minor habitat degradation for stream and riparian habitat using species within the project area due to the removal of moss, grasses, shrubs, and in rare cases sapling trees under eight inches d.b.h., over areas generally less than 100 square feet per worksite, and slight short-term degradation of water quality due to inputs of sediment as areas where culverts are removed re-vegetate.

Based on previous experience with road decommissioning, it is estimated that an average of 115 square feet or 0.18 acre of vegetation may be affected at any one site where culverts and fill slopes are removed. The 38 roads or road segments (on 56 miles) identified as being a high priority for decommissioning, have 92 culverts to be removed, for an average of 1.62 culverts per mile. This equates to 92 scattered disturbed areas over an estimated total of 16.6 acres for the high priority roads. Disturbed areas would be re-vegetated with native grasses, shrubs and trees reflective of what was previously growing at the site. These effects are expected to be offset by the closing and decommissioning of roads that had been producing sediment, and by the re-vegetation of fill slopes where culverts were removed. The project will impact less than 1% of the available habitat for any terrestrial MIS species within the Klamath River watershed.

Restoration practices outlined within the OTRRP are, for the most part, intended to fix chronic watershed problems that are presently, and likely to continue, degrading aquatic habitat. Inherent within these practices is the potential that certain activities (*e.g.*, culvert replacement, road decommissioning) will minimally increase background suspended sediment loads for a short period following project completion. However, the potential increase in background sediment levels resulting from restoration activities will be low and is therefore unlikely have a measurable effect on the health and survival of listed salmonids.

The temporal and spatial scale at which project activities are expected to occur in the future will likely preclude significant additive sediment related effects at the watershed scales. Individual restoration projects tend to occur over a broad spatial scale. Due to budget and workforce constraints, few restoration projects are likely to occur in close proximity to other projects during a given restoration season, thus diminishing the likelihood that project effects would combine. Hence, sediment effects generated by each individual project will likely impact only the immediate footprint of the project location and a short distance of channel downstream of the site, with effects diminishing further downstream of the project. Also, effects to instream habitat and fish are only expected to be short-term, since most project-related sediment will likely mobilize during the initial high flow event the following winter season. In summary, any minor sediment input resulting from habitat restoration activities is not anticipated to appreciably affect aquatic MIS.

Cumulative Effects

The Orleans Ranger District is currently in the planning stages of the Orleans Community Fuel Reduction project (OCFR). This project proposes to treat fuels within an approximately 4000 acre area on Forest Service Lands surrounding the town of Orleans. While it is possible that there may be some cumulative impacts to individuals and the late seral habitats and other habitats used by the Forest Management Indicator Species addressed in this document, it is too early in the planning process to accurately assess what these impacts are, or how they might be cumulative with those of the OTRRP.

There are ongoing private timber harvests on the Downs Ranch (T11N R5E Sec. 25 and 36, T11 N R6 E Sec. 30), at the Owl Mine (T10N R5E Sec. 2) and on industrial timber lands at T10N R4E Sec. 35 and 35. None of these activities are within ¼ mile of any roads proposed for any OTRRP treatments.

There are other private lands in close proximity to roads proposed for decommissioning in T11N R6E Sections 5, 8, 17, and 18, and T10N R6E Sections 19 and 30, and along the western District boundary in Townships 10 and 11 North, that it is reasonable to expect some form of future timber harvest, other potential habitat loss or noise disturbance.

The effects of the Orleans Transportation and Road Restoration Project on Management Indicator Species would be cumulative with the removal of approximately ¼ acre of early to mid-mature hardwood-conifer habitat with a component of understory brush, which occurred during the Red Cap/County Road Reconstruction Project. This project was implemented in 2003. The Red Cap/County Road Reconstruction Project also planned, but has not yet implemented a 150 acre cool underburn in and adjacent to the Wilder Project, the effects of which could be cumulative with the OTRRP.

The Orleans Hazard Fuels Reduction Project, currently being implemented on private lands within ½ mile of OTRRP areas, could have effects on individual MIS and the Down Woody Debris MIS Assemblage that would be cumulative with the effects of the OTRRP.

The effects of the OTRRP would be cumulative with the effects of the Hazel Vegetation Management Project, which is an approximately 400 acre thinning project currently being implemented in early to mid-mature conifer/hardwood habitats adjacent to areas of the OTRRP.

The effects of the OTRRP could be cumulative with the effects Wilder Fire Salvage and Rehabilitation Project, which is a 2.5 acre fire salvage project and 30 acre fuels reduction project adjacent to areas of the OTRRP.

There are no known other recent or reasonably likely to occur projects on Federal or private lands that might have effects to management indicator species that would be cumulative with the effects of the OTRRP.

6.9 Appendix I. Road Maintenance Level Descriptions (FSH 7709.58)

Maintenance Level 1

Roads assigned this maintenance level are retained as intermittent use service roads. These roads are closed to vehicular traffic when not in use for management activities. Basic custodial maintenance is performed to keep damage to adjacent resources to an acceptable level. Road maintenance is extremely limited with emphasis given to drainage facilities and maintaining runoff patterns. There are 156 miles of road in this category within the District (24% of total miles).

Maintenance Level 2

Roads assigned this maintenance level are open for use by high clearance vehicles. Passenger car traffic is not a consideration. Traffic is normally minor, usually consisting of one or a combination of administrative, permitted, dispersed recreation, or other specialized uses. Traffic management strategies can either discourage or prohibit passenger cars or accept or discourage high clearance vehicles (4-wheel drives). Road maintenance is focused on keeping drainage structures open and maintaining runoff patterns. There are 247 miles of road in this category within the District (38% of total miles).

Maintenance Level 3

Roads assigned this maintenance level are open and maintained for travel by a prudent driver in a standard passenger car. User comfort and convenience are not considered priorities. Roads in this maintenance level are typically low speed, single lane with turnouts and spot surfacing. Some roads may be fully surfaced with either native or processed material. Traffic management strategies may accept or discourage certain classes of vehicles or users. Maintenance is focused on keeping drainage structures open and maintaining runoff patterns, with limited application of brush removal for sight distance management. There are 138 miles of road in this category within the District (21% of total miles).

Maintenance Level 4 and 5

Roads assigned these maintenance levels are open and maintained as primary access roads. These roads are rated for use by passenger cars, provide a moderate degree of user comfort and convenience, and have moderate travel speeds. Road maintenance activities within the District are primarily focused at these maintenance levels. There are 80 miles of road in this category within the District (12% of total miles).

Motorized Trails

Motorized trails are part of the NFS transportation network. Motorized trails are designated as single track trails (12”-18”), ATV trails (greater than single track <50”) or OHV/Jeep trails (> 50” but managed as a trail). There is only one designated motorized trail, 3.1 miles long, on the District and it is known as the Lubbs Trail (6E55). This motorized trail is located in the Red Cap Watershed.

Non-System Roads

In 2005, all non-system roads were inventoried. Approximately eight miles of previously unknown non-system miles were mapped bringing the total non-system roads with the District to 39 miles (6% of total miles). Non-system roads within the District include old logging roads, segments of old roads from new road realignments, and user-created roads. Since many of these non-system roads were not built for permanent use or recreation access, they can be very steep and rugged and often are only passable at very low speeds by high clearance vehicles.

Previously Decommissioned Roads

There are approximately 26 miles of road that were previously decommissioned under previous analysis. These decommissioned roads are a combination of high risk, low needed old roads, old abandoned roads, and old temporary roads associated with past timber sales. Previously decommissioned roads comprise 3% of the total road miles within the District.

KARUK ECOSYSTEM RESTORATION PROGRAM

FINAL REPORT

FY 2002

Salmon River

Karuk Tribe of California
Department of Natural Resources
Orleans, CA
31 March 2003

KARUK ECOSYSTEM RESTORATION PROGRAM

Karuk Ancestral Territory
Mid-Klamath/Salmon River Sub-basin
Humboldt and Siskiyou Counties, California

PROGRESS REPORT
31 March 2003

Prepared by
Karuk Tribe of California

CONTENTS

Page
4 Executive Summary
5 Background
Needs and Priorities
Plans, Analyses and Policies
7 Overview
Steinacher Road Unit
East Ishi-Pishi Unit
8 Initial Phases:
Funding
Training
Internship
11 Steinacher Road Unit
Introduction
Treatment Specifications
Treatment Locations
Treatment Volume Estimates
Technical Challenges
Work Schedule
Completed Work Field Seasons FY99-FY02
Prescriptive Work Completed Phase I-III
Phase III Financial Summary
28 Issues and Concerns
29 Funding Needs for the Future
Maps
30 1. Karuk Ancestral Territory Map
31 2. Watershed Restoration Unit Location Map
32 3. Steinacher Watershed Map
Appendix
33 1. Six Rivers and Klamath National Forests Road Decommissioning Priorities
36 2. Technical Treatment Prescription Descriptions for Steinacher Rd.

EXECUTIVE SUMMARY

The Karuk Tribe of California and the Six Rivers and Klamath National Forests are developing a programmatic approach to watershed restoration in the Karuk Ancestral Territory, an area that encompasses the Mid-Klamath and Salmon River sub-basins. In 1996, the Tribe and the two National Forests entered into a Memorandum of Understanding (MOU) that established a framework for the two partners to jointly identify, plan, and accomplish mutually beneficial projects within Karuk Ancestral Territory. The projects identified to benefit both partners are watershed restoration, job training opportunities, and community economic development.

Past mining, excessive logging, and road building activities contributed to environmental degradation within the territory. Many sub-basins are listed as sediment, temperature and/or nutrient “impaired” under 303 (d) of the Clean Water Act and classified as “key watersheds”—critical spawning and rearing habitat for endangered or threatened fish species—by the Northwest Forest Plan.

The Karuk Tribe, in collaboration with the Northern California Indian Development Council, Inc. (NCIDC), hired a contractor to assist in developing a Karuk Ecosystem Restoration Program, as envisioned by the Director of Natural Resources, Leaf Hillman. The initial effort of the program was to create a watershed division to design, manage and implement watershed restoration activities on Steinacher Unit, East Ishi-Pishi Unit, and Thompson Unit over a five-year period.

In fiscal year 1999 (FY99), the initial training of 16 Tribal members who began work primarily on the Steinacher Road Unit. According to the Steinacher Unit Restoration Plan, decommissioning of the 5.2-mile road would require three years to complete. As of November 1st 2002, this task was completed as expected. To date, approximately $3,005,353.00 dollars has been spent decommissioning Steinacher Road. In fiscal year 2000 (FY00), only winter maintenance and monitoring of previous work was done due to insufficient revenue.

Without stable revenue, continuation of the Karuk Ecosystem Restoration Program is uncertain. Adequate funding remains a significant challenge in other watersheds within the Karuk Ancestral Territory, which are in dire need of restoration. We gratefully acknowledge the following funding providers who have made possible the progress to date (see Figure 1): California Department of Fish and Game (CDFG), US Forest Service (USFS), US Environmental Protection Agency (EPA), US Bureau of Indian Affairs (BIA), US Fish and Wildlife Service (USFWS), Northern California Indian Development Council, Inc. (NCIDC, the source for funding from the California State Block Grant [CSBG] and the Job Training Partnership Act [JTPA], and the National Fish and Wildlife Foundation (Natl F&W). “Funding for this project has been provided in full or in part through a contract with the State Water Resources Control Board (SWRCB) pursuant to the Cost-Machado Water Act of 2000 (Proposition 13) and any amendments thereto for the implementation of California’s Nonpoint Source Pollution Control Program. The contents of this document do not necessarily reflect the views and policies of the SWRCB, nor does mention of trade names or commercial products constitutes endorsement or recommendation for use.”

BACKGROUND

Needs and Priorities

The Karuk people have continually lived in their ancestral territory for over 10,000 years, and have a vested interest in restoring ecological and economic vitality to this land, an area encompassing over 1562 square miles in the Mid-Klamath and Salmon River sub-basins. Ninety-six percent of Karuk ancestral territory lies within the Klamath and Six Rivers National Forests, (Map 1). The environmental degradation of the territory affects water quality, forests, fisheries, and cultural sites important to the Tribe. Anadromous fish species are both economically and culturally valuable, and the restoration of riparian, aquatic, and upslope habitat is crucial for their survival.

A sincere partnership between the Tribe and National Forests is clearly the most effective means for economic and environmental renewal of this region. The Karuk Tribe of California is interested in long-term employment for Tribal members. Karuk Tribe 1999 census data show 87 percent of its members are unemployed or live under the national poverty level. Due to the considerable budget cuts and reduction of Forest Service personnel, the two National Forests lack the necessary funding and staff to restore the Mid-Klamath and Salmon River sub-basins within an acceptable time frame.

In 1979, the Karuk Tribe gained sovereign status with the US federal government and began government-to-government protocols with the USDA Forest Service. While former Tribal participation in Forest Service planning efforts had been limited (being, at best, advisory), recent federal mandates have fostered a more cooperative climate. The Tribe and Klamath and Six Rivers National Forests have since entered into MOUs that established a framework for both to jointly identify, plan, and accomplish mutually beneficial projects and activities.

Redefining and expanding the role of the Karuk Tribe in managing their traditional resources has brought about the development of this new watershed restoration partnership between the Karuk Tribe and the Forest Service. Building the Tribe's capacity to play an appropriate role in ecosystem management is an effective means by which the Mid-Klamath and Salmon River sub-basins will be restored and community development achieved.

Plans, Analyses and Policies

The Karuk Tribe and Klamath and Six Rivers National Forests have prepared independent management plans to guide restoration of the ancestral territory; these are, respectively, the "Non-Point Source Pollution Assessment and Management Plan" and the "Land and Resource Management Plans" (LRMP). Both plans addressed large-scale watershed restoration by:

- providing brief descriptions of existing Karuk Tribe and Forest Service programs;
- identifying watershed restoration priorities;
- establishing criteria that defines practical completion of restoration efforts; and

• establishing a watershed restoration program that implements a large-scale effort in a cost-effective and timely manner.

In the Karuk plan, watersheds with the most serious or potential impacts to spawning habitat were ranked highest. This ranking was supported by Forest Service's LRMP. Socioeconomic factors are also addressed by this prioritization, given that many of the Karuk people gain cultural and economic support from the fishery resources and habitat associated with healthy fisheries.

Since the establishment of the Forest Service in 1905, the organization has aimed at balancing commodity production with beneficial uses of water. However, commodity production (principally timber) was the dominant management focus in the Mid-Klamath and Salmon River sub-basins during the 1960s and 1970s. The Forest Service has since increased its emphasis on environmental concerns through the National Environmental Policy Act with respect to water, fish and wildlife resources. In addition, new water quality protection programs were added in the 1980s and 1990s:

• "Water Quality Management for National Forest Systems Lands in California" (also known as the Best Management Practice program), 1981;
• "Best Management Practices Effectiveness Program" (BMPEP), 1992;
• Northwest Forest Plan, 1994–1996; and
• LRMP's of the Klamath and Six Rivers National Forest, 1994–1995.

The following has provided further direction for the Karuk Ecosystem Restoration Program:
• Watershed Analyses prepared by Klamath National Forest include: Ishi Pishi/Ukonom, 1998; Indian Creek, 1997; Thompson/Seiad/Grider, 1999; Main Salmon, 1995), and about 15 others;
• Westside Roads Analysis, Klamath National Forest, 1997;
• Happy Camp Ranger District Environmental Assessment (EA), 1999;
• East Ishi Pishi Road Restoration Project, Six Rivers National Forest, draft NEPA scooping document, July 2000; and
• Environmental Assessment for Steinacher Rd. (Rd. 12NO1) Rehabilitation Project Klamath National Forest, 1995.

In the former Forest Service Chief Mike Dombeck's "Natural Resource Agenda for the 21st Century," an emphasis was placed on watershed health, restoration and forest roads. The newly developed long-term road policy is based on four primary objectives:

1. More carefully considered decisions to build new roads;
2. Elimination of old, unneeded roads;
3. Upgrade and maintenance of roads important to public access; and
4. Development of new and dependable funding for forest road management.

The Karuk Ecosystem Restoration Program focuses on all of these objectives, yet two of them have a higher priority: the elimination of old, unneeded roads; and the development of new revenues to provide critically needed watershed restoration.

OVERVIEW

The Karuk Ecosystem Restoration Program began as collaboration between the Tribe and Klamath and Six Rivers National Forests with the assistance of the Northern California Indian Development Council, Inc. to achieve mutual ecosystem management goals and watershed restoration objectives. To expedite those goals and objectives, a watershed division within the Natural Resources Department of the Karuk Tribe was created. The strategy of the watershed division is to systematically implement prioritized watershed restoration action plans in partnership with the National Forests while providing family wage jobs to tribal members and the river community.

The start-up phase of the program focused on staff development and implementing the first priority restoration unit, which was the Steinacher Unit. The East Ishi-Pishi Unit is next in priority (see Appendix 1 and Map 2). Funding for the initial phase of East Ishi-Pishi Restoration has been developed through the assistance of NCIDC.

Steinacher Unit

Steinacher Road was in the lower segment of the Salmon River sub-basin, specifically affecting the lower portion of Wooley and Steinacher Creeks (see Map 3). These watersheds have been classified as "key watersheds" within the Northwest Forest Plan and the top priority for the Tribe. In 1996, the Klamath National Forest decommissioned the upper 2 miles of the 7.2-mile road. The Karuk Tribes' Watershed Restoration Program decommissioned the remaining 5.2 miles of road during fiscal years 1999, 2001, and 2002 respectively.

East Ishi Pishi Unit

Sub-watersheds within the East Ishi Pishi Unit are identified as of "critical concerns" and considered "impaired" by the Northwest Forest Plan and the Clean Water Act. These watersheds include the Ti, Irving, Rogers and Ukonom Creeks, and contain high potential sources of sediment contributing to the degradation of water quality within the Klamath River system. Cool water from the sub-watersheds of East Ishi Pishi is important for maintaining water quality in the Klamath River, and provides optimum water temperature for anadromous fish species. In addition, the lower stream reaches contain spawning and rearing habitat critical to the future viability of these species.

Approximately 64 miles of road are identified as candidates for road decommissioning and roughly 8.5 miles are to be converted to trail. The proposed actions will take over 8-12 years to complete depending on funding availability.

Initial Phases

Program efforts during the start-up phase focused on training watershed division personnel, implementing the Steinacher Unit, and moving forward in the planning and implementation of East Ishi Pishi and Thompson Units. In June 1999, a watershed restoration specialists training program was initiated. Graduates of the basic skills course then interned on the Steinacher Unit and participated on road assessments for Ishi Pishi planning efforts.

Funding. NCIDC has been a vital resource for securing revenue for the program. Revenues for the program came through eight different funding entities (Figure 1). Contracts between grantors and the Karuk Tribe were administered through the Karuk Community Development Corporation, and later through the Karuk Tribe Administration. Each independently written contract accounted for specific elements that were cumulatively important for the success of the program.

Collectively, these funding sources have contributed approximately $3 million towards program development, planning, training, and implementation. The graph below (Figure 1) depicts the amount and source of the funding.

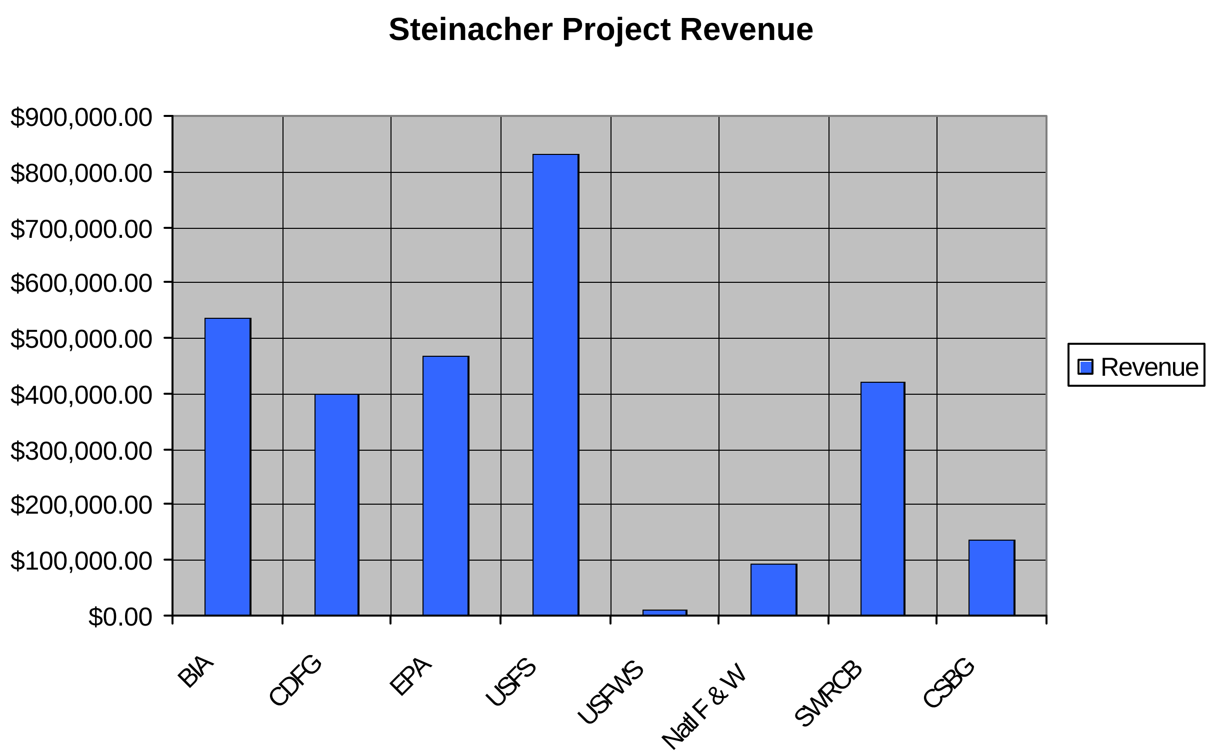


Figure 1.

Training. The training phase was designed to provide the basic knowledge and advanced job skills necessary to accomplish cost-effective, long-term watershed restoration within the Karuk Ancestry Territory. Sixteen Tribal members were hired through the Karuk Community Development Corporation to participate in the Karuk Department of Natural Resources, Watershed Division.

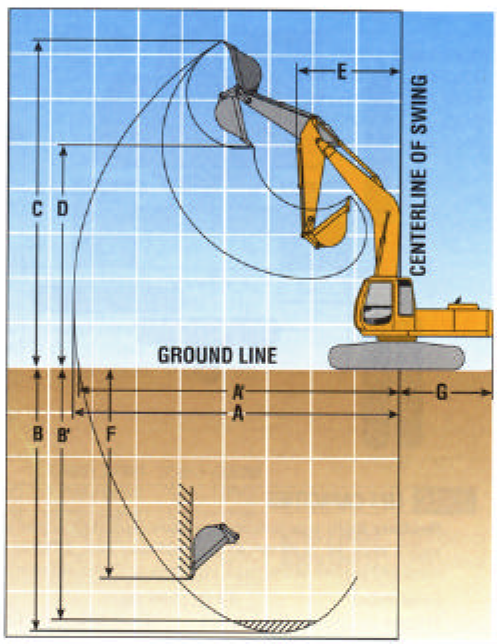
A top-quality watershed restoration-training program is an investment in the Karuk Watershed Division. Training has focused on specific regional restoration objectives and cultural demands; the high quality skills these require will pay off many times over as the program grows in maturity.

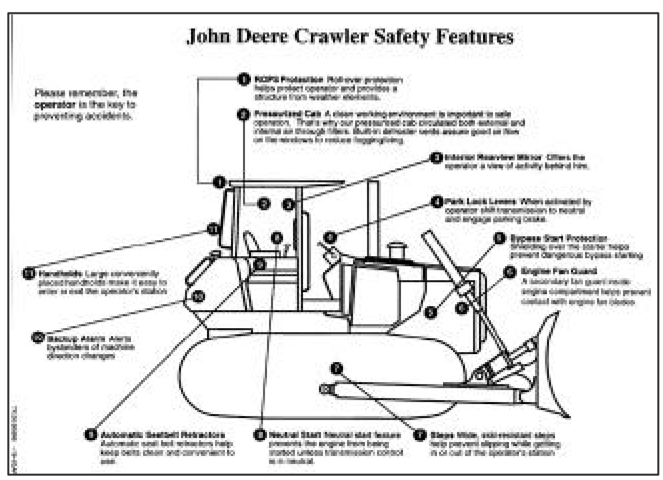
The training curriculum was developed to prepare the Karuk Watershed Division for site management and heavy equipment operations. Students were subjected to rigorous classroom and field study. The curriculum, covered:

- Basic geomorphology and hydrology principles within the regional geologic context;
- Mapping, inventorying and surveying techniques;
- Prescriptions and treatment layout;
- Heavy equipment operations and labor-intensive application;
- Unit management, record keeping and monitoring methods; and
- Communications, safety, CPR and first aid.

Initial training began with formal classroom and on-the-ground training modules that covered step-by-step operations in the following areas: program management, site management, heavy equipment operations, labor-intensive operations, and native plant operations.

Internship. The internship phase provided on-the-job apprenticeships for watershed restoration specialists after completing the basic core curriculum. Internships reinforce the consistency and quality taught in initial training, and continues until a sufficient knowledge base is acquired.





STEINACHER ROAD UNIT

Introduction

The Steinacher Road Unit is defined by the hydrologic boundary of Steinacher Creek, a lower tributary to Wooley Creek, which flows into the Salmon River, (map 3). In 1996, the Steinacher Road Environmental Assessment was completed and identified the need to decommission Steinacher Road (Forest Service road #12N01).

Steinacher Road was the only road within the Steinacher Creek watershed. Planned to be the primary transportation route to cut timber and haul logs from the Salmon River basin to mills in Happy Camp, road construction began in 1968. However, only 7.2 miles of it was completed due to the creation of Marble Mountain Wilderness. Construction of the road was complex: topography, incompetent soils, and bedrock presented engineering difficulties in maintaining a 26-foot roadbed with a uniform grade. In 1997, the Klamath National Forest decommissioned the upper 2 miles of the 7.2-mile road.

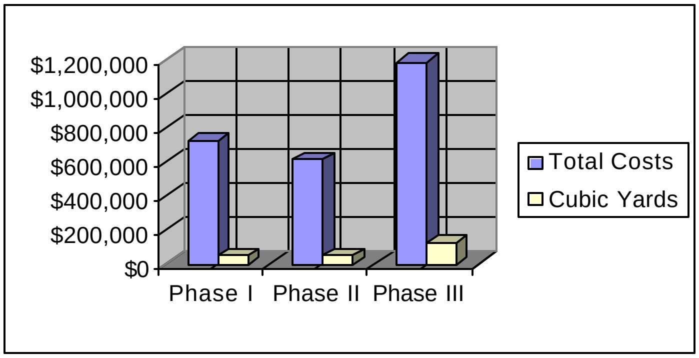
Steinacher Road

In 1997, the Karuk Tribe contracted with Pacific Watershed Associates (PWA) to prepare a technical specifications report for decommissioning the remaining 5.2 miles of Steinacher Road. This report estimated **172,265 yd^3** of fill material to be excavated from 23 treatment sites over a three-year, heavy equipment work schedule at an estimated cost of $2.2 million.

By 1999, planning efforts were underway to include Steinacher Road in the program. The Karuk Tribe then contracted with TerraWave Systems Inc. to assist in the development of the Tribe's Watershed Restoration Division and implement the road decommissioning as part of the training and internship phase. During the road decommissioning survey-training component, a critical treatment volume disparity surfaced between the two contractors estimates.

These differences were great enough to require revision of the treatment specifications, which increased the final excavation volume by 23,791 yd^3. Technical changes were required to be made before heavy equipment began, which significantly impacted the work schedule and logistics.

By the end of FY99, the first field season of heavy equipment operations excavated approximately 52,000 cubic yards of fill were removed and placed in stable locations, and winter maintenance measures were implemented. From August to November 2000 (FY 2000), the Karuk Program resurveyed the rest of the road (RX10 to the gate), and implemented winter maintenance measures, no additional excavation work occurred due to inadequate revenue. During FY 2001, approximately 48,823 cubic yards of fill material was excavated and placed in a stable location. The final phase of the Steinacher Project completed in FY 2002 removed and placed in appropriate locations approximately 117,853 cubic yards of fill material. The graph below compares cost to cubic yardage. **Overall, for the entire project the cost per cubic yard is calculated to be $11.52.**



Treatment Specifications

The revised treatment specifications detail the work schedule by itemizing: excavation and disposal sites, secondary erosion control measures, labor-intensive work, winterization measures, monitoring, and other special conditions or concerns.

The treatment specifications require the removal of road fill from stream crossings, swales, and unstable sidecast areas that threaten waterways and downstream salmonid habitat. Stream crossings are to be excavated to original width, depth, and slope to expose natural channel armor and buried topsoil or achieve stable engineered dimensions for maximum cost-effectiveness. Sidecast fill material, with high failure potentials affecting watercourses, is to be excavated to reduce erosion hazard and expose buried topsoil. Excavated material is to be moved to stable road locations, placed along cutbanks and in through-cuts, and then shaped to specific slope and compaction requirements.

Treatment specifications (see Appendix 2) are designed with tentative grades and dimensions, which provide the basis for estimates of volumes to be excavated. As the work progresses, the site supervisor (who monitors the excavation) determines the final grades and dimensions. The final grades and dimensions provide the basis for determining actual volumes excavated. While monitoring the excavations, the site supervisor instructs the equipment operators to adjust the excavation's grade, alignment, and bank dimensions to preserve latent boundary conditions, such as: original topsoil, natural channel armor, bedrock outcrops, or stumps in the growth position. (It is extremely important not to remove or disturb these natural boundary features.)

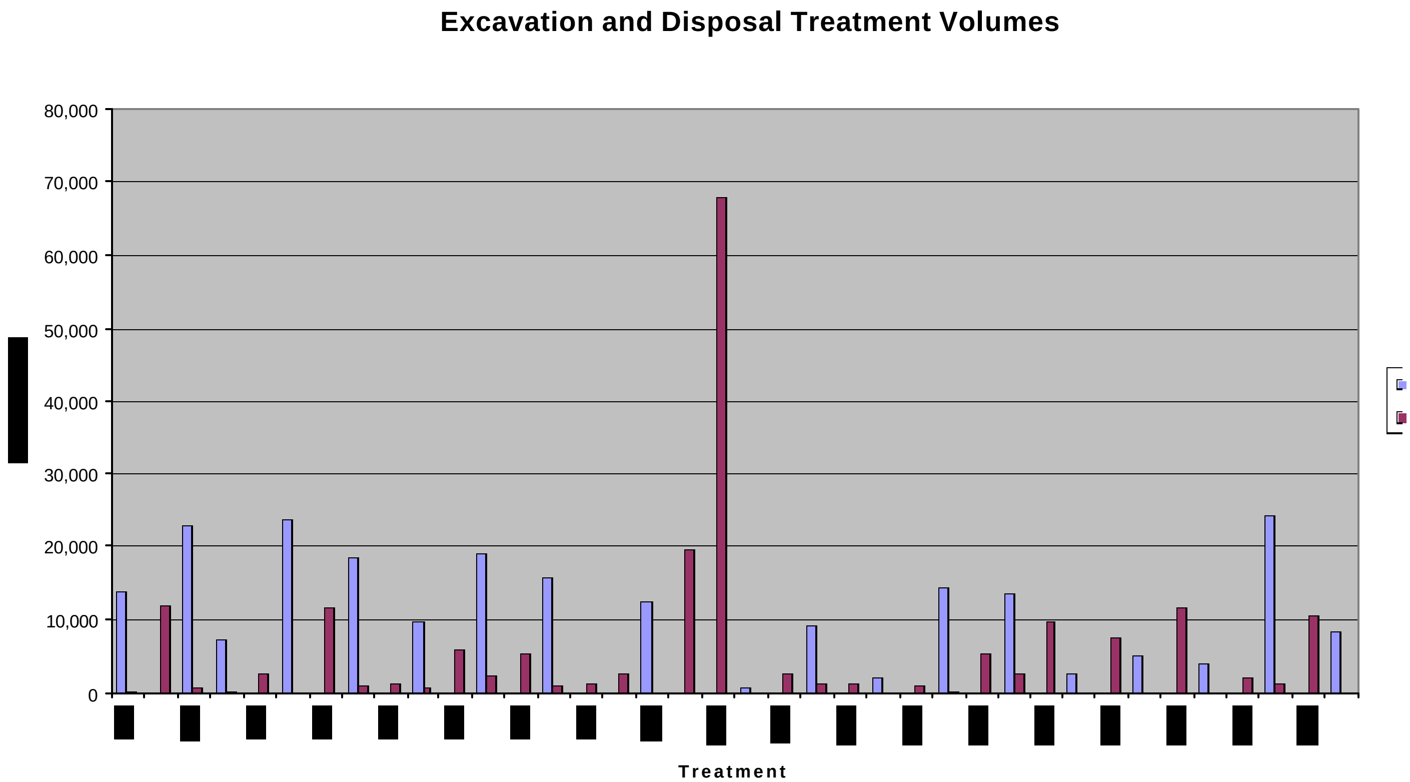
Treatment Locations. All treatment sites are referenced to a common datum using the standard engineering P-Line "station" method. Station stakes or wire flagging are installed on the cutbanks along the road every 100 feet at the start or end of a work site. These stakes are labeled with a station number, such as "STA 25" or "STA 25+00."

Locations between station stakes are identified such as "STA 25+25," which means a location is found 25 feet beyond the station "STA 25+00" stake (2,525 feet) from the start of the work site.

Each stream crossing (RX) or road reach (RR) treatment is referenced by a control point (CP) to a common datum, such as RX10 located at station CP155+80. Road reaches are segmented into individual treatment types depending on road stability and construction design.

As mentioned above, earlier treatment specification estimates required refinement. Final revisions to the treatment specifications [for (STA 0+00) to RX10 (CP 155+80)] affecting approximately 3 miles of road were made during FY99. The remaining changes to the treatment specifications [from RX10 to the end of the road (STA 260+00)] were completed in FY00.

Treatment Volume Estimates. All stream crossing excavations and a variety of road reach treatments required volume calculations for managing fill materials, developing the work schedule, and for estimating costs. A detailed volume survey was undertaken to revise prescriptions and improve the accuracy of earlier excavation and storage volume estimates. The graph below shows the results of the new volume survey.



Stream crossings and swale treatments accounted for 94 percent of the total 196,056 yd^3 volume to be excavated on the project. (Excavation sites ranged in volume from about 1,100 yd^3 to nearly 68,000 yd^3 in size.) Road reach volume storage capacities range from about 200 yd^3 to about 24,000 yd^3 in size, and collectively have a maximum-engineered capacity of 228,919 yd^3 to dispose fill material along the entire road (see Appendix 3). Note the sharp excavation volume spikeed at RX9 and R 10 and the lack of disposal space adjacent to them (discussed below).

Technical Challenges

Decommissioning Steinacher Road presented more technical challenges than usual. Although we estimated a net disposal site volume surplus of 32,863 yd^3 over the length of the entire project, this actual excavation/storage volume difference is less than 6 percent after factoring for material expansion and compaction coefficients. Because fill material is imported into a disposal reach from both end-hauled sources (end-hauling is loading fill into dump trucks) and adjacent excavation sources, experienced supervision is essential to achieve cost-efficiency and accurate volume capacity.

Steinacher Road traversed steep, erosive, mountainous terrain. Variations in fill material and ground conditions add to decommissioning complexity. The majority of fill material was composed of uniform, very coarse-grained rock fragments typical of a grus regolith, commonly known as decomposed granite (DG), with occasional concentrations of small rocks and boulders.

The moisture content of the fill material varied from dry to completely saturated. Ground conditions changed frequently, with variable road width, cut bank height, hillslope repose, crossing orientation, channel flow, and bedrock competency.

Fifteen stream crossing excavation sites contained more than 2,500 yd^3 of fill. Seven of those sites contained more than 10,000 yd^3 and two sites contained more than 19,000 yd^3. The largest excavation is estimated at 67,828yd^3 at RX10 (CP155+80), halfway through the project.

Two crossings (RX 9 and RX 10) have fill volumes that exceeded nearby disposal site capacity by 86 percent. Nearly 75,000 yd^3 from these two crossings were trucked to distant disposal sites along the length of the road. Careful supervision of end-hauling material was required to balance locally derived excavated fill with fill from distant areas, while at the same time maximizing disposal site volume.

Stream crossing excavations were further complicated and consequently time-consuming due to their size and geometry. For example, many crossing excavations have asymmetric geometry, in which the natural channel is oblique to the road alignment and/or natural channel beds curve through crossings. Some channels had culverts with buried elbow joints, while other channels had culverts not set to natural grade. Many pipes carry flowing water year round, required additional water quality measures during excavation.

Three crossing excavations were considered double crossings, in which the design geometry and final shape must take into account the crossing being built on the confluence of two stream channels. These excavations were very complex and complicated operations.

For example, RX10 was a double crossing; as well, about 90 percent of the 67,828 cubic yard volume was end-hauled. The culvert in the primary channel, a 5-foot diameter, bolted multi-plate pipe, and 330 feet in length required it to be cut into manageable sections. The secondary channel is an intermittent stream on the exit side of the excavation; it had a 24-inch culvert that was not set to grade, and oblique to the road and primary channel.

Work Schedule

Decommissioning the 5.2 miles of Steinacher Road required three heavy equipment work seasons. The work schedule details the heavy equipment, labor intensive and monitoring operations needed to complete the project. At the end of each season, erosion and sediment control measures were implemented.

Work generally started nearest the end of the road and proceeded backward to the beginning of the road. However, due to the large volume of end-hauled material from RX9 and RX10, the work schedule incorporated complex end-hauling operations to manage the interspersed disposal sites.

RX10 is the largest excavation of the Steinacher Unit, and together with RX9, required ten separate road reaches to dispose of the 75,000 cubic yards of end-hauled fill they generated. Consequently, individual disposal sites had to be managed so to balance the needs for local storage (from adjacent excavations) with that of imported fill to maximize the available capacity within the limited storage capacity of the entire road. The rate of linear road progress (that is, miles completed) was directly linked to the rate of excavation at RX9 and RX10.

It is important to note that there is an economic push-distance threshold for disposing of fill by the bulldozer, at which it becomes necessary to end-haul material. The larger the excavation, the further material has to be moved, requiring multiple pieces of heavy equipment to manage. Therefore, the farther the distance material must be moved, the greater the cost.

Due to the erosive nature of soils in the unit, secondary erosion-control measures are required on completed work. These measures consist of applying a layer of certified weed-free rice straw mulch at 4,000 lbs/acre to bare surfaces and an erosion-control native grass seed mix with fertilizer. In addition, a few crossings required rock armor in the final channels. The rock armor was onsite thereby not requiring the importation of said material.

After each heavy equipment season, winterization measures were implemented for the remaining road not yet decommissioned. These measures included: reopening rolling dips that were filled to facilitate end-haul operations; examining and maintaining straw-bale surface-erosion check dams; and, because RX10 is very large, constructing a sediment detention basin within the excavation to capture local sediment runoff. This sediment detention basin captured a considerable amount of material during the 2001-2002 off-season.

Completed Work Field Seasons 1999-2003

On July 13, 1999, the Steinacher Road heavy equipment phase began and continued through October 15 of that year. Six large pieces of heavy equipment and up to nine dump trucks were used to execute the earthwork. Large bulldozers, excavators, dump trucks, a water truck, and for a brief time, a grader were all used on the project. Interns from the Karuk Training Program operated the heavy equipment. Trucks and their operators were provided through a local subcontractor.

No heavy equipment work except winterization measures occurred in FY 2000 due to lack of funding. During this period rolling dips and straw bale check dams were installed. Treatment revisions were also accomplished during this time.

The field season for 2001 ran from June 18 through September 21. The occurrence of a summer storm stopped work from June 27 through June 29. In addition no work occurred July 4 through July 6. Due to funding limitations heavy equipment operations were limited to four ten-hour days.

The third and final phase began June 19, 2002 with the staging of post project erosion and sediment control material (weed-free rice straw) and revegetation supplies (native grass seed and fertilizer). Also during this time frame heavy equipment mobilization occurred. This was the first year the Tribe has taken on the responsibility of heavy equipment rental. Heavy equipment operations started on June 24 and continued until November 1. The Final Phase work schedule was the most demanding to date. The crews and heavy equipment maintained five-ten hour days throughout the length of the project. The only day operations ceased was July 4. To keep up with the decommissioning, Watershed Restoration Laborers classification was created and tribal members hired, to implement erosion and sediment control measures as the project progressed.

Prescriptive Work Completed

Phase I

All prescriptive work from the beginning of the Phase I through RX2, nearly 1 mile in length, were completed by October 15 1999; this includes all heavy equipment, operations, straw mulching, seeding, and stocking native plants. Only two stream crossing excavations (RX1 and RX2) were completed within the FY99 budget. In addition, approximately 31,800 yd^3 (45 percent) of the fill in RX10 has been excavated and end-hauled to disposal sites in RR1, RR2, RR3, and RR4.

RR1 stored approximately 13,766 yd^3 of fill: 600 yd^3 was end-hauled from RX10; 11,164 yd^3 was pushed by bulldozers from RX1; and 411 yd^3 came from internal excavation sites. Before starting to excavate RX1, end-hauling to RR1 had to be completed. As well, before RX1 could be completed, all disposal outsloping within RR1 had to be finished.

RX1 was a complicated double-crossing excavation with 12,151 yd^3 of fill: channel A had a 48-inch culvert on grade with the natural bed; channel B had a 24-inch culvert that was not on grade. Both pipes contained flowing water at the time of excavation. Water quality measures were taken to safeguard off-site effects, which consisted of diverting flow away from the excavation and installing in-channel straw bale catchments. Approximately 92 percent of the fill material is disposed in RR1. The remaining 987 yd^3 is disposed in RR2.

RR2 has the second largest storage capacity on the road at 23,010 yd^3. Spoils imported into RR2 came from RX1, internal excavation treatments, and end-hauled material from RX10—approximately 987 yd^3, 561 yd^3 and 21,462 yd^3, respectively. While disposal operations were occurring on RR2, a pioneer road had to remain open to access RX1. Once RX1 was finished, outsloping of fill disposed in RR2 could then proceed.

RR3 had a disposal storage volume estimate of 7,243 yd^3. Its capacity was filled with 340 yd^3 from a small internal swale, 750 yd3 from RX2, and 6,153 yd^3 from RX10.

RX2 was an average size stream crossing with a massive rock outcrop on the left bank. A 42-inch engineered oval culvert was set above natural channel grade with an elbow and 70 feet of down spout. Although the crossing had a volume estimate of 2,771 yd^3, only about 1,800 yd^3 was necessary to excavate due to the rocky composition of the fill and high percentage of large boulders encountered during excavation. We suspect the boulders came from the massive rocky outcrop during road construction. Because the culvert was oblique to the channel grade, minimum water quality measures were necessary so that stream flow could remain in the pipe during the excavation process. Boulders extracted from the fill were stockpiled for later transport to RX8, a crossing that will require channel armoring. Fill from RX2 was disposed in RR3 and RR4—approximately 750 yd^3 and 1,050 yd^3, respectively.

Phase II

RR4 had the largest disposal storage capacity of the project: 23,772 yd^3. There are no internal excavation treatments in the reach; therefore RR4's storage potential was used for fill from RX2, RX3, and RX10. The reach was filled with 4,746 yd^3 from RX2 and RX10 in FY99, and the remaining 17,976 yd^3 were filled from RX3 and RX10. After the spoils were imported, the CAT 325L shaped materials to the finished slope specifications.

RX3 was the first stream crossing to be completed in FY01; over 11,917 yd^3 of material was excavated. A D8R began by excavating the stream crossing. The material was pushed into disposal areas in RR4 and RR5. The original crossing fillslopes were veneered with rock slope protection (RSP), large boulders that act to reduce surface erosion and stabilize the fill prism. This RSP was salvaged and reused to armor the new channel bottom. More RSP was recovered than needed locally so the excess was hauled down to RX10; over 200 yd^3 was loaded into an A30 and hauled out. Although RX3 was a very large crossing, working conditions soon were cramped due to staging of the rock and as the excavation got deeper. Heavy equipment worked for 26 days to reach and remove the 60 inch diameter culvert.

Technical specifications for RX3 did not prescribe rock armor; however, due to the abundance of RSP, specifications were changed to include rock armor placement; a considerable amount of time, effort and expense.

RR5 was 1,542 feet in length and designed to store 18,705 yd^3 of material. Its capacity was filled with 964 yd^3 from four internal swales, over 8,810 yd^3 from RX3, 300 yd^3 from RX4 and 8,331 yd^3 from RX10. Material imported from RX10 occupied two specific reaches, CP 74+41 to CP 77+09 and CP 79+83 to CP 81+21. The remaining area was reserved for local excavations (RX3,RX4 and swales). Extra material from RX3 required a specifications change to increase specific reach grade to 50 percent to accommodate added volume. Approximately 195 bales of straw were used for mulching the bare ground.

RX4 was a normal, average size stream crossing with a volume of 1,362 yd^3. A D8R was used to excavate the top portion of the crossing; then a CAT 325L and D6R finished the job. A 36-inch diameter culvert (not to grade) was removed. No channel armoring was prescribed. Rock salvaged during excavation was installed as channel armor conjunct with native rock outcropping in the bed and on the right bank. Fill removed from RX4 was disposed in RR5 and RR6.

RR6 contains two road segments (A and B), separated b y RX5, a total treatment length of 1,571 feet; segment-A extended between RX4 and RX5, segment-B extended between RX5 and RR7. Nine specific treatments were prescribed within the total reach. Disposal sites were designed to store 9,615 yd³ of material. Spoils imported from RX4, RX5 and RX10 filled most of the storage capacity, 741 yd³ were filled from spring drain and swale excavations within the reach.

RX5 is a large stream crossing excavation between segments A and B of RR6, approximately 5,981 yd³ in volume. A 36 –inch diameter, 145 –foot long culvert was removed and hauled away for disposal. The natural crossing banks are steep, the left bank averages 150% slope, the right bank averages 81% slope. The channel is 31% grade. Water quality was maintained through out the excavation by pumping stream flow around the job.

The initial crossing volume was excavated using a Volvo 360 excavator and end-hauling by an A30 off-road dump truck to the farthest disposal site in RR6. Rock RSP was encountered during the excavation and salvaged for reuse in armoring the finished channel. No rock channel armor was originally prescribed. The crossing was left unfinished to allow access to the above work then completed between September 7th and 11th using the CAT 325L, D8R and D6R. The total excavation took approximately 9 days to complete (about 2.5 days were spent moving rocks during excavation and armoring the finished channel).

RR7 is 1,929 feet long and designed to hold 18,075 yd³ of material. Within the reach 3,007 yd³ of local excavations occur. In FY01, about 100 feet of the reach was completed. The remaining length was completed in Phase III, FY02.

RX10 is the largest stream crossing excavation undertaken on Steinacher road and in the region. Built on the confluence of two streams, it is also the most technically challenging design and excavation. The 60-inch diameter culvert was buried in the primary channel and is constructed of multiple metal plates bolted together forming a 330-foot long straight pipe. Although the general grade will be uniform when completed in FY02, the primary channel will have an "S" shape emulating the original valley contour.

Estimating the volume of fill to excavate at a double crossing, where two or more streams join at the road crossing, is difficult to calculate. Complex buried landscape and natural channel geometry adds uncertainty to the volume estimate. To date, approximately 56,203 yd³ (83%) of fill has been removed from the original estimate of 67,828 yd³ in RX10: approximately 32,000 yd³ in FY99 and an additional 24,403 yd³ during a 25-day period beginning on 26 June 2001.

All spoil material from RX10 was end-hauled to disposal sites as described above. From volume survey calculations at the end of Phase II there was approximately 11,625 yd³ of remaining fill to excavate. However, to excavate the best channel alignment based on natural hillslope and channel irregularities the surveys suggest the remaining volume could range between 12 and 15 thousand cubic yards depending on the final configuration as exposed during channel excavation.

Excavation of **RX10** commenced on July 19. The trucking operation ran from July 20 to September16. A Hitachi 330 excavator with a 2.5-yd^3 bucket capacity was used to load dump trucks that hauled the fill to disposal sites mentioned above. Up to nine trucks were used per day, making a total of 3,673 loads, hauling approximately 31,800 yd^3 of fill. A truck was loaded or dumped every four to seven minutes for 39 days. Daily haul production rate fluctuated, depending on disposal site conditions, such as: frequency of turn around locations; length of back up in the disposal reach; road width, and steepness of disposal ramps. Approximately 45 percent of RX10's volume had been extracted at the end of Phase II. Size can be deceptive in photographs. RX10 is less than half excavated, and about 36,028 yd^3 remained.

<u>Phase III</u>

RR7 was 1,929 feet in length and accommodated approximately 18,075 yd³ of fill material. In FY01, about 100 feet of the reach was completed. The remaining length was completed during Phase III, FY02. Of the 18,075 yd³ of capacity within this reach, 3,007 yd³ of which was local fill. The local fill was excavated from three swales and two spring drains. Imported material totaling 11,512 yd³ from RX 10 was disposed of along four separate reaches of RR 7. An additional 3,556 yd³ was end-hauled from RX 9. The

finished grade along this road reach is less than 40 percent.

RR8 contains two road segments (A and B) separated by RX6 and terminates at RX7. The total length of road treated was 2,096 feet. Nine road treatments were prescribed in this reach including a 1,014-yd³ swale located in RR8B. The total designed fill capacity of this reach was 15,811 yd³. The excavation and placement of fill from RX6 contributed 5,487 yd³ toward filling this reach. An additional 6,362 yd³ was end-hauled from RX9, and 1,349 yd³ from RX7.

RX6 was a relatively large stream crossing excavation located between RR8A and RR8B. The total amount of fill within this crossing was approximately 5,487 yd³. A 36" diameter, 155' culvert was excavated and transported to a temporary storage area onsite. The natural bank steepness within this crossing varies between 38%-156% depending upon location. The channel length, measured in slope distance (SD) is 172' with a 10' channel bottom. The channel gradient is approximately 32%, with a slight curvature (meander) to approximate natural conditions. At the time of excavation no water quality control measures were necessary due to dry conditions. Rock (RSP) encountered during excavation was utilized to armor the head of the channel. The head of the channel on the left bank was widened to incorporate a spring into the finished crossing. The total post-excavation disturbed area of 21,672ft² was mulched with certified weed-free rice straw, and seeded with a native grass seed mix to the extent possible due to slope steepness.

RX7 located at the termination of RR8B was an average size crossing with an approximate volume of 1,549yd³. The culvert in this crossing was a 36" width and 110" in length. The bank steepness varied between 41%-98%, once again depending upon location within the crossing. Finished channel gradient in this crossing is 40% and the length is166' (SD), with a channel width of 10'. The majority of the volume excavated was utilized in RR8B.

RR9 contained three segments: A, B and C separated by RX 8 and RX 9, respectively. RR9 had the design capacity to accommodate approximately 14,906 yd³ of fill material. RR9A was filled to design capacity utilizing fill material from RX7. Imported fill material from RX8 and RX9 was used in RR9B. The finished fill grade is 40% throughout RR9. A large through-cut in RR9C was filled and outsloped using material from RX9. An additional 2,350 yd³ of material was imported from the ongoing excavation of RX10 into this reach.

RX8 was a moderate sized stream crossing with a total volume of 2,844 yd³. The material from this crossing was utilized in RR9B. The bank steepness varied between 30%-71%, and the overall channel length is 104' (SD) with a gradient of 27%. A 36" 100' culvert was excavated and hauled to storage site. This crossing required the use of a gasoline-powered trash-pump and over 120' of hose to dewater this site for water quality purposes. The total disturbed area consisted of 12,245 ft², which was mulched and seeded by Restoration Laborers.

RX9 was the second largest crossing excavation on the Steinacher Project. The total volume of material excavated exceeded 19,597 yd³. The depth of excavation at the outboard edge of road (OBR) to the top of the culvert was approximately 62.2' as compared to RX6 with a depth of excavation at the OBR of only 33.5'. The bank steepness through this excavation varies between 65%-104%. The channel excavation length was 254' (SD), with a gradient of 18%-19%. As with RX6, a meander was re-established to approximate natural conditions prior to road building activities. Rock encountered during excavation was used as channel armoring. In addition a series a rock check dams were placed in the channel. The culvert used to convey flow through this crossing was a 60"-multi-plate, with a total length of 235' and a cement headwall. A multi-plate culvert is assembled on-site utilizing sections that are bolted together resulting in one continuous length of culvert. The cement headwall had to be broken apart with a hydraulic hammer attachment in lieu of a bucket on the CAT 330 excavator. The amount of stream flow encountered during excavation required dewatering the site to protect water quality.

RX10 with an initial 67,828 yd³ of fill material required three seasons to completely excavate and reshape. In FY99 32,000 yd³ was excavated, while in FY01 resulted in the removal of

24,403 yd³. During the Final Phase excavation of FY02, 36,267 yd³ had been excavated along with the dismantling and disposal of 325 linear feet of 60? MULTI-PLATE culvert. Two channels merging in the excavation, forming a double stream crossing exacerbated the complexity of this excavation. The sheer amount of RSP encountered during excavation required it to be handled numerous times before final placement. The RSP salvaged from the excavation was utilized for channel armoring along the entire channel length. As with previous crossings a meander was re-established to emulate the original valley contour. This excavation included RX10B, which created a double crossing. Without the dedication of our team coupled with the expertise provided by our contractor, this crossing would still have the potential to deliver over 67,000 yd³ of material downstream.

RR 10 required the treatment of 93 linear feet of road. This reach was designed to hold 551 yd^3 of material. The excavation of RX10 contributed 451yd^3, while fill material from RX11 included 100yd^3 to be disposed and outsloped.

RX11 was another mid-sized crossing excavation with 2,669 yd^3 of material. The channel length for this crossing was 102 feet with a 46% grade. A 24? culvert was removed and hauled to storage site for future removal from site. The average left bank slope gradient 69%, while the right bank averages 68%.

RR11 resulted in the treatment of 1,144 feet of road. This road reach was designed to accommodate 9,386 yd^3 of material. The majority of fill (2,569yd^3) came from RX11, while another 782 yd^3 came from RX12. Internal fill material (1,492 yd^3) was derived from the excavation of one swale, two outslope portions, and a spring-drain. The net fill volume reserve was utilized to accommodate fill material from other locations.

RX12 was another relatively small crossing with a volume of approximately 1,452 yd^3. This crossing required the removal of a 24? culvert and anchors. The designed channel configuration consisted of an 8 ft channel width that was 107 ft in length, with a channel gradient of 31%. The average left bank slope was 54%, while the average right bank slope was 58%.

RR12 was only 160 ft in length and designed to hold 2,079 yd^3 of fill material. Imported fill material consisted of 670 yd^3 from RX12 and 461 yd^3 from RX13. The majority of this material was used to fill and outslope a through-cut. A total of 127 yd^3 was obtained through internal prescriptions.

RX13 was one of the smallest crossings excavated with 922 yd^3 of fill material. The final channel length is 115 ft., with a gradient of 41%. The channel width is 8 ft. with a average left bank slope of 54% and on average a right bank slope of 54%. Removal of a 24-inch culvert was also accomplished. The culvert inlet was buried for an undetermined amount of time, which is the major contributor to road crossing failures.

RR13 totaled 635 ft. of road treatment, with a design capacity of 14,575 yd^3. RX13 contributed 461 yd^3 of fill material to this reach, while RX14 added an additional 2,853 yd^3. An internal swale excavation of 486 yd^3 was also disposed and outsloped within this road reach.

RX14 had 5,705 yd^3 of material, which was evenly distributed between RR13 and RR14. The channel length is 242 ft., with a channel gradient of 51%, which is the steepest, yet encountered during the Final Phase. The channel width of 8 ft. was achieved, while the left and right bank slope averaged 69% and 75% respectively. We also removed a 24inch culvert with about 60 ft. of downspout. In addition we removed a 12" culvert on the right-side outboard edge of road (OBR) with an 80 ft. downspout.

RR14 was 1,204 ft. in length and designed to accommodate 13,373 yd^3. A portion of this road reach was filled with 2,853 yd^3 from RX14 and 3,890 yd3 from RX15. Two internal swales accounted for an additional 2,493 yd^3 of local fill. Approximately 2,803 yd^3 of this material was utilized to fill a through-cut and outslope the material to a 40% grade.

RX15 had approximately 9,904 yd^3 of fill material. This crossing had a curved channel alignment adding to the complexity of excavation. The channel length was 283 ft., and an average 10ft. width with a channel grade approaching 44%. The average left bank slope is 89%, while the average right slope of 84% is representative of the natural slopes both upstream and downstream of the site. A 36" CMP with accompanying perforated pipe was removed. This channel has also been armored with RSP.

RR15 treated 234 feet of road with a design capacity of 2,878 yd³. One minor internal excavation consisted of removing a 12" CMP cross drain. As with other cross drains throughout the project, associated down spouts and anchors were removed early in the season. This task was completed with an excavator and a ground crew using chains and logging cables (chokers and straps). The vast majority of material disposed of and outsloped in this reach was excavated from RX15 (2,778 yd^3). The remaining material, 100 yd³ had been end hauled from RX16.

RX16 was another large stream crossing excavation containing approximately 7,654 yd³ of material. The 24"CMP angled 45 degrees to the right edge of cut, at this point an elbow reduced the pipe to 12" CMP down the fillslope had to be excavated and removed. The channel length is 221 ft. in length with a 42% gradient. The channel width at the top of the crossings is 8 ft., while the bottom portion approaches 15 ft. The finished left and right bank slope average is 58% and 77%. Extensive gully erosion on the bottom half of the fill added a complexity that had yet been encountered so far in the project.

RR16 had a design capacity of 5,138 yd³ and is 320 ft. in length. A 12" CMP drop outlet and hardware was removed from this road reach. The fill material used in this reach was acquired from the excavation of RX15-17. RX15 contributed approximately 3,059 yd³, while RX16 and RX17 contributed 1,979 yd³ and 100 yd³ respectively.

RX17 was another large stream crossing excavation with 11,699 yd³ of material. The channel length of 276 ft. is the second longest excavated during this Final Phase. The channel gradient through this crossing is approximately 43%. Channel width in this crossing is 10ft. The average left bank slope is 75%, while the average right bank is 68%. The culvert removed from this crossing was a 36" CMP with a flared inlet.

RR17 is 287 feet in length with a design capacity of 4,088 yd³ of material. Another through-cut was filled and outsloped in this road reach. The majority of fill used to outslope this reach came from RX17, totaling approximately 3,988 yd³. A 12" CMP drop outlet and downspout was also removed

RX18 contained approximately 2,077 yd³ of fill material. The length of this channel is around 153 feet, with a gradient approaching 49% that makes it one of the steeper channel gradients. A 24" CMP and associated perforated pipe was excavated and removed. The final channel slopes are on average 68% for the left bank, and 84% for the right bank.

RR18 was one of the longer road reaches treated with a design capacity of 1,915 yd³ of storage. Internal excavation prescriptions for a swale and spring drain accounted for approximately 1,368 yd³ of fill material. In addition, two 18" and one 12" CMPs with over 480 feet of downspout were removed. This road reach is also the beginning of trail construction, which will link the end of the road to Steinacher Trail Head. Logs were placed diagonally across the finished slope to demarcate where the trail heads downslope. Pioneer road width along portions of this road reach was a safety concern involving the off-road dump trucks, so extra added caution was used in negotiating this reach.

Tribal Chairman Alvis Johnson with crew

RX19 was the final crossing to be excavated on the Steinacher Project. This crossing exhibited more physical traits of a swale, so was survey and excavated accordingly. The survey indicated a possible 10,672 yd³ of fill material. The handling and outsloping of this material was extremely difficult due to amount of rock/rubble encountered during excavation. Natural ground was encountered shallower than expected, especially very large boulder outcrops, precluding the need for further excavation.

RR19 had a design capacity of 8,147 yd³ of material and is 878 linear ft. in length. The prescription for this reach called for the finished slope to be less than 40%. Due to the limited amount of excavated material from RX19, a portion of the road reach has a less than 20% grade. A spring drain excavation of approximately 40 yd³ and the removal of two sections of 18" CMP also occurred. On November 1st at approximately 10:20 am a Gate Pulling Ceremony was held to show our gratitude to all who were involved with this monumental project.

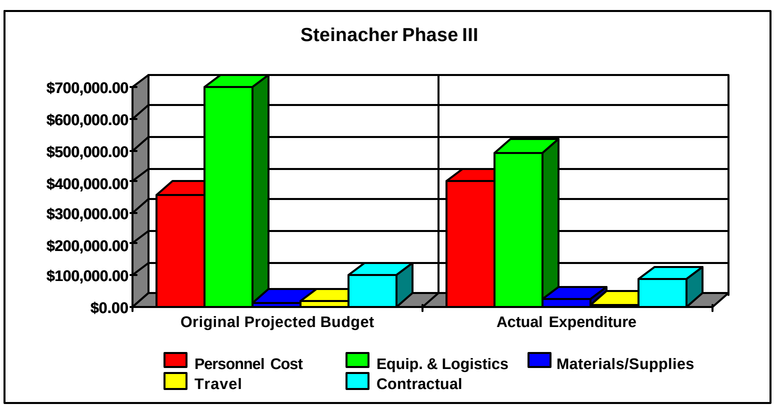
TO ALL WHO PARTICIPATED IN THE STEINACHER ROAD DECOMMISSIONING PROJECT

YOOTAV

Phase III Financial Summary

Due to the project size and technical complexity, the total Steinacher Road Decommissioning Project cost is approximately $3 million. In FY02, $1,189,322.00 was secured from four independent sources. These sources included the Environmental Protection Agency, Bureau of Indian Affairs, U.S. Forest Service and finally funding secured by the Northern California Indian Development Council through the State Water Resources Control Board.

Phase III expenses were tracked in five categories: personnel, heavy equipment and logistical, supplies and materials, travel, contractual. Personnel costs (for heavy equipment operators, project site monitoring, and labor intensive tasks) account for about 39.59 percent of total expenditures. Heavy equipment procurement was the largest expense, at 48.96 percent of the total project cost for Phase III. Material and supplies were 2.39 percent, while travel accounted for a mere 0.66 percent. Contractual expenses accounted for 8.41 percent of the total.



Issues and Concerns

On a project of this magnitude, accurate survey detail was critical for its ecological and financial success. Determining the appropriate survey resolution is crucial. For example, a less detailed survey of a stream crossing in the 2,000 yd^3 range may amount to only a 10 percent increase in volume with minor cost adjustments; however, a 10 percent increase in a 15,000 yd^3 crossing, results in significant unexpected financial outlays. Another issue which had been raised before the project started was the need for the technical drawings to match the staking in the field, and to agree on the edge of cuts for stream crossing excavation. A further concern expressed was the desire by both the Tribe and USFS to improve the lines of communication and mutual respect.

Personnel involved in the Karuk Program and the USFS have done an excellent job documenting and revising and addressing these concerns. As partners in this extensive watershed restoration effort this is the only path on which to tread. Many pieces of heavy equipment were used on this project, due to diligent training and safety discussions, no significant injuries or major heavy equipment damage has occurred over the past three phases of the project.

FUNDING NEEDS FOR THE FUTURE

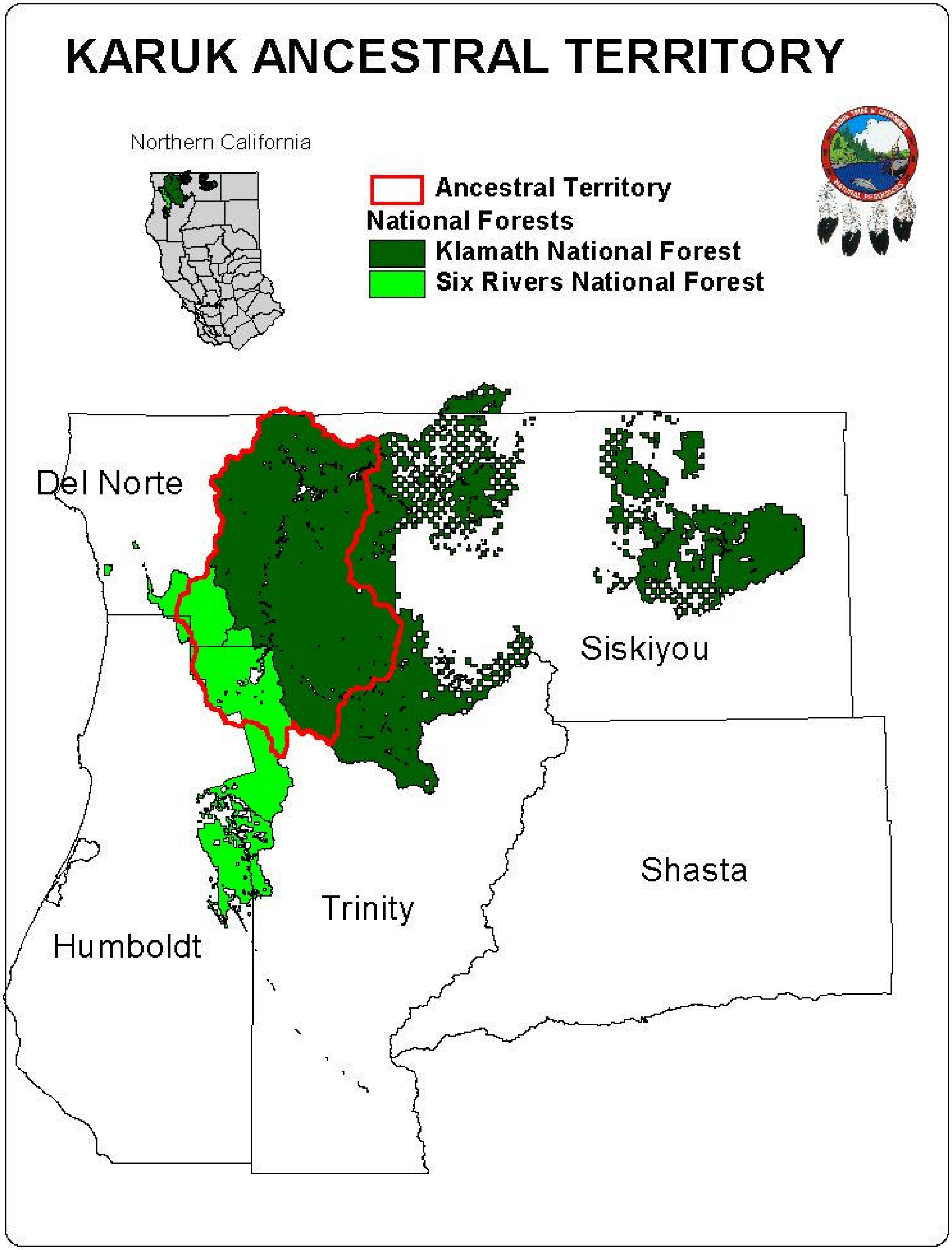
The Karuk Tribe and the Forest Service should be commended for tackling one of the largest road decommissioning projects in the Pacific Northwest to date. This project was vitally important for maintaining viable fish populations in the Wooley Creek watershed, as well as for the local economy. However, continued financial commitment is necessary to move on to other important watershed restoration work in East Ishi Pishi and other critical watersheds within the Ancestral Territory.

Competition for limited funds has exponentially increased. Funding sources relied on to date must be applied for on an annual basis, and evaluated among others submitted within a highly competitive climate. This factor is jeopardizing the continuity of the Karuk Program.

The Karuk Tribe is continuing to seek and apply for funding from various sources to maintain a viable program. With national priorities focused elsewhere the funding pool from which we compete are becoming very limited. At this junction, the Federal Government must not forget the Tribal Trust Responsibility it has with the Karuk Tribe and the resources we depend on as a people.

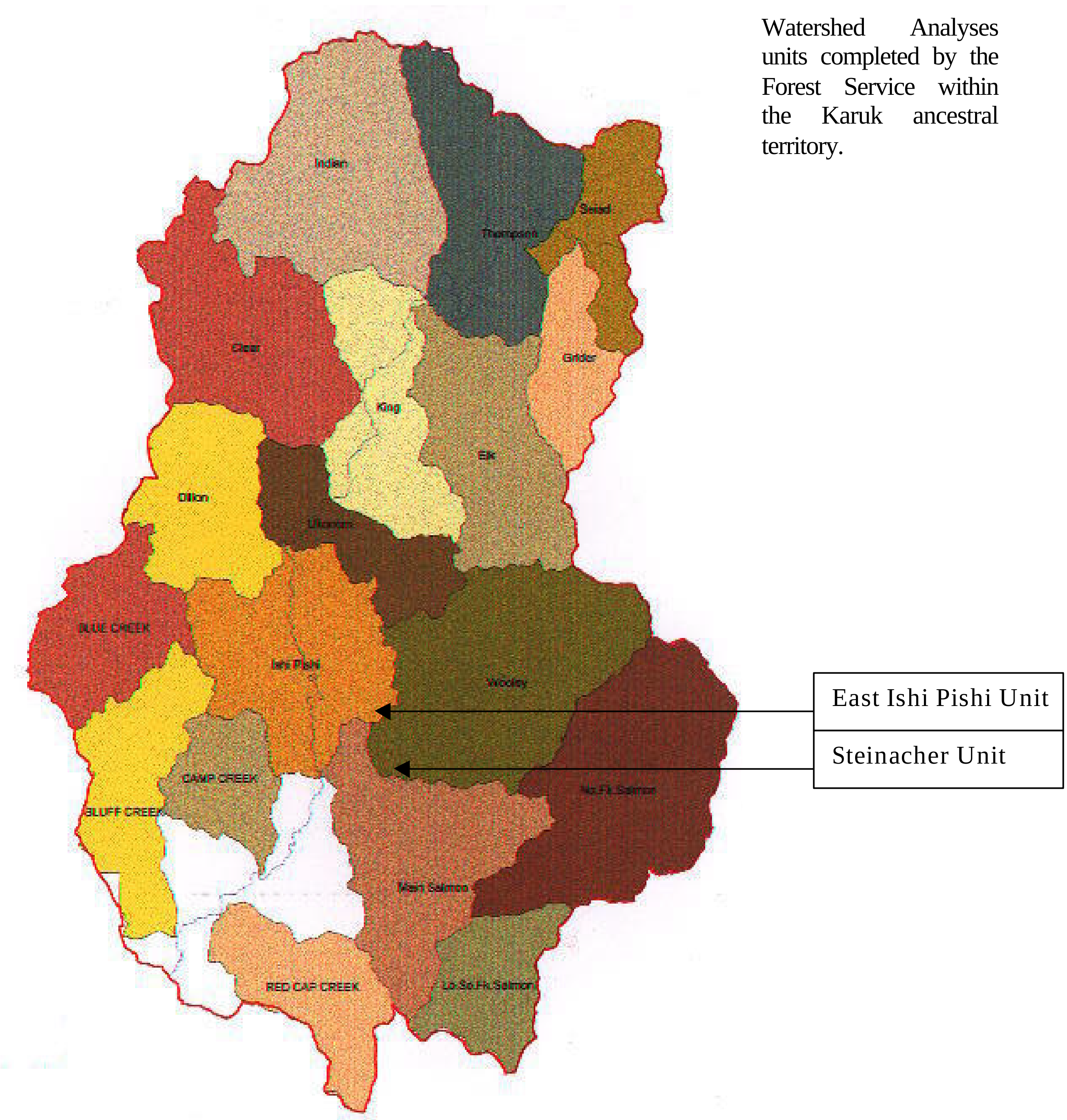
To achieve the goals of the Karuk Ecosystem Restoration Project and realize the benefits of a programmatic/scale of economy approach; a steady stream of revenue must be sustained. In a economically depressed area, the jobs we provide is a mechanism by which native people can live and raise their children in a land we have called home since the beginning of time.

Map 1.

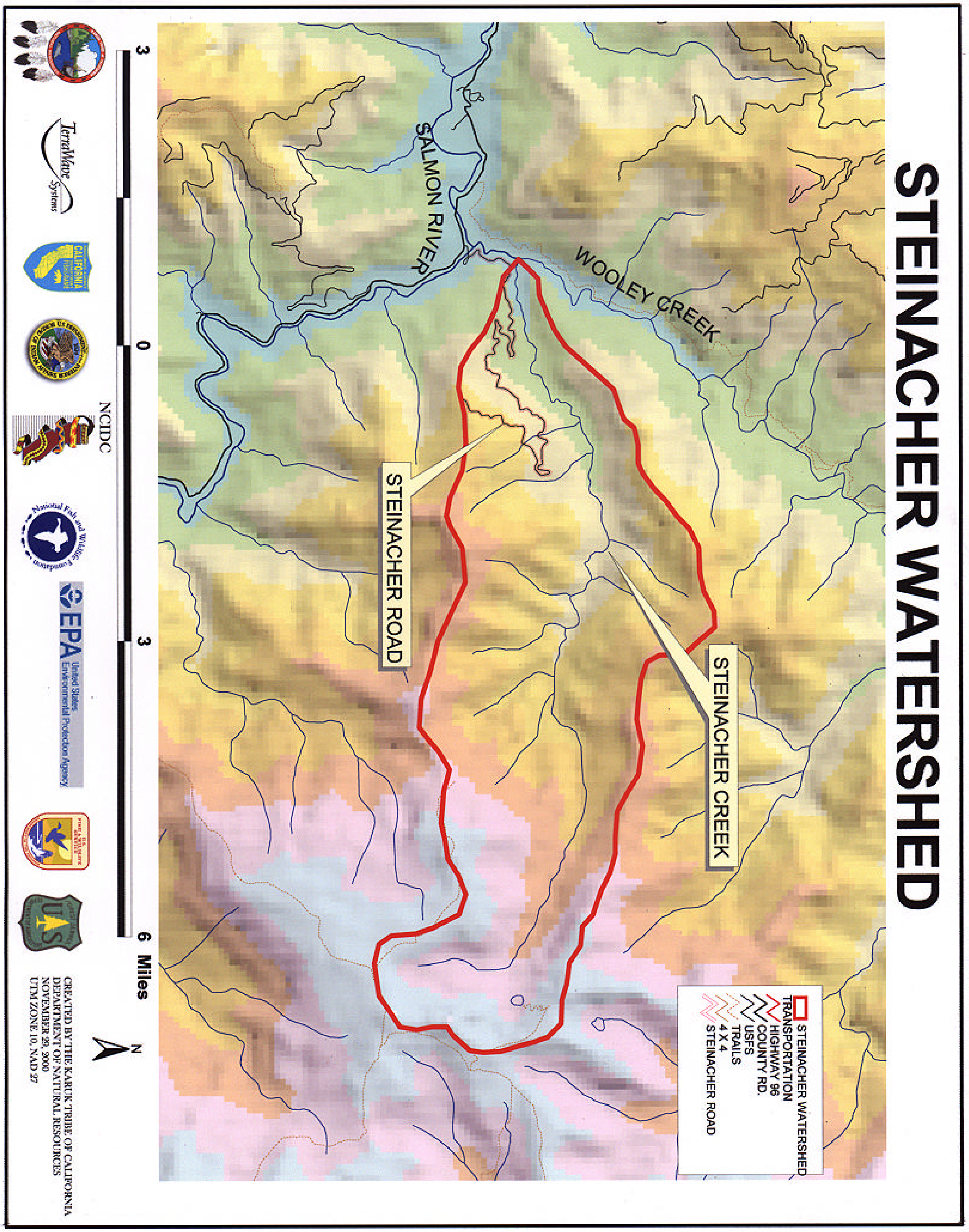

KARUK ANCESTRAL TERRITORY
Northern California
Ancestral Territory
National Forests
Klamath National Forest
Six Rivers National Forest
Del Norte
Siskiyou
Humboldt
Trinity
Shasta

Map 2. Watershed Restoration Unit Location Map.

Watershed Analyses units completed by the Forest Service within the Karuk ancestral territory.



Map 3.



STEINACHER WATERSHED
SALMON RIVER
WOOLEY CREEK
STEINACHER ROAD
STEINACHER CREEK
STEINACHER WATERSHED
TRANSPORTATION
HIGHWAY 96
COUNTY RD.
USFS
TRAILS
4 X 4
STEINACHER ROAD
3
0
3
6
Miles
N
NCIDC
EPA United States Environmental Protection Agency
CREATED BY THE KARUK TRIBE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
NOVEMBER 29, 2000
UTM ZONE 10, NAD 27

APPENDIX 1:

Six Rivers And Klamath National Forests Road Decommissioning Priorities

I. Steinacher Unit

Road #	Road Name	Watershed	Length (mi.)	Crossings	Cu. Yds	Remarks
12N01	Steinacher	Wooley Cr.	5.2	18	196,000	Completed

II. East Side Ishi Pishi

UNIT 1

Road #	Road Name	Watershed	Length (mi.)	Remarks
12N08	Irving Gates	Irving	4.3	High Priority
12N08A	Irving Gates	Irving	.9	High Priority
12N08B	Irving Gates	Irving	.3	High Priority
12N26	Flatlander	Irving	.4	High Priority
12N26A	Flatlander	Irving	.5	High Priority
12N26B	Flatlander	Irving	.2	High Priority
12N29	Bald Butte	Irving	2.0	High Priority
12N29A	Bald Butte	Irving	1.3	High Priority
Total Miles			9.9	

UNIT 2

Road #	Road Name	Watershed	Length (mi.)	Remarks
12N09B	Merrill Mtn. Loop	Rogers	.1	
12N13N	Bull Pine	Rogers	.2	
12N13X	Bull Pine II	Rogers	2.0	Convert to Trial
12N13Y	East Bull Pine	Irving	.5	Convert to Trial
12N14	Leach	Katamin	.5	
12N24	Camp Out	Rogers/Irving	1.0	
12N24A	Camp Out	Rogers/Irving	.3	
12N32A	West Camp Three	Rogers/Irving	.2	
12N41	Merrill Mtn. Loop	Rogers/Wooley	1.0	
12N43	View-it	Rogers	1.1	High Priority
12N44	Roger Davis	Rogers	.7	High Priority
12N46 Spur	Merrill Off	Merrill	.2	
15N17N	Camp Three	Merrill	.1	
Total			7.9	

UNIT 3

Road #	Road Name	Watershed	Length (mi.)	Remarks
12N05	Haypress	Wooley	3.3	After silviculture treatment
12N07 & A	Merrill Creek.	Merrill	2.75	After silviculture treatment
12N47	Gates Creek	Wooley	1.1	
12N47A	Gates Creek	Wooley	1.8	
13N04	Bridge Creek	Wooley	2.09	
13N04A	Bridge Creek	Wooley	.2	
Total			**11.24**	

UNIT 4

Road #	Road Name	Watershed	Length (mi.)	Remarks
13N06	Ti Creek	Ti	.7	
13N06A	Ti Creek	Ti	1.3	
13N06B & Spur	Ti Creek	Sandy Bar	.5	After silviculture and fuels treatment
13N06E	Ti Creek	Ti	1.2	
13N07A	Karoo	Ti	.7	
13N10	Sandy Bar Loop	Sandy Bar	4.2	Convert to Trail, after silviculture treatment
13N11B	Sandy Bar	Stanshaw	.7	
13N11D	Sandy Bar	Ti	.4	
13N11F	Sandy Bar	Sandy Bar	.3	After silviculture treatment, arch. survey
13N12A	Stanshaw	Stanshaw	1.1	After silviculture treatment, arch. survey
13N12D	Stanshaw	Stanshaw	.6	
13N25	Ti Tie	Sandy Bar	1.0	Convert to Trail, after silviculture treatment
13N33	Cabbage Head	Ti	1.5	After silviculture treatment, arch. survey
13N43	Ti Loop	Ti	1.1	After silviculture treatment, arch. survey
13N51Y	Sandyshaw	Sandy Bar	1.1	After Sandollar
13N52	Potse	Eyese	.4	
15N17D	Camp Three	Irving	.9	After fuels treatment
Total			**17.7**	

UNIT 5

Road #	Road Name	Watershed	Length (mi.)	Remarks
13N01	Upper Cub	Ukonom	1.1	
13N03	Camp Four	Ti	2.5	After silviculture and fuels treatment
13N06Y	No. Ti Creek	Ti	1.3	
13N09	Middle Ti	Ti	3.0	After silviculture and fuels treatment
13N09A	Middle Ti	Ti	.3	After silviculture and fuels treatment
13N22	Poo Bear	Ukonom	1.0	
13N45	Ten Bear Trail	Ti, Ukonom	.8	Road to trail, after fuels treatment

13N45A	Ten Bear Trail	Ukonom	.5	
14N01A	Ten Bear	Ukonom	.5	
14N01B	Ten Bear	Ti	.7	
14N01F	Ten Bear	Ti	.8	
14N01N	Ten Bear	Ti	.2	Unnamed spur
14N12	Cub Creek	Ukonom	1.2	
14N63	Cub Poo	Ukonom	.3	After silviculture treatment, arch. survey
14N63A	Cub Poo	Ukonom	.3	After silviculture treatment, arch. survey
15N17H	Camp Three	Ukonom	.9	
Total			**15.4**	

UNIT 6

Road #	**Road Name**	**Watershed**	**Length (mi.)**	**Remarks**
13N08A	Ukonom Mtn.	Ti	.2	
13N08C	Ukonom Mtn.	Ukonom	.2	
13N08E	Ukonom Mtn.	Kennedy	.4	
13N08F	Ukonom Mtn.	Thomas	.3	
13N08H	Ukonom Mtn.	Ukonom	.3	
13N11J	Sandy Bar	Ti	.4	After silviculture treatment, arch. survey
13N15	Lower Ten Bear	Ti	2.8	After silviculture and fuels treatment
13N15A	Lower Ten Bear	Ti	.3	After silviculture and fuels treatment
14N01C	Ten Bear	Ti	.4	After silviculture and fuels treatment
14N01D	Ten Bear	Ti	.4	After silviculture and fuels treatment
14N01E	Ten Bear	Ti	.7	
14N01G	Ten Bear	Ti	.4	
14N08	Kennedy Flats	Burns	1.6	Maintain now, then silviculture and fuels treatment
14N08A	Kennedy Flats	Burns	.8	
14N15A	Delahaye	Burns	.2	
14N22 Spur	Grand Slam	Ukonom	.2	Unnamed spur
Total			**9.6**	

APPENDIX 2:

Technical Treatment Descriptions For Steinacher Road

Treatment specification plans provide prescriptions for each road segment and detail the work to be performed, providing volume estimates, road dimensions, culvert sizes and lengths, disposal locations, and special instructions that are included in the prescriptions.

Several types of treatments are required for Steinacher Road. The road alignment may traverse a hillslope, cross a stream channel, or cut through a ridge. The reach may contain ditches, berms, seeps, or springs. The road grade and surface composition may differ from one reach to another, just as the stability of fills and cutbanks may differ. Some road reach treatments require both excavation and disposal prescriptions. This is determined by the original construction design of a particular reach. Road reaches are delineated between major stream crossings and require specific treatments, depending on the road stability and original construction design. Excavated fill goes to disposal sites.

Disposal sites serve two functions: to provide stable, long-term storage for imported fill; and to buttress cutbank instability.

The disposal site capacities stated in the technical specifications are derived from detailed, on the ground surveys, and represent estimated volumes. Disposal site volumes are defined by road prism cross-section surveys and treatment length. Natural conditions may cause actual disposal site volumes to vary from designed volumes by minute variations in cutbank shape or changes in the finished grade.

The fill material is shaped and compacted to specifications. All fill is placed against cutbanks so that a seam is not created between the cutbank and fill in a manner that prevents concentration, containment, or diversion of surface run off. The finished grade must be a free-draining surface. Except for designated locations, all finished grades on Steinacher Road were at 40 percent slope.

Unless otherwise stated in the technical specifications, all areas to be buried with fill are first decompacted to a minimum depth of 80 cm (2 feet) prior to the placement of fill. Technical specifications for Steinacher Road require specific fill compaction density.

Stream crossing excavations (RX). Stream crossing excavations involved the removal and disposal of the road fill and culverts from a stream channel, and shaping the excavation to blend with the surrounding terrain. Salvaged culverts were transported off site to Karuk property for storage and subsequent recycling. The completed excavation mimics the original pre-road construction stream channel and side bank configuration.

The technical specifications for each crossing treatment are described and include information on: total expected excavated volume; channel gradient, length and bottom width; average side bank slope; and maximum depth. The estimated volumes were calculated from defining an upper and lower excavation point in each channel and taking several cross-sections perpendicular to the channel across the road prism at important locations. This data was then entered into Redwood National Park's roads software program (WinRoad). Volume estimate accuracy is subject to site conditions and the number of cross-sections taken. Surveys are benchmarked to allow for important pre- and post-excavation volume calculations and channel adjustment monitoring.

Several stream crossing excavations are double crossings, meaning the crossing was built on the confluence of two streams. In other stream crossings, the channel curves. In both of these situations, volume estimates are less accurate. Experienced site supervision is critical in these situations. Stream crossing treatments occur in perennial and intermittent stream channels and through-fill locations.

Spring Drain (SD). A spring drain treatment is a mini-crossing excavation. The primary purpose of the treatment is to allow for water from springs emerging from the road cutbank or roadway and to follow the natural hillslope fall line. Usually the base-of-cut is the same depth as adjacent treatments, and the top-of-cut is the in-board edge of road. No fill is stored on or above the spring, and the finished channel grade does not exceed 40 percent.

Exported Outslope (EOS). An exported outslope treatment can either remove the entire road prism width or only the outboard portion of the prism. In both cases, some or the entire excavated fill cannot remain local and must be moved some distance to a stable disposal site. The estimated excavation volume exceeds that of the local disposal volume. EOS prescriptions commonly occur in topographic swales or ephemeral streams where the risk of debris landslides is great. Any fill that is placed locally is shaped according to specifications. In the situation of partial excavation, the remaining road bench is a free draining surface, minimally graded to a 5-percent outslope. The average finished EOS grade does not exceed 50 percent slope.

Straight Outslope (OS). An outslope treatment excavates fill material from the outer edge of the road or landing; however, there are no landings on Steinacher Road. The material is placed directly against the adjacent local cutbank and shaped to according to specifications. Commonly, OS prescriptions occur in balanced cut/fill road locations where the fill slope grade exceeds the stable angle of repose of the material, and the risk of failure (causing impacts to waterways) is high. The finished OS grades do not exceed 40 percent, per specification, and excavation volume is defined by surveys. There are few OS treatments on Steinacher Road.

Fill Outslope (FOS.) A fill outslope treatment is prescribed at locations where a side-cast excavation is required and the volume of excavated fill material is less than the volume of maximum local storage. The unstable road edge can be pulled back and there is room for importing and disposing fill from other excavations treatments. A majority of the road bench can be used for disposal storage. The cut and fill area is defined by cross-section surveys. Fill is placed against the cutbank and graded from the fill-to-here mark to the catch-point and excavated from the cut-to-here flag to the top-of-cut mark. The two grades may not be the same.

Disposal Outslope (DOS). A disposal outslope treatment occurs on full bench-cut road segment where in-situ regolith (stable native ground) is present at the out-board edge of road. The road prism is bedrock or native soils, with no side-cast materials. The entire road bench can be used for storage. Fill is placed against the cutbank and graded from the fill-to-here mark on the cutbank to zero at a defined catch-point, commonly the outboard edge of road.

Straight Disposal (DS). Straight disposal treatments occur at through-cut locations or large topographic flats. In through-cut locations, DS treatments are flanked by and blend with disposal outslope (DOS) treatments and/or taper to fill outslope (FOS) treatments. Fill is graded to the top of both cut banks and compacted to specifications. The entire through-cut can be filled with imported material. The finished grade is less than 50 percent slope. Because through-cuts often cut spur ridges, the finished grade averages 20 percent slope, and the 50-percent slope is the transition to other treatments.

Other Road Treatments

There are two other road reach treatment types commonly prescribed to dissipate water flow paths along stable road segments. These prescriptions are designed to decrease hillslope run off and increase water infiltration; they include: rip and pull berm (RPB) and cross road drains (XRD).

Rip and Pull Berm (RPB). A rip and pull berm treatment is the thorough decompaction of a road or landing surface and all berms that concentrate run off removed to re-establish the natural hillslope run off pattern. Any method of decompaction is acceptable, as long as the areas are thoroughly scarified to a depth of 80 cm (2 feet).

Cross-Road Drain (XRD). A cross-road drain is a deeply cut ditch excavated across a road surface that drains the roadbed and inboard ditch to the outboard edge of the road. Cross road drains are more substantial and deeper than conventional waterbars and are steeper and more abrupt than rolling dips described below. Cross-road drains are not a usual restoration treatment, but more typically a winterization treatment to reduce erosion on untreated road segments. Properly constructed XRDs are deep enough to prevent vehicular access.

The depth of the XRD is coincident to the depth of the existing inboard ditch at its inlet and deep enough on the outboard side to be free draining. Each XRD grade is steep enough to prevent sediment from building up in the drain, and steeper than the original road grade. The orientation of the XRD ranges from 60 to 90 degrees perpendicular to the inboard ditch, depending on grade of road as specified in the technical specifications. Fill from XRD construction are placed and smoothed on the downhill side and inboard ditch of the XRD. No spoils are disposed on the road surface uphill of the drain, and the uphill inboard ditch freely drains into the XRD. On level roads, spoils are placed such that the existing inboard ditch remains open so that run off can enter the XRD from either direction.

KARUK TRIBE OF CALIFORNIA

NON - POINT SOURCE

MANAGEMENT PLAN

Table of Contents - Non-Point Source Management Plan

List of Tables *i*

1.0 Introduction 1

2.0 Identification of Best Management Practices 2

3.0 Identification of Needed Implementation Programs 3

4.0 Implementation Milestones 5

5.0 Federal Funding Sources for Non-point Source Pollution 6

6.0 Consistency of Federal Programs with State Non-Point Source Requirements 7

7.0 Public Notice and Opportunity for Public Comment 8

List of Table - Non-point Source Management Plan

Table 1	**Waterbody Prioritization within Karuk Ancestral Territory**	**4**
Table 2	**Implementation Milestones**	**5**

1.0 INTRODUCTION

The Karuk Ancestral Territory is located along the Klamath River in both Humboldt and Siskiyou Counties in northwestern California. It has 1,345 miles of perennial streams, numerous acres of wetlands and riparian areas, and 112 lakes. The Klamath River is the primary water body that exists in the Karuk's Ancestral Territory: The Tribe has identified several primary sources of non-point source impairment to waters within the Ancestral Territory. Major sources of siltation have resulted from road cuts associated with historic and current logging operations, and access roads to residential and back country areas. Toxic metals, residual cyanide, and acidic drainage have resulted from various historic mining operations within the Ancestral Territory.

The Karuk Tribe's Ancestral Territory includes more than 4,000 square miles, most of which is currently under co-management with the US Forest Service and includes three wilderness areas. The Karuk Tribe's governmental authority was established by Federal Recognition in 1979 and by adoption of the Tribe's Constitution on April 6, 1985. The Karuk Tribe has a population of approximately 2,500 members, and has maintained its culture, crafts, and language throughout times of disruption and adverse conditions.

Water quality issues of special concern to the Karuk Tribe are (1) that the streams, lakes, and wetlands benefit the Karuk people through employment, services, and preservation of traditional ways and lifestyles; (2) that wetland resources support a viable subsistence fishery and provide recreational opportunities (e.g., swimming, boating, and sport fishing); (3) the protection of public health and the environment through programs designed to ensure that drinking water is potable.

2.0 IDENTIFICATION OF BEST MANAGEMENT PRACTICES

Best Management Practices (BMPs) are defined as methods, measures, or practices used to prevent or reduce discharges and pollutant loading. They should be cost effective, practical, and acceptable to the public in preventing or reducing the amount of water pollution generated by non-point sources. BMPs include information and educational programs, technical and financial assistance, technology transfer, demonstration projects, monitoring/evaluation systems, and regulation and enforcement. The Karuk Tribal Department of Natural Resources will develop and present BMPs for projects on Tribal lands to the Tribal Council for approval in accordance to the Karuk Tribe's Constitution.

A requirement of Section 319 of the Clean Water Act is the identification of methods used to select the BMPs identified for each type of non-point source pollution problem. This selection process will include the participation of Tribal and non-Tribal input to define the most appropriate measures to be taken to minimize impact from each of the various non-point source types. The Karuk Tribe will formally adopt BMPs under the authority of the governing body, the Karuk Tribal Council. Areas to be addressed include non-point source pollution from silviculture, land disposal, hydrologic modification, resource exploration/ extraction, and agriculture.

3.0 IDENTIFICATION OF NEEDED IMPLEMENTATION PROGRAMS

The following Tribal Ordinances, plans and regulations should be drafted and presented to the Tribal Council for adoption to establish Best Management Practices, and to impose liability for monitoring, investigation, cleanup, and enforcement costs, together with damages for all resulting injuries to Tribal natural resources:

- Water Quality Control Plan
- Wellhead Protection Plan
- Pesticide Control Ordinance
- Solid Waste Ordinance
- Solid Waste Management Plan
- Hazardous Waste Management Plan
- Emergency Preparedness Plan
- Underground Storage Tank Regulations

The prioritization of the Karuk Tribe's Non-point Source Management Program is as follows:

- Implement safeguards for habitat of anadromous fisheries runs endemic to Karuk waters from non-point sources of pollution.

- Implement *Best Management Practices* for construction, mining, silviculture, grazing, agriculture, and other potential non-point source pollution areas.

- Implement a management plan to safeguard watersheds supplying drinking water.

- Locate and characterize septic tanks and leachfields throughout the Ancestral Territory.

- Update the *Karuk Tribe of California Non-Point Source Assessment and Non-Point Source Management Plan*

Primarily, watersheds were ranked according to habitat condition requirements for salmonid fisheries. Watersheds with the most serious impacts, or potential impacts to salmonid spawning habitat were ranked higher, supported by Forest Service prioritization of Watersheds for Restoration (see Appendix C of Assessment, note: Karuk Ancestral Territory closely coincides with the orange and yellow areas between Happy Camp and Orleans). Socioeconomic factors are also addressed by this prioritization given that much of Karuk society gains its social, cultural, and economic support from the fishery resources, and habitat associated with healthy fisheries (i.e. special forest products). Specific prioritization of impaired watersheds, by rank, are illustrated in **Table 1**.

Table 1
Waterbody Prioritization within Karuk Ancestral Territory

Name of Waterbody	Cause(s) of Concern/ Water Quality Issues	Priority Ranking
Wooley Creek	turbidity/sedimentation of sensitive salmonid spawning habitat	1
Indian Creek	residual cyanide, toxic metals, acidic drainage (mines)	2
Elk Creek	domestic water supply, sedimentation	3
Camp Creek	turbidity/sedimentation	3
Salmon R. (N. Fork)	water temperature, mines	4
Salmon R. (S. Fork)	mines, turbidity	4
Bosie Creek	Cumulative Impacts	5
Bluff Creek	Cumulative Impacts	5
Dillon Creek	(-)	6
Clear Creek	(-)	6
Ukonom Creek	(-)	6
Redcap Creek	(-)	6
Somes Creek	(-)	6
Knownothing Creek	(-)	6
Independence Creek	(-)	6
Negro Creek	(-)	6
Slate Creek	(-)	6

4.0 IMPLEMENTATION MILESTONES

The following schedule should provide milestones for achieving implementation of the Non-Point Source Management Plan.

Table 2 - Implementation Milestone	Anticipated Completion Date
. Review currently approved Tribal and USFS BMPs.	May 1997
. Review upcoming and current forest management, road building, and water diversion projects for possible non-point source pollution .	June 1997
. Identify non-point source restoration projects.	Sept 1997
. Implement *Best Management Practices for* potential non-point source pollution areas.	April 1998
. Implement non-point source restoration projects.	June 1998
. Monitor projects which may create non-point source pollution problems *for* compliance	June 1998
. Update Karuk Tribe's Non-Point Source Assessment.	Dec 1998
. Implement non-point source restoration projects.	June 1999
. Update Karuk Tribe's Non-Point Source Management Plan.	Dec 1999

Beginning in FY 98, the Karuk Tribe will begin to implement projects to reduce non-point source pollution to waters in the Ancestral Territory. Wooley Creek, in the Salmon River watershed, has been prioritized by the Karuk Tribe because of impacts to salmonid habitat, and the President's Forest Plan via designation of both the Salmon River and Wooley Creek as "Key Watersheds". Other projects are being developed between the Karuk Tribe and the US Forest Service on an ongoing basis.

5.0 FEDERAL FUNDING SOURCES FOR NON-POINT SOURCE POLLUTION

A number of funding opportunities exist for the development of programs to monitor, control, and remediate surface and ground water non-point source pollution in the Karuk Ancestral Territory. These include, but are not limited to:

US EPA	CWA Section 319	Non-Point Source Pollution Control Program
US EPA	CWA Section 106	Water Pollution Control Program
US EPA	CWA Section 104	State Wetlands Protection Program

Additional funding may be accessed through:

US Department of Agriculture
US Department of the Interior
US Department of Energy
Bureau of Indian Affairs
President's Forest Plan (Option IX)
Indian Health Services

6.0 CONSISTENCY OF FEDERAL PROGRAMS WITH STATE NON-POINT SOURCE REQUIREMENTS

The Karuk Tribal Department of Natural Resources will be responsible for the review of activities and programs conducted by all federal agencies on Tribal land to ensure compliance with the Tribal NPS Program. The following list includes federal agencies which would fall within the guidelines of the Tribal NPS Program:

US Department of Agriculture - Forest Service, Soil Conservation Service

US Department of the Interior - Bureau of Indian Affairs

US Department of Reclamation

US Fish and Wildlife Service
HUD
Indian Health Services

The Tribe's Non-Point Source Management Plan is consistent with the Tribe's goals and objectives, as articulated and ratified by the following:

(1) Article five of the Karuk Constitution allows the Tribal Council to establish, amend, or modify policies, ordinances, and acts, or to take other major governmental actions on behalf of the Tribe.

(2) Anti-Pollution Ordinance of April 25, 1996 (Resolution 96-R-24, Appendix D of Assessment) which states the Tribe's wish to "eliminate all discharges of pollutants into the waters of the Karuk Ancestral Territory [and that] elimination of all discharges of pollutants into the waters of the Karuk Ancestral Territory is necessary at this time in order to maintain protection of public health and the environment."

7.0 PUBLIC NOTICE AND OPPORTUNITY FOR PUBLIC COMMENT

Section 319 of the Clean Water Act requires that the applicant identify the process by which public comment will be incorporated into the Tribe's planning process. In addition, public support for the Karuk Tribe's efforts to control non-point source pollution is critical. Public notification will be conducted in compliance with 40 CFR Part 25. As the Program develops, additional mechanisms for public involvement will be provided.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Arcata Fish and Wildlife Office
1655 Heindon Road
Arcata, California, 95521
Phone: (707) 822-7201 FAX: (707) 822-8411

RECEIVED 2-22
2007

In Reply Refer To:
8-14-2007-3069

FEB 2 0 2007

Mr. Tyrone Kelley
Forest Supervisor
Six Rivers National Forest
1330 Bayshore Way
Eureka, California 95501

Dear Mr. Kelley:

Subject: Formal Consultation on the Smith River National Recreation Area Road Management and Route Designation Project and the Orleans Transportation and Road Restoration Project

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion based on our review of the proposed Smith River National Recreation Area Road Management and Route Designation Project (SRRMRD), located in Del Norte County, and the proposed Orleans Transportation and Road Restoration Project (OTRR), located in Humboldt, Del Norte, and Siskiyou Counties, California and their effects on the federally threatened marbled murrelet (*Brachyramphus marmoratus*), northern spotted owl (*Strix occidentalis caurina*), bald eagle (*Haliaeetus leucocephalus*), marbled murrelet critical habitat, and northern spotted owl critical habitat. This document was prepared in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.). Your requests for formal consultation were received on November 21, 2006, and January 11, 2007, respectively. Due to the similar nature of the proposed projects, we have consulted on both projects in this document.

This biological opinion is based on information provided in the November 16 and December 19, 2006 biological assessments and other sources of information. A complete administrative record of this consultation is on file in this office.

Consultation History

Streamlined Consultation Process

The proposed projects were discussed during an Interagency Consultation Level 1 Team meeting on May 23, 2006. The OTRR project was discussed again on August 25, 2006, and November 30, 2006. The SRRMRD project draft biological assessment was submitted to the Service on November 8, 2006, and the OTRR project draft biological assessment was submitted to the Service on November 28, 2006. The Service provided comments on the SRRMRD project draft biological assessment on November 13, 2006, and on the OTRR project draft biological assessment on October 23 and November 7, 2006. We received the final SRRMRD and OTRR project biological assessments with the requests for consultation from the Six Rivers National Forest (Forest) on November 21, 2006, and January 11, 2007, respectively.

Other Services' Conclusions

The Forest determined that the proposed SRRMRD project may affect, but is not likely to adversely affect northern spotted owl and marbled murrelet critical habitats. The Forest determined that the proposed OTRR project may affect, but is not likely to adversely affect the bald eagle. For complete project descriptions refer to the biological assessments and the descriptions of the proposed actions in the following biological opinion.

The proposed SRRMRD project will remove 27 culverts within marbled murrelet critical habitat and 35 culverts within northern spotted owl critical habitat. The project may degrade up to 2.7 acres of marbled murrelet critical habitat and 3.5 acres of northern spotted owl critical habitat as a result of the potential removal of trees up to 11 inch diameter-at-breast height (dbh) located at the culvert removal sites.

The Service concurs with your determination that the proposed SRRMRD project may affect but is not likely to adversely affect northern spotted owl and marbled murrelet critical habitats, based on the following factors:

1. The proposed project will not change the function of nesting habitat for marbled murrelets or nesting, roosting, foraging habitat for northern spotted owls.

2. The acreage of suitable habitat that could be potentially degraded is minimal in size.

3. No trees greater than 11 inches dbh will be removed.

4. The proposed project will result in short-term habitat degradation; however, it will also provide long-term benefits by allowing the re-growth of forest on restored roadbeds.

The Service concurs with your determination that the proposed OTRR project may affect but is not likely to adversely affect the bald eagle, based on the following factors:

1. The proposed project will not remove suitable habitat.

2. Road work along the 10N13 road system will not occur from January 1 through August 1 unless surveys during the season of implementation determine that nesting is not occurring or that young have fledged in the Waakar bald eagle territory.

3. The decommissioning of roads 10N13.1 and 10N13.3 will result in a permanent decrease in disturbance from vehicular traffic within the Waakar bald eagle nest protection zone.

Northern spotted owl and marbled murrelet critical habitats, and bald eagles will not be addressed further in this biological opinion, and, unless new information reveals effects of the proposed actions that may affect northern spotted owl and marbled murrelet critical habitats or the bald eagle in a manner or to an extent not considered, no further action pursuant to the Act is necessary relative to northern spotted owl and marbled murrelet critical habitats and bald eagles. The following biological opinion will deal only with impacts to the northern spotted owl and marbled murrelet.

BIOLOGICAL OPINION

Description of the Proposed Actions

Project Description

SRRMRD Project Elements

The proposed project encompasses the entire Smith River National Recreation Area (Smith River NRA) and the Gasquet District which are managed under the Northwest Forest Plan (NWFP). The goal of the proposed project is to implement results of a recently completed Smith River National Recreation Area Roads Analysis and Off-Highway Vehicle Strategy. The goal of the strategy is to design a road system that is economically and ecologically sustainable by reducing maintenance costs and risk to sensitive species, and that meets the access needs of the Forest and the public.

Approximately 638 miles of National Forest Service system and non-system roads, and 201 miles of County and State roads were assessed. System roads are constructed or maintained to specific Forest Service standards. Non-system roads are not maintained by the Forest Service and are not on the Forest Road Inventory. Main access roads and roads that were already assessed under previous decisions or are not currently drivable are not part of the proposed action. Management options were defined for the assessed roads and included the options to keep and maintain, upgrade or downgrade, add to the National Forest System transportation network, designate as a motorized trail, decommission or make a non-motorized trail, or impose seasonal use periods.

The Gasquet District identified 52 roads that have high risk to aquatic resources and that require either decommissioning and/or culvert removal. Work on these high priority roads will occur during the breeding season of northern spotted owls and marbled murrelets.

The Gasquet District states that the proposed project will contribute to the desired future condition of habitat for threatened, endangered and sensitive species by reducing road density across the action area which will in turn reduce fragmentation of habitat, increase patch size, reduce sedimentation in steam channels, and reduce disturbance and direct mortality. In the long-term, the proposed project will benefit threatened, endangered and sensitive species.

Implementation of the proposed project would begin in 2007 and would be completed by the end of 2021 depending upon available funding and workforce.

Conservation Measures
When used in the context of the Act, "conservation measures" represent actions proposed by the Federal agency that are intended to further the recovery of and/or to minimize or compensate for project effects on the species under review. Because conservation measures are pledged in the project description by the action agency, their implementation is required under the terms of the consultation (USDI Fish and Wildlife Service and USDC National Marine Fisheries Service 1998).

Recovery Measures
No recovery measures are proposed.

Minimization Measures
The Gasquet District is proposing the following project design features that will minimize impacts to the northern spotted owl.

1. On all roads except for high priority roads scheduled for upgrades or decommissioning, noise generating activities within 500 feet of unsurveyed or occupied suitable northern spotted owl nesting habitat will not occur from February 1 through July 9 unless surveys determine the area is unoccupied.

2. On high priority roads scheduled for upgrades or decommissioning, noise generating activities within 500 feet of occupied suitable northern spotted owl nesting habitat will not occur from February 1 through July 9 unless surveys determine the area is unoccupied

The Gasquet District is proposing the following project design features that will minimize impacts to the marbled murrelet:

1. On all roads except for high priority roads scheduled for upgrades or decommissioning, noise generating activities within 500 feet of unsurveyed *low-quality* suitable marbled murrelet nesting habitat will not occur from March 24 through August 5. In addition, work from August 6 through September 15 will not begin until 2 hours after sunrise and stop 2 hours before sunset unless surveys determine the area is unoccupied.

2. On all roads except for activities on high priority roads, noise generating activities within 500 feet of unsurveyed *high-quality* suitable marbled murrelet nesting habitat will not

occur from March 24 through September 15 unless surveys determine the area is unoccupied.

3. If new occupied sites are discovered, no noise generating activities will occur within 500 feet of the site from March 24 through September 15.

OTRR Project Elements

The proposed project encompasses the entire Orleans District which is managed under the NWFP. The goal of the proposed project is to implement results of a recently completed Orleans Roads Analysis Process. Each road within the Orleans District was evaluated with respect to its need for landowner access, public access, wildfire and fuels management, vegetation management, environmental risk and cultural uses.

Approximately 685 miles of National Forest Service system and non-system roads were assessed. Management options were defined for the assessed roads and included the options to keep and maintain, upgrade or downgrade, designate as a motorized trail or restrict motorized vehicle use, decommission or make a non-motorized trail, add to the National Forest System transportation network, or impose seasonal use periods.

The Orleans District identified 58 high-priority and 49 moderate priority roads that have hydrologic concerns and that require either decommissioning and/or culvert removal. Work on these high and moderate priority roads will occur during the breeding season of northern spotted owls and marbled murrelets. The Orleans District may apply any unused northern spotted owl incidental take authorized in this opinion from high or moderate priority road work to cover low priority road work as long as the total amount of incidental take is not exceeded.

Implementation of the proposed project would begin in 2007 and would be completed by the end of 2021 depending upon available funding and workforce.

Conservation Measures

When used in the context of the Act, "conservation measures" represent actions proposed by the Federal agency that are intended to further the recovery of and/or to minimize or compensate for project effects on the species under review. Because conservation measures are pledged in the project description by the action agency, their implementation is required under the terms of the consultation (USDI Fish and Wildlife Service and USDC National Marine Fisheries Service 1998).

Recovery Measures

No recovery measures are proposed.

Minimization Measures

The Orleans District is proposing the following project design features that will minimize impacts to the northern spotted owl.

1. Noise generating activities within 500 feet of unsurveyed or occupied suitable northern spotted owl nesting habitat on all low priority roads scheduled for decommissioning and

water quality improvements will not occur from February 1 through July 9 unless surveys determine the area is unoccupied.

The Orleans District is proposing the following project design features that will minimize impacts to the marbled murrelet:

1. Noise generating activities associated with water quality improvement projects within 500 feet of unsurveyed *low quality* suitable marbled murrelet nesting habitat will not occur from March 24 through August 5. In addition, work from August 6 through September 15 will not begin until 2 hours after sunrise and stop 2 hours before sunset unless surveys determine the area is unoccupied.

2. Noise generating activities associated with water quality improvement projects within 500 feet of unsurveyed *high quality* suitable marbled murrelet nesting habitat will not occur from March 24 through September 15.

3. Noise generating activities associated with decommissioning Road 11N28 within 500 feet of known occupied marbled murrelet habitat will not occur from March 24 through September 15.

4. All road decommissioning work (except as noted in 3 above) within 500 feet of suitable habitat will not begin until 2 hours after sunrise and stop 2 hours before sunset from March 24 through September 15 unless surveys determine the area is unoccupied.

Action Area

For purposes of this biological opinion, the action area includes the Smith River NRA, and the Gasquet and Orleans Districts, Six Rivers National Forest.

Time-frame of Biological Opinion

This biological opinion is valid for a period of 15 years from the date of issuance.

Status of the Species: Northern Spotted Owl

Legal Status

The northern spotted owl was listed as threatened under the Act on June 26, 1990, due to widespread habitat loss and the inadequacy of existing regulatory mechanisms to provide for its conservation (USDI Fish and Wildlife Service 1990a).

Species Description and Range

The northern spotted owl is one of three spotted owl subspecies (American Ornithologists Union 1957). The distribution of this subspecies includes southwestern British Columbia, Washington and Oregon, and northwestern California south to Marin County (Gutiérrez et al. 1995).

Life History

Habitat Use

Northern spotted owls generally inhabit older forested habitats because they contain the structures and characteristics required for nesting, roosting, foraging, and dispersal (Forsman et al. 1984; Gutiérrez 1996; LaHaye and Gutiérrez 1999). Specifically, northern spotted owls require a multi-layered, multi-species canopy dominated by large overstory trees; moderate to high canopy closure; a high incidence of trees with large cavities or other types of deformities; numerous large snags; an abundance of large, dead wood on the ground; and open space within and below the upper canopy for northern spotted owls to fly within (Thomas et al. 1990). Forested stands with high canopy closure also provide thermal cover (Weathers et al. 2001), and protection from avian predators. Recent landscape-level analyses suggest that in parts of the subspecies' range a mosaic of late-successional habitat interspersed with other vegetation types may benefit northern spotted owls more than large, homogeneous expanses of older forests (Franklin et al. 2000; Zabel et al. 2003; Olson et al. 2004).

Prey

Northern spotted owls are mostly nocturnal (Forsman et al. 1984), but they may forage opportunistically during the day (Sovern et al. 1994). Composition of prey in northern spotted owl diet varies regionally, seasonally, annually, and locally, likely in response to prey availability (Carey 1993; Forsman et al. 2001). Northern flying squirrels (*Glaucomys sabrinus*) and woodrats (*Neotoma* spp.) are usually the predominant prey both in biomass and frequency (Forsman et al. 1984; Ward et al. 1998; Forsman et al. 2001, 2004) with a clear geographic pattern of diet paralleling differences in habitat (Thomas et al. 1990). Northern flying squirrels are generally the dominant prey item in the more mesic Douglas-fir (*Pseudotsuga menziesii*)/western hemlock (*Tsuga heterophylla*) forests characteristic of the northern portion of the range, whereas woodrats are generally the dominant prey item in the drier mixed conifer/mixed evergreen forests typically found in the southern portion of the range (Forsman et al. 1984; Thomas et al. 1990; Sztukowski and Courtney 2004). These two prey items were found to be co-dominant in the southwest interior of Oregon (Forsman et al. 2001, 2004). Other prey species (e.g., red tree vole [*Arborimus longicaudus*], red backed voles [*Clethrionomys gapperi*], mice, rabbits and hares, birds, and insects) may be seasonally or locally important (Rosenberg et al. 2003; Forsman et al. 2004).

Home Range Size

Home range size varies geographically, increasing from south to north, which is likely in response to differences in habitat quality (USDI Fish and Wildlife Service 1990b). Home ranges are larger where northern flying squirrels are the predominant prey and are smaller where woodrats are the predominant prey (Zabel et al. 1995). When available prey density is low or there is an increased reliance on a single large prey species (e.g., northern flying squirrels), owls respond by increasing home range size (Carey et al. 1992; Zabel et al. 1995). Estimates of home range size vary from 1,166 acres in southern Oregon (Carey et al. 1992) to 9,066 acres in Washington (King et al. 1993). Home ranges are smaller during the breeding season and often increase dramatically in size during fall and winter (Forsman et al. 1984; Glenn et al. 2004).

Reproduction
In relative terms, the northern spotted owl is long-lived, has a long reproductive life-span, produces fewer and larger young, invests significantly in parental care, exhibits later or delayed maturity and has high adult survivorship (Gutiérrez et al. 1995). Reproduction can vary greatly among years, with most pairs breeding in good years, and few pairs breeding in poor years (Forsman et al. 1984; Franklin et al. 1999; Anthony et al. 2004). Delayed maturation, small clutch size, and temporal variability in nesting success all contribute to the relatively low fecundity (number of female offspring produced per territorial female) of this species (Gutiérrez 1996).

Northern spotted owls are highly territorial (Forsman et al. 1984; Gutiérrez et al. 1995; Franklin et al. 1996) and usually monogamous. Courtship begins in late February to early March and nesting occurs from March to June. Timing of nesting and fledging varies with latitude and elevation (Forsman et al. 1984). At about 35 days old, the young leave the nest but are incapable of flight (Forsman 1976). By September, parents feed their young irregularly and some juveniles begin to disperse (Gutiérrez et al. 1985; Forsman et al. 2002).

Dispersal
Most young disperse by early November (Gutiérrez et al. 1985; Forsman et al. 2002). Dispersal by juveniles (natal dispersal) occurs in stages, with juveniles settling in temporary home ranges between bouts of dispersal (Forsman et al. 2002). Median natal dispersal distances are approximately 10.5 miles for males and 14 miles for females (range = 0.4 to 69 miles) (Forsman et al. 2002). Miller (1989) reported relatively high first year mortality rates for juvenile northern spotted owls (77 percent), an indication that juvenile owls are vulnerable during their first year. Leading causes of mortality are starvation, predation, and accidents (Miller 1989; USDI Fish and Wildlife Service 1990a; Forsman et al. 2002). Parasitic infection may contribute to these causes of mortality (Forsman et al. 2002). In addition to dispersing as juveniles, a small percentage of non-juvenile northern spotted owls (6 percent in Forsman et al. 2002) disperse in search of new mates and/or new territories (breeding dispersal).

Dispersing owls typically traversed a wide range of forest conditions and levels of habitat fragmentation (Forsman et al. 2002). Large non-forested valleys (e.g., the Willamette Valley) are apparent barriers to dispersing juvenile and adult northern spotted owls (Forsman et al. 2002). Analysis of genetic structure of northern spotted owl populations suggests that relatively high rates of gene flow occur between the Olympic Mountains and Washington Cascades (across the Puget Trough) and between the Olympic Mountains and the Coast Range of Oregon (across the Columbia River) (Haig et al. 2001), indicating that these areas may not be substantial barriers to movement.

Reasons for Listing
The northern spotted owl was listed as threatened throughout its range "due to loss and adverse modification of suitable habitat as a result of timber harvesting and exacerbated by catastrophic events such as fire, volcanic eruption, and wind storms" (USDI Fish and Wildlife Service 1990b). At the time of listing, significant threats to the northern spotted owl included low populations; declining populations; limited habitat; declining habitat; distribution of habitat or

populations; isolation of provinces; predation and competition; lack of coordinated conservation measures; and vulnerability to natural disturbance (USDI Fish and Wildlife Service 1992a).

Threats

Habitat Trends

The amount of northern spotted owl habitat continues to decline on a range-wide basis across all ownerships, although at a rate that is less than in the years prior to the listing of the owl, particularly on Federal lands within the NWFP boundary (Bigley and Franklin 2004). Approximately 7.4 million acres of suitable habitat were estimated to exist on Federal lands in 1994 (Table 1). As of January 22, 2007, action agencies have consulted with the Service on the removal or downgrading of 198,803 acres of suitable habitat on Federal lands managed under the NWFP. (Acres of consulted-on effects reported above are from a January 22, 2007, query of the NWFP and section 7 Consultation Effects Tracker database [northern spotted owl database]). (Removal refers to habitat that no longer provides nesting, roosting, or foraging function after the effect, and downgrading refers to reduction in the function of the habitat [i.e., a change from nesting/roosting habitat to foraging habitat]). Because not all consulted-on effects have been realized, the northern spotted owl database is also updated to reflect action agency projects or portions of projects that were not implemented. Thus, acres displayed in the northern spotted owl database represent the best approximation of consulted-on effects that have and are expected to occur. As of January 22, 2007, range-wide consulted-on effects were consistent with NWFP timber harvest rate assumptions as expressed in the ROD (USDA Forest Service and USDI Bureau of Land Management 1994b).

Although most provinces have experienced some degree of habitat loss since 1994, total effects have been disproportionately distributed across the range of the northern spotted owl (Table 1). Most management-related, consulted-on habitat loss has been concentrated in Oregon. Reported habitat loss (i.e., expected and realized loss through consulted-on federal actions and reported loss through natural disturbance) in the Oregon Klamath Mountains Province and the two Oregon Cascades provinces make up approximately 85 percent of the reported habitat loss on Federal lands range-wide since 1994. Reasons for the comparatively greater rates of loss in these provinces include a higher percentage of acres outside of reserves than in other provinces, a shift to density-management harvest (which can impact up to three times as many acres as a regeneration harvest for an equal amount of timber volume removed) and habitat loss due to fires and subsequent salvage.

From 1994 through 2005, habitat removed or downgraded due to natural events is estimated to be approximately 224,000 acres range-wide (Table 1) (Acres of habitat removed or downgraded from natural events are from Courtney et al. 2004). A large portion of this loss can be attributed to the Biscuit Fire that burned over 500,000 acres in southwest Oregon and northern California in 2002. This fire resulted in the loss of approximately 66,000 acres of suitable northern spotted owl habitat, including habitat within five LSRs and five critical habitat units.

There is little information available regarding trends in northern spotted owl habitat on non-Federal lands. Federal and/or state databases that track changes to habitat on non-federal lands are currently not in place. Internal Service consultations conducted since 1992 have authorized the removal or downgrading of 407,849 acres of habitat on non-Federal lands. Most of these losses have yet to be realized because they are part of large-scale, long-term Habitat Conservation Plans (HCPs). Since 1999, the Service has issued technical assistance for Timber Harvest Plans that have removed or downgraded an unknown but possibly substantial amount of northern spotted owl habitat.

Wildfire

At the time of listing there was recognition that catastrophic wildfire posed a threat to the northern spotted owl (USDI Fish and Wildlife Service 1990a). The amount of habitat lost to wildfire in the relatively dry East Cascades and Klamath Provinces suggests that fire may be more of a threat than was previously thought. However, the risk to northern spotted owls associated with large scale wildfire may be mitigated by the NWFP reserve design (Lint et al. 2005).

Barred Owls

Since 1990, the barred owl (*Strix varia*) has expanded its range south into Marin County, California and the central Sierra Nevada Mountains, such that it is now roughly coincident with the range of the northern spotted owl (Gutiérrez et al. 2004). Barred owl populations appear to be increasing throughout the Pacific Northwest, particularly in Washington and Oregon (Zabel et al. 1996; Dark et al. 1998; Wiedemeier and Horton 2000; Kelly et al. 2003; Pearson and Livezey 2003; Anthony et al. 2004). Based on current density estimates and apparent distribution, barred owl populations also appear to be self-sustaining (Gutiérrez et al. 2004).

New information suggests that competition with the barred owl is a greater threat to northern spotted owls than previously anticipated (Gutiérrez et al. 2004), whereas hybridization is less of a threat (Kelly and Forsman 2004). Barred owls apparently compete with northern spotted owls through a variety of mechanisms: prey overlap (Hamer et al. 2001); habitat overlap (Hamer et al. 1989; Dunbar et al. 1991; Herter and Hicks 2000; Pearson and Livezey 2003); and agonistic encounters (Leskiw and Gutiérrez 1998; Pearson and Livezey 2003). The only study comparing food habits of northern spotted owls and barred owls in the Pacific Northwest indicated that barred owl diets overlapped strongly (>75 percent) with northern spotted owl diets (Hamer et al. 2001). However, barred owl diets were also more diverse than northern spotted owl diets, including species associated with riparian and other moist habitats, as well as more terrestrial and diurnal species. Recent studies indicate that barred owls are capable of utilizing a broader range of habitat types than northern spotted owls (Hamer 1988; Kelly et al. 2003). Anecdotal reports also indicate that barred owls react more aggressively towards northern spotted owls during encounters than the reverse (Gutiérrez et al. 2004).

Recent research and observations also indicate that barred owls may displace northern spotted owls. Kelly et al. (2003) reported northern spotted owl occupancy was significantly lower where barred owls were detected within 0.5 mile of the northern spotted owl territory center than in territories where no barred owls were detected. In Southern Oregon, 46 percent of northern spotted owls moved more than 0.4 mile, and 39 percent of northern spotted owls were not relocated again in at least 2 years after barred owls were detected within 0.5 mile of their territory centers (Kelly 2001). Using new methods to model the effect of barred owls on northern spotted owl site occupancy in Western Oregon, Olsen et al. (2005) found that barred owl presence led to increases in local extinction probabilities on 2 study areas and a decline in colonization probabilities on another. Similar findings regarding displacement of northern spotted owls by barred owls have been reported for the Olympic National Park (Gremel 2000) and the Gifford Pinchot National Forest (Pearson and Livezey 2003).

Anthony et al. (2004) reported that barred owls had a negative effect on northern spotted owl survival in three demographic study areas in Washington (Anthony et al. 2004). Olson et al. (2005) found a significant (but weak) negative effect of barred owl presence on northern spotted owl reproductive output but not on survival in Southern Oregon. At two study areas in Washington, investigators found relatively high numbers of territories previously occupied by northern spotted owls that are now apparently not occupied by either spotted or barred owls (e.g., 49 of 107 territories in the Cascades [Herter and Hicks 2000]; 23 of 33 territories in the Olympic Experimental State Forest [Wiedemeier and Horton 2000]). Given that habitat was still present in these vacant territories, some factor(s) may be reducing habitat suitability or local abundance of both species. This suggests that factors other than barred owls alone are contributing to declines in northern spotted owl abundance and territorial occupancy (Gutiérrez et al. 2004).

Despite these uncertainties, the preponderance of the evidence gathered thus far is consistent with the hypothesis that barred owls are playing some role in the decline of some northern spotted owl populations, particularly in Washington and portions of Oregon and the northern coast of California (Gutiérrez et al. 2004).

Although the barred owl currently constitutes a significantly greater threat to the northern spotted owl than originally thought at the time of listing, it is unclear whether forest management has an effect on the outcome of interactions between barred owls and northern spotted owl (Gutiérrez et al. 2004).

Potential Threats

West Nile Virus and Sudden Oak Death

Health officials expect that West Nile Virus (WNV) will eventually spread throughout the range of the northern spotted owl (Blakesley et al. 2004), but it is unknown how WNV will ultimately affect owl populations. Sudden Oak Death poses a threat of uncertain proportions because of its potential impact on forest dynamics and alteration of key habitat components (i.e., hardwoods); especially in the southern portion of the northern spotted owl's range. Because the magnitude of these threats is unknown at this time, they do not represent relevant information pertinent to analyses conducted for this biological opinion.

Inbreeding Depression, Genetic Isolation, and Reduced Genetic Diversity

Inbreeding and other genetic problems due to small population sizes were not considered an imminent threat to the northern spotted owl at the time of listing. Recent studies show no indication of reduced genetic variation in Washington, Oregon, or California (Barrowclough et al. 1999; Haig et al. 2004; Henke et al. unpublished).

Population Size and Trends

There are no estimates of the historical population size and distribution of the northern spotted owl. The species is believed to have inhabited most old growth forests throughout the Pacific Northwest prior to modern settlement (mid-1800s). According to the final rule listing the owl as threatened (USDI Fish and Wildlife Service 1990a), approximately 90 percent of the roughly

2,000 known northern spotted owl breeding pairs were located on federally managed lands, 1.4 percent on State lands, and 6.2 percent on private lands; the percent of northern spotted owls on private lands in northern California was slightly higher.

Gutiérrez (1994), using data from 1986-1992, tallied 3,753 known pairs and 980 singles throughout the range of the northern spotted owl. At the time the NWFP was initiated (July 1, 1994), there were 5,431 known locations of northern spotted owl pairs or resident singles: 851 sites (16 percent) in Washington, 2,893 (53 percent) in Oregon, and 1,687 (31 percent) in California (USDI Fish and Wildlife Service 1995). The actual population of owls across the range was undoubtedly larger than either of these counts because some areas were not surveyed (USDI Fish and Wildlife Service 1992a; Thomas et al. 1993).

Because existing survey coverage and effort are insufficient to produce reliable population estimates, researchers use other indices, such as demographic data, to evaluate trends in NSO populations. Analysis of demographic data can provide an estimate of the rate and direction of population growth [i.e., lambda (λ)]. A λ of 1.0 indicates a stationary population (i.e., neither increasing nor decreasing), a λ less than 1.0 indicates a declining population, and a λ greater than 1.0 indicates a growing population.

At the January 2004 northern spotted owl demographic meta-analysis workshop, two meta-analyses were conducted to estimate the rate of owl population change. Data were analyzed separately for 13 individual study areas, and simultaneously across study areas (true meta-analysis). (See Figure 1 for locations of demographic study areas by state and physiographic province). Estimates of λ ranged from 0.896-1.005 for the 13 areas, and all but one of the estimates were <1.0, suggesting population declines for most areas (Anthony et al. 2004). The weighted mean λ for all of the study areas was 0.963 (SE = 0.009, 95% CI = 0.945-0.981), suggesting that populations over all of the areas were declining by about 3.7 percent per year from 1985-2003. The mean λ for the eight monitoring areas on Federal lands was 0.976 (SE = 0.007, 95% CI = 0.962-0.990) and 0.942 (SE = 0.016, 95% CI = 0.910-0.974) for non-Federal lands, an average 2.4 versus 5.8 percent decline per year. This suggests that northern spotted owl populations on Federal lands had better demographic rates than elsewhere, but interspersion of land ownership on the study areas confounds this analysis.

The number of populations that have declined and the rate at which they have declined are noteworthy, particularly the precipitous declines on the four Washington study areas and the Warm Springs Reservation in Oregon (Anthony et al. 2004). Declines in adult survival rates may be an important factor contributing to declining population trends. Survival rates declined over time on all four study areas in Washington. In Oregon, there were no time trends in apparent survival for four of six study areas, and remaining areas had weak non-linear trends. In California, two study areas showed no trend, one showed a slight decline, and one showed a significant linear decline (Anthony et al. 2004). Like the trends in annual rate of population change, trends in adult survival rate showed clear declines in some areas, but not in others.

Conservation Needs

Based on the above assessment of threats, the northern spotted owl has habitat-specific and habitat-independent conservation (i.e., survival and recovery) needs. Habitat-specific needs include: (1) large blocks of suitable habitat maintained to support clusters or local population centers of northern spotted owls (e.g., 15 to 20 breeding pairs) throughout the owl's range; (2) suitable habitat conditions and spacing maintained between local northern spotted owl populations throughout its range to facilitate survival and movement; (3) suitable habitat managed across a variety of ecological conditions within the northern spotted owl's range to reduce risk of local or widespread extirpation; (4) a coordinated, adaptive management effort to reduce the loss of habitat due to catastrophic wildfire throughout the northern spotted owl's range; (5) a research program to clarify whether these risk reduction methods are effective and how owls use habitat treated to reduce fuels; and, (6) in areas of significant population decline, owl habitat managed to sustain the full range of survival and recovery options for this species in light of significant uncertainty. Habitat- independent needs include: (1) a coordinated research and adaptive management effort to better understand and manage competitive interactions between spotted and barred owls; (2) research to better understand the risk that WNV poses to northern spotted owls and, if significant, additional research into methods that may reduce the likelihood or severity of outbreaks; and (3) research to better understand the impacts that Sudden Oak Death impart on northern spotted owl habitat.

Ongoing Conservation Efforts

The NWFP is the current conservation strategy for the northern spotted owl on Federal lands. It includes a system of repetitive reserves, designed to protect large blocks of habitat for population clusters that provides the variety of ecological conditions that support owls. Reserves are distributed to maintain connectivity between these clusters and to reduce the likelihood of catastrophic events impacting connectivity and population dynamics within and between provinces. Several land-use allocations are intended to contribute primarily to supporting population clusters: LSRs, Managed Late Successional Areas (MLSAs), Congressionally Reserved Areas (CRAs), and Managed Pair and Reserve Pair Areas. The remaining land-use allocations—Matrix, Adaptive Management Areas (AMAs), RRs, Connectivity Blocks, and Administratively Withdrawn Areas (AWAs)—are designed to provide connectivity between habitat blocks intended for population clusters. Although the NWFP anticipated that northern spotted owl populations would decline in areas outside of reserves populations were expected to stabilize and eventually increase within reserves, as habitat conditions improved over the next 50 to 100 years (Thomas and Raphael 1993; USDA Forest Service and USDI Bureau of Land Management 1994a, 1994b). Recent reports have indicated that declines in northern spotted owl populations in portions of the species range may be greater than was expected (Anthony et al. 2004, Franklin and Courtney 2004). However, despite these declines Franklin and Courtney (2004) noted that there is little reason to doubt the effectiveness of the core of the NWFP conservation strategy. Additionally, Lint et al. (2005) felt that results from the first decade of NWFP monitoring failed to provide any reason to depart from the objective of habitat maintenance and restoration identified in that plan.

The FEMAT report noted that limited Federal ownership in some areas constrained the ability to form an extensive reserve network to meet conservation needs of the northern spotted owl. Thus, non-Federal lands were regarded as an important factor to the range-wide goal of achieving conservation and recovery of the NSO. The Service proposed a special rule under section 4(d) of the Act for non-Federal lands in 1995, but it was never finalized. Thus, take of northern spotted owls on non-Federal lands remains prohibited under section 9 of the Act unless authorized pursuant to a Federal Habitat Conservation Plan (HCP). The Service's primary expectation for private lands are for their contributions to demographic support (pair or cluster protection) to and/or connectivity with NWFP lands. Additionally, timber harvest within each state is governed by rules that provide protection of northern spotted owls and/or their habitat to varying degrees.

- *Washington*: In 1993, the State Forest Practices Board adopted rules (Washington Forest Practices Board 1996) that would "contribute to conserving the northern spotted owl and its habitat on non-Federal lands," based on recommendations from a Science Advisory Group which identified important non-Federal lands and recommended roles for those lands in owl conservation (Hanson et al. 1993; Buchanan et al. 1994). Owl-related HCPs in Washington generally provide both demographic and connectivity support as recommended in these reports and the Final Draft Recovery Plan for the northern spotted owl (USDI Fish and Wildlife Service 1992a). Thus, these areas support the NWFP.

- *Oregon*: The Oregon Forest Practices Act provides for protection of 70-acre core areas around known northern spotted owl nest sites, but it does not provide for protection of owl habitat beyond these areas (Oregon Department of Forestry 2000). In general, no large-scale northern spotted owl habitat protection strategy or mechanism currently exists for non-Federal lands in Oregon. The four owl-related HCPs currently in effect address relatively few acres of land; however, they will provide some nesting habitat and connectivity over the next few decades.

- *California*: In 1990, State Forest Practice Rules (FPRs) (California Department of Forestry and Fire Protection 2001), which govern timber harvest on private lands, were amended to require surveys for northern spotted owls in suitable habitat and to provide specific amounts of habitat around activity centers. Under the FPRs, no timber harvest plan (THP) can be approved if it is likely to result in the incidental take of federally listed species, unless authorized pursuant to a Federal HCP. Although the Yreka Fish and Wildlife Office has observed an increase in requests for recognition of non-occupied status of northern spotted owl sites on industrial timberlands, neither the Service nor the California Department of Forestry and Fire Protection, who regulates non-federal timber harvest, have conducted a comprehensive review of the effectiveness of the take avoidance process for private land timber harvest in California. Five large industrial landowners currently operate under Spotted Owl Management Plans that are approved by the Service. Four of these plans are located within portions of the range containing very low densities of northern spotted owls. These plans specify basic measures for owl protection. Three HCPs, authorizing take of northern spotted owls, have been approved. These HCPs are located in the California Coast Province and are expected to provide for owl demographic and connectivity support to NWFP lands.

Status of the Species: Marbled Murrelet

Legal Status

The marbled murrelet was federally listed as a threatened species in Washington, Oregon and California on September 28, 1992 (USDI Fish and Wildlife Service 1992b). The final recovery plan was released in 1997 (USDI Fish and Wildlife Service 1997). The species is State-listed as endangered in California and as threatened in Oregon and Washington (USDI Fish and Wildlife Service 1997).

In 2004, the Service completed a 5-year status review of the marbled murrelet. As part of the status review process the Service contracted the task of compiling all new and relevant information available on the species. The contractor produced a report summarizing information relevant to the status of the species (McShane et al. 2004). Based on this report, the Service concluded that the California, Oregon and Washington distinct population segment of the marbled murrelet should remain listed as a threatened species. The Service also determined that the California, Oregon, and Washington distinct population segment of the marbled murrelet does not meet the criteria set forth in the Service's 1996 distinct population segment policy (61 FR 4722) (USDI Fish and Wildlife Service 2004a). Currently, the marbled murrelet remains listed and retains its' protected status as a threatened species under the Act until the original 1992 listing decision is revised through formal rule-making procedures.

Life History

Marbled murrelets are long-lived seabirds that spend most of their life in the marine environment, but use old-growth forests for nesting. Accounts of the taxonomy, ecology, and reproductive characteristics of the marbled murrelet are found in the following publications: Ecology and Conservation of the Marbled Murrelet (Ralph et al. 1995a), the Final Recovery Plan Marbled Murrelet *(Brachyramphus marmoratus)* Washington, Oregon, and California Populations (Recovery Plan) (USDI Fish and Wildlife Service 1997), the Final Supplemental Environmental Impact Statement on Management of Habitat for Late-successional and Old-growth Forest Related Species Within the Range of the Northern Spotted Owl (USDA Forest Service and USDI Bureau of Land Management 1994a), the Status of the Marbled Murrelet in North America: with Special Emphasis on Populations in California, Oregon, and Washington (Marshall 1988), Marbled Murrelet *(Brachyramphus marmoratus)* (Nelson 1997), and in the Evaluation Report in the 5-Year Status Review (McShane et al. 2004). Information from these sources is incorporated by reference and summarized as follows.

Physical Description

The marbled murrelet is taxonomically classified in the family Alcidae, a family of Pacific seabirds possessing the ability to dive using wing-propulsion. The plumage of this relatively small seabird is identical between males and females, but adult plumage changes during the winter and breeding periods providing some distinction between adults and juveniles. Breeding adults have light, mottled brown under-parts below sooty-brown upperparts contrasted with dark bars. Adults in winter plumage have white under-parts extending to below the nape and white scapulars with brown and grey mixed upperparts. The plumage of fledged young is similar to the adult winter plumage (USDI Fish and Wildlife Service 1997).

Current and Historical Range

The breeding range of the marbled murrelet extends along the Pacific coast from Alaska to Monterey Bay in central California. Some wintering birds occur as far south as northern Baja California, Mexico. However, only the Washington, Oregon, and California population segment is federally listed as threatened (USDI Fish and Wildlife Service 1992a). Limited information is available on their historic distribution and numbers; however, most summaries give indications that the distribution of marbled murrelet populations was significantly reduced as habitat was removed throughout its' range. Populations declined as a result. In some areas, only small numbers of marbled murrelets persist or have been locally extirpated, risking maintenance of the species' distribution. These areas are identified as "areas of concern" (USDI Fish and Wildlife Service 1997). They include distribution gaps in central California, northwestern Oregon, and southwestern Washington, where very little suitable habitat remains, and what habitat does remain occurs in small, fragmented patches.

Marine Environment

The breeding and winter range of the marbled murrelet in the listed range occur within the oceanographic system known as the California Current. The California Current is subject to high interannual frequency of anomalous conditions such as an El Niño which can affect prey availability (McShane et al. 2004).

Courtship, foraging, loafing, molting, and preening occur in near-shore marine waters. Beginning in early spring, courtship continues throughout summer with some observations even noted during the winter period (Speckman 1996; Nelson 1997). Observations of courtship occurring in the winter suggest that pair bonds are maintained throughout the year (Speckman 1996; Nelson 1997). Courtship involves bill posturing, swimming together, synchronous diving, vocalizations, and chasing in flights just above the surface of the water. Copulation occurs both inland in the trees and at sea (Nelson 1997).

Marbled murrelets forage at all times of the day, but most actively in the morning and late afternoon (Strachan et al. 1995). They typically forage in pairs, but have been observed to forage alone or in groups of three or more (Carter and Sealy 1990; Strachan et al. 1995; Speckman et al. 2003). Strachan et al. (1995) believe pairing influences foraging success and cooperative foraging techniques may be employed. For example, pairs consistently dive together during foraging and often synchronize their dives by swimming towards each other before diving (Carter and Sealy 1990) and resurfacing together on most dives. Strachan et al. (1995) speculate pairs may keep in visual contact underwater. Paired foraging is common throughout the year, even during the incubation period, suggesting that breeding marbled murrelets may temporarily pair up with other foraging individuals or non-mates (Strachan et al. 1995; Speckman et al. 2003).

Marbled murrelets generally forage within nearshore marine waters at about 1.25 miles of shore (Strachan et al. 1995), but are also known to forage in freshwater lakes (Nelson 1997). Traditional feeding areas are used consistently on a daily and yearly basis (Carter and Sealy 1990). Activity patterns and foraging locations are influenced by biological and physical processes that concentrate prey, such as weather, climate, time of day, season, light intensity, up-wellings, tidal rips, narrow passages between islands, shallow banks, and kelp (*Nereocystis* spp.) beds (Ainley et al. 1995; Strong et al. 1995; Speckman 1996; Nelson 1997).

Marbled murrelets forage at depths generally less than 98 feet deep (Strachan et al. 1995; Burger 2002). The most common foraging depths are not known. However, marbled murrelets are known to feed on small schools of fish within the upper 16.4 feet of marine waters (Mahon et al.

1992). An alcid the size of a marbled murrelet is expected to have a maximum diving depth of about 154 feet (Mathews and Burger 1998), although the deepest record of a marbled murrelet was from one captured at 89 feet in a gill net off of California (Carter and Erickson 1992). Jodice and Collopy (1999) reported most diving in Oregon occurred in water less than 33 feet deep.

Juveniles are found closer to shore than adults; rarely greater than 0.625 mile offshore (Beissinger 1995). They forage without the assistance of adults (Strachan et al. 1995). Kuletz and Piatt (1999) found that in Alaska, juvenile marbled murrelets congregated in kelp beds. Kelp beds are often associated with productive waters and may provide protection from avian predators (Kuletz and Piatt 1999). McAllister (unpublished data–cited in Strachan et al. 1995) found that juveniles were more common within 328 feet of shorelines, particularly where bull kelp was present.

Throughout their range, marbled murrelets are opportunistic feeders and utilize prey of diverse sizes and species. They feed primarily on fish and invertebrates in near-shore marine waters although they have also been detected on rivers and inland lakes (Carter and Sealy 1986; USDI Fish and Wildlife Service 1992a). In general, small schooling fish and large pelagic crustaceans are the main prey items. Pacific sand lance *(Ammodytes hexapterus)*, northern anchovy *(Engraulis mordax)*, immature Pacific herring *(Clupea harengus)*, capelin *(Mallotus villosus)*, and surf smelt (Osmeridae) are the most common fish species taken and are eaten year round. Squid (*Loligo* spp.), euphausiids, mysid shrimp, and large pelagic amphipods are the main invertebrate prey and are primarily eaten during the non-breeding season, thus are not a significant part of a nestling's diet.

Breeding marbled murrelets appear to be more selective in their choice of prey when feeding their chicks. They usually select a single, relatively large, energy-rich fish such as larger sand lance, immature herring, anchovy, smelt, and occasionally salmon smolt to carry and feed to their chicks (Burkett 1995; Nelson 1997). Freshwater prey appears to be important to some individuals during several weeks in summer and may facilitate more frequent chick feedings, especially for those that nest far inland (Hobson 1990). The distribution and abundance of prey suitable for feeding chicks may greatly influence the overall foraging behavior and location(s) during the nesting season. For example, the availability of abundant forage fish during the nestling period may significantly affect the energy demand on adults by influencing both foraging time and the number of trips inland required to feed nestlings (USDI Fish and Wildlife Service 1992a).

Marbled murrelets go through two molts each year. The timing of molts varies temporally throughout their range likely due to prey availability, stress, and reproductive success (Nelson 1997). Adult or after hatch-year marbled murrelets have two primary plumage types: alternate plumage during the breeding season and basic plumage during the winter. The pre-alternate molt occurs from late February to mid-May. This is an incomplete molt during which the birds lose their body feathers but retain their ability to fly (Carter and Stein 1995; Nelson 1997). A complete pre-basic molt occurs from mid-July through December (Carter and Stein 1995; Nelson 1997). During the pre-basic molt, marbled murrelets lose all flight feathers somewhat synchronously and are flightless for up to 2 months (Nelson 1997).

Little is known about marine-habitat preference outside of the breeding season, but use during the early spring and fall is thought to be similar to that preferred during the breeding season (Nelson 1997). Adults and subadults may move away from breeding areas prior to molting and must select areas with predictable prey resources during the flightless period (Carter and Stein 1995; Nelson 1997). During the non-breeding season, marbled murrelets disperse and can be found farther from shore (Strachan et al. 1995). During the winter there may be a general shift from exposed outer coasts into more protected waters (Nelson 1997). For example, many marbled murrelets breeding on the exposed outer coast of Vancouver Island appear to congregate in the more sheltered waters within the Puget Sound and the Strait of Georgia in fall and winter (Burger 1995). However, in many areas, marbled murrelets remain associated with their inland nesting habitat during the winter months (Carter and Erickson 1992). In central California, a radio telemetry study of marbled murrelet movement during the late summer and fall months revealed that most birds remained near their nesting areas immediately following molt, but then began to disperse distances greater than 100 miles to wintering areas (Peery et al. 2003a).

At sea predators include bald eagles, peregrine falcons (*Falco peregrinus*), western gulls (*Larus occidentalis*), and northern fur seals (*Callorhinus ursinus*) (McShane et al. 2004). California sea lions (*Zalophus californianus*), northern sea lions (*Eumetopias jubatus*), and large fish may also be occasional predators (Burger 2002).

Terrestrial Environment

Marbled murrelets generally nest in old-growth forests, characterized by large trees, multiple canopy layers, and moderate to high canopy closure. Marbled murrelet nests have been located at a variety of elevations from sea level to 5,020 feet (Burger 2002). However, most nests have been found below 3,500 feet. In California, nest stands are typically composed of low elevation conifers, which include coastal redwood and Douglas-fir. These forests are located close enough to the marine environment for the birds to fly to and from nest sites. The furthest known inland occupied site is in Washington, about 52 miles from the coast. However, marbled murrelets have been detected up to 70 miles from the coast in the southern Cascade Mountains (Evans Mack et al. 2003).

Radar and audio-visual studies have shown marbled murrelet habitat use is positively associated with the presence and abundance of mature and old-growth forests, large core areas of old-growth, low amounts of edge and fragmentation, proximity to the marine environment, total watershed area, and increasing forest age and height (McShane et al. 2004). In California and southern Oregon, areas with abundant numbers of marbled murrelets were farther from roads, occurred more often in parks protected from logging, and were less likely to occupy old-growth habitat if it was greater than 3 miles from other nesting marbled murrelets (Meyer et al. 2002). Meyer et al. (2002) also found at least a few years passed before birds abandoned fragmented forests.

Marbled murrelets do not form dense colonies, which is atypical for most seabirds. Limited evidence suggests they may form loose colonies or clusters of nests in some cases (Ralph et al. 1995b). The marbled murrelets reliance on cryptic coloration to avoid detection would suggest they utilize a wide spacing of nests in order to prevent predators from forming a search image

(Ralph et al. 1995b). However, active nests have been seen within 98 feet in Oregon (Nelson and Wilson 2002). Estimates of marbled murrelet nest densities vary depending upon the method of data collection. For example, nest densities estimated using radar range from 0.003 to 0.042 mean nests per hectare, while nest densities estimated from tree climbing efforts range from 0.11 to 1.42 mean nests per hectare (Nelson 2005).

Of particular importance to recovery options is evidence that breeding marbled murrelets displaced by the loss of nesting habitat apparently do not pack in higher densities into remaining habitat (McShane et al. 2004). Thus currently unoccupied habitat with suitable nesting structure may be important to displaced marbled murrelets and first-time breeders.

There are little data available regarding marbled murrelet nest site fidelity because of the difficulty in locating nest sites and observing bands on birds attending nests. However, marbled murrelets have been detected in the same nesting stands for many years suggesting marbled murrelets have a high fidelity to nesting areas (Nelson 1997). Use of the same nest platform in successive years and multiple nests in the same tree has been documented, although it is not clear whether the repeated use involved the same birds (Divoky and Horton 1995; Nelson and Peck 1995; Nelson 1997; Hebert et al. 2003a).

It is unknown whether juveniles disperse from natal breeding habitat or return to their natal breeding habitat after reaching breeding age. Divoky and Horton (1995) predicted that juvenile dispersal is likely to be high because marbled murrelets are non-colonial and nest in widely dispersed nest sites. Conversely, Swartzman et al. (1997 cited in McShane et al. 2004) suggested juvenile dispersal is likely to be low, as it is for other alcid species.

When tending active nests during the breeding season, breeding pairs forage within commuting distance of the nest site. Daily movements between nest sites and foraging areas for breeding marbled murrelets averaged 10 miles in Prince William Sound, Alaska (McShane et al. 2004), 24 miles in Desolation Sound, British Columbia, and 48 miles in southeast Alaska (Hull et al. 2001). In California, Hebert et al. (2003b) found the mean extent of north-south distance traveled by breeding adults to be about 46 miles.

Known predators of adult marbled murrelets in the forest environment include the peregrine falcon (*Falco peregrinus*), sharp-shinned hawk (*Accipiter striatus*), common raven (*Corvus corax*), northern goshawk (*Accipiter gentilis*), and bald eagle (*Haliaeetus leucocephalus*). Common ravens and Steller's jays (*Cyanocitta stelleri*) are known to take both eggs and chicks at the nest, while sharp-shinned hawks have been found to take chicks. Common ravens account for the majority of egg depredation, as they appear to be the only predator capable of flushing incubating or brooding adults from a nest Nelson and Hamer 1995a). Suspected nest predators include great horned owls (*Bubo virginianus*), barred owls (*Strix varia*), Cooper's hawks (*Accipiter cooperi*), northwestern crows (*Corvus caurinus*), American crows (*Corvus brachyrhynchos*), and gray jays (*Perisoreus canadensis*) (Nelson and Hamer 1995a, Nelson 1997). Predation by squirrels and mice has been documented at artificial nests and cannot be discounted as potential predators on eggs and chicks (Luginbuhl et al. 2001; Raphael et al. 2002; Bradley and Marzluff 2003).

Reproductive Biology
Life history information is limited for the marbled murrelet (USDI Fish and Wildlife Service 1997). However, marbled murrelets probably do not reach sexual maturity until at least their second year, and most birds probably do not lay eggs until they are at least 3 years old (USDI Fish and Wildlife Service 1997). Marbled murrelets are estimated to live an average of 10 years (Beissinger 1995). Marbled murrelets produce one egg per nest and usually only nest once a year, however re-nesting is documented (Hebert et al. 2003a). Nests are not built, but rather the egg is placed in a small depression or cup made in moss or other debris on the limb (USDI Fish and Wildlife Service 1997). In California, egg-laying and incubation span a long period, beginning around March 24 and ending August 15, with the nestling period beginning April 23 and ending September 13 (Hamer et al. 2002).

Incubation lasts about 30 days, and chicks fledge after about 28 days after hatching. Both sexes incubate the egg in alternating 24-hour shifts. The chick is fed up to eight times daily, and is usually fed only one fish at a time. Adults fly from the ocean to inland nest sites at all times of the day, but most often at dusk and dawn (Nelson and Hamer 1995a). New information from a radio-telemetry study in northern California indicates that inland flights at dusk are exclusively made by breeding birds, whereas inland flights at dawn are made by both breeding and non-breeding birds (B. Accord pers. comm.). The young are semiprecocial, capable of walking but not leaving the nest. Fledglings apparently fly directly from the nest to the ocean, but are sometimes found on the ground, indicating that they were unable to sustain flight to reach the marine environment (USDI Fish and Wildlife Service 1997).

Threats
Marbled murrelets remain subject to a variety of threats both in the terrestrial and marine environment including the loss of nesting habitat, predation, noise and visual disturbance, gill-net fishing operations, oil spills and marine pollution, trends in prey availability from oceanographic conditions and overfishing, and disease (USDI Fish and Wildlife Service 1997, McShane et al. 2004).

Habitat loss
Marbled murrelets prefer late-successional and old-growth forests for nesting. Loss of this type of habitat due to timber harvest was the primary reason for listing the species (USDI Fish and Wildlife Service 1992b). Loss of nesting habitat exacerbated by poor reproductive success in remaining habitat are the primary factors responsible for a decline in the marbled murrelet population, compared to the historical population level in the early 1800's (USDI Fish and Wildlife Service 1997).

Predation
Predation of eggs and chicks is a major cause of nest failure (Nelson and Hamer 1995b). Even small increases in predation can have deleterious effects to population viability, due to the marbled murrelet's low reproductive rate (Nelson and Hamer 1995b). Poor reproductive success is likely caused by high predation rates. In particular, human activities which increase the number of predators or risk of predation near nesting areas should be discouraged (USDI Fish and Wildlife Service 1997).

Predation rates are influenced largely by habitat patch size, habitat quality, nest location relative to edge of nest stand, and proximity of nesting habitat to areas of human activity, where many of the corvid species are in high abundance. The quality of nesting habitat decreases as patch size decreases because the amount of forest edge increases in relation to the amount of interior forest habitat. As the amount of forest edge increases, the probability that nests would be located near an edge also increases. Nests placed near the edge of a stand are more likely subject to predation (Ralph et al. 1995b). Nelson and Hamer (1995b) found successful nests were farther from edges and were better concealed than unsuccessful nests. Furthermore, independent of patch size, the quality of nesting habitat decreases when in close proximity to human activity. Forest stands within 0.6 mile of human activity centers, such as campgrounds, can experience increased nest predation because human food sources attract corvids (Marzluff et al. 2000). The probability of predation on simulated marbled murrelet nests decreased from 95 percent to 50 percent when visitors and their food were not allowed into an area of the Olympic National Park (Marzluff and Neatherlin in review).

Disturbance
In coastal and offshore marine environments, vehicular disturbance (e.g., boats, airplanes, personal watercraft) is known to elicit behavioral responses in marbled murrelets of all age classes (Speckman 1996; Nelson 1997). Aircraft flying at low altitudes and boating activity, in particular motorized watercraft, are know to cause marbled murrelets to dive and are thought to especially affect adults holding fish (Nelson 1997). It is unclear to what extent this kind of disturbance affects the distribution and movements of marbled murrelets.

Marine projects that include seismic exploration, pile driving, detonation of explosives and other activities that generate percussive sounds can expose marbled murrelets to elevated underwater sound pressure levels. High underwater sound pressure levels can have adverse physiological and neurological effects on a wide variety of vertebrate species (Yelverton and Richmond 1981; Cudahy and Ellison 2002; Popper 2003). It is unknown to what extent this kind of disturbance may affect marbled murrelets. However, diving birds are able to detect and alter their behavior based on sound in the underwater environment (Ross et al. 2001) and elevated underwater sound pressure levels may cause marbled murrelets to alter normal behaviors, such as foraging. Disturbance related to elevated underwater sound pressure levels may reduce foraging efficiency resulting in increased energetic costs to all marbled murrelet age classes in the marine environment and may result in fewer deliveries or lower quality food being delivered to nestlings.

Marbled murrelets may be sensitive to human-caused disturbance in the terrestrial environment due to their secretive nature and their vulnerability to predation. There are little data concerning the marbled murrelet's vulnerability to disturbance effects, however research on a variety of other species, including other seabirds, indicates an animal's response to disturbance follows the same pattern as its response to encountering predators. Anti-predator behavior has a cost to other fitness enhancing activities, such as feeding and parental care (Frid and Dill 2002).

Anecdotal researcher observations indicate that marbled murrelets typically exhibit a limited, temporary behavioral response to noise disturbance at nest sites and are able to adapt to auditory stimuli (Singer et al. 1995 cited in McShane et al. 2004; Long and Ralph 1998). Responses by marbled murrelet adults and chicks to calls from corvids and other potential predators include no response, alert posturing, and aggressive attack. Adults may temporarily leave a nest (McShane et al. 2004). However, the most typical behavior of chicks and adults in response to the presence of a potential predator is to flatten against a tree branch and remain motionless (Nelson and Hamer 1995b; McShane et al. 2004). In addition, there may be physiological responses researchers cannot account for with visual observations. Corticosterone studies have not been conducted on marbled murrelets, but studies on other avian species indicate chronic high levels of this stress hormone may have negative consequences on reproduction or physical condition (Wasser et al. 1997; McShane et al. 2004).

Though largely inconclusive, Hebert et al. (2003a) examined the effects of operating chainsaw noise during incubation and chick rearing periods on nesting adult marbled murrelets and chicks. Adult marbled murrelets and chicks both spent less time motionless and resting and more time exhibiting "raised head" and "bill up" behaviors during the disturbance trial than pre- and post-trial. The relevance of these behaviors is unknown; however, a species that relies on being cryptic and motionless to avoid predation at the nest may risk being detected by a predator if it moves more often.

Gill-net fishing

Marbled murrelets can become entangled in gill-nets and drown. Marbled murrelets can also be killed by hooking with fishing lures and entanglement with fishing lines (Carter et al. 1995). There is little information available on marbled murrelet mortality from net fishing prior to the 1990s, although it was known to occur (Carter et al. 1995). In the mid-1990s, a series of fisheries restrictions and changes were implemented to address mortality of all species of seabirds, resulting in a lower mortality rate of marbled murrelets (McShane et al. 2004). Fishing effort has also decreased since the 1980s because of lower catches, fewer fishing vessels, and greater restrictions (McShane et al. 2004); although a regrowth in gill net fishing is likely to occur if salmon stocks increase.

Oil spills and marine contaminants

Marbled murrelets are highly vulnerable to oiling. Oil spills which have occurred near murrelet concentrations have had catastrophic effects on marbled murrelet populations (USDI Fish and Wildlife Service 1996). Marbled murrelets exposed to oil floating on the water's surface likely die within days of exposure. Though the number of oil spills has generally declined since passage of the U.S. Oil Pollution Act in 1990, marbled murrelet and seabird mortality remains a significant conservation issue (McShane et al. 2004).

The primary consequence from the exposure of marbled murrelets to contaminants is reproductive impairment. Reproduction can be impacted by food web bioaccumulation of organochlorine pollutants and heavy metals discharged into marine areas where marbled murrelets feed and prey species concentrate (Fry 1995). However, marbled murrelet exposure is likely a rare event because marbled murrelets have widely dispersed foraging areas and they feed extensively on transient juvenile and subadult midwater fish species that are expected to have low pollutant loads (McShane et al. 2004). The greatest exposure risk to marbled murrelets may occur at the regularly feeding areas near major pollutant sources, such as those found in Puget Sound (McShane et al. 2004).

Reduced prey availability
Many fish populations have been depleted due to overfishing, reduction in the amount or quality of spawning habitat, and pollution. Other than anchovies and herring, primary marbled murrelet prey species have little commercial fishery value and, in general, there is little geographic overlap between marbled murrelet distribution and areas of commercial harvest (McShane et al. 2004).

Oceanographic variation can also influence prey availability. While the effects to marbled murrelets from events such as the warm phase of the Pacific Decadal Oscillation or El Niño have not been well documented, El Niño events are thought to reduce overall prey availability and several studies have found that El Niño events can influence the behavior of marbled murrelets (McShane et al. 2004). Even though changes in prey availability may be due to natural and cyclic oceanographic variation, these changes may exacerbate other threats to marbled murrelets in the marine environment.

Disease
The emergence of fungal, parasitic, bacterial, and viral diseases and biotoxins has affected populations of seabirds in recent years. West Nile virus disease has been reported in California which is known to be lethal to seabirds, but little is known about its potential impact on marbled murrelets (McShane et al. 2004). No diseases have been documented to have caused marbled murrelet mortality; however, four marbled murrelets may have died from domoic acid toxicosis in central California in 1999 (Burkett et al. 1999).

Genetics
Loss of genetic variation among populations was identified as a potential threat to the marbled murrelet (McShane et al. 2004). To date, analyses indicate that marbled murrelets from California, British Columbia/mainland Alaska, and the Aleutian Islands differ genetically (Friesen et al. in press). Evaluation of the genetic structure of Oregon and Washington populations is currently underway. Loss of any of the genetically distinct populations could reduce the species' genetic variability and its potential to adapt and evolve (McShane et al. 2004).

<u>Conservation Needs</u>
Recovery objectives for the marbled murrelet include the following (USDI Fish and Wildlife Service 1997): (1) stabilize and then increase population size, changing the current downward trend to an upward trend throughout the listed range; (2) provide conditions in the future that allow for a reasonable likelihood of continued existence of viable populations; and (3) gather the necessary information to develop specific delisting criteria. Stabilizing and increasing habitat quality and quantity on land and at sea are the primary means for stopping the current population decline and encouraging future population growth (USDI Fish and Wildlife Service 1997).

In order to achieve the recovery objectives, the following short-term conservation actions are needed (USDI Fish and Wildlife Service 1997): (1) maintain all occupied nesting habitat on Federal lands administered under the NWFP (USDA Forest Service and USDI Bureau of Land Management 1994b); (2) on non-Federal lands, maintain as much occupied habitat as possible and use the HCP process to avoid or reduce the loss of this habitat; (3) maintain potential and suitable habitat in large contiguous blocks; (4) maintain and enhance buffer habitat surrounding occupied habitat; (5) decrease adult and juvenile mortality; and (6) minimize nest disturbances to increase reproductive success.

In order to achieve the recovery objectives, the following long-term conservation actions are needed (USDI Fish and Wildlife Service 1997): (1) increase the amount and quality of suitable nesting habitat; (2) decrease fragmentation by increasing the size of suitable stands; (3) protect "recruitment" nesting habitat to buffer and enlarge existing stands, reduce fragmentation, and provide replacement habitat for current suitable nesting habitat lost to disturbance events; (4) increase speed of development of new habitat; and (5) improve and develop north/south and east/west distribution of nesting habitat.

Six marbled murrelet conservation zones occur throughout the listed range. They are as follows: Puget Sound (Zone 1); Western Washington Coast Range (Zone 2); Oregon Coast Range (Zone 3); Siskiyou Coast Range (Zone 4); Mendocino (Zone 5); and Santa Cruz Mountains (Zone 6). Specific conservation management plans need to be developed for each zone (USDI Fish and Wildlife Service 1997). Zones 1 to 4 must be managed to produce and maintain well distributed, viable populations to address the long-term survival and recovery of the marbled murrelet.

Zone 4 extends from North Bend, Coos County, Oregon, south to the southern end of Humboldt County, California. It includes marbled murrelet populations in National and State Parks and land of the Pacific Lumber Company, as well as large blocks of suitable habitat critical to recovery of marbled murrelet populations in Washington, Oregon, and California over the next 100 years (USDI Fish and Wildlife Service 1997). The amount of suitable habitat protected in parks is probably not sufficient by itself to guarantee long-term survival in this Zone. Private land at the southern end of the Zone is important for maintaining the current distribution of the species (USDI Fish and Wildlife Service 1997). A gap of 300 miles exits in the distribution of suitable habitat between the southern portion of Zone 4 and the northern portion of Zone 6. Expansion of this gap should be avoided. Actions in Zone 4 should focus on preventing the loss of occupied nesting habitat, minimizing the loss of unoccupied but suitable habitat, and decreasing the time for development of new suitable habitat (USDI Fish and Wildlife Service 1997).

Maintaining marbled murrelet populations on private lands is critical for arresting the population decline in the next 50 to 100 years, especially where additional nesting habitat will not be available on nearby Federal lands. The demographic bottleneck that the murrelet population may experience during the next 50 to100 years makes the maintenance of populations found on private lands an important component to improve viability and the likelihood for recovery. On private lands, the maintenance of all occupied sites should be the goal where possible.

Conservation Strategy

The conservation strategy is to conserve as much of the remaining suitable or occupied habitat on Federal land (i.e., the NWFP) and on key non-Federal lands. These habitats would provide a system of long-term habitat reserves which are needed to stabilize and eventually recover the declining population. This approach assumes that marbled murrelet populations have not already declined below an extinction threshold from which recover is not possible (USDA Forest Service and USDI Bureau of Land Management 1994b). It also assumes that marbled murrelet populations will respond positively to a long-term reversal in the trend of habitat loss (Raphael et al. 2002). Our ability to predict extinction thresholds for the marbled murrelet is still quite crude (National Research Council 1995). In addition, our ability to estimate the size and trend in the marbled murrelet population is limited (Becker et al. 1997).

The NWFP is a conservative approach to managing marbled murrelet habitat, and it accommodates our inability to identify an extinction threshold. The biological opinion on the NWFP concluded that it "...should provide for the survival of a marbled murrelet population that is well distributed on Federal lands throughout the planning area" (USDI Fish and Wildlife Service 1994). The NWFP is designed to enable Federal lands to bear most of the burden for recovering and maintaining late-successional species such as the marbled murrelet. The NWFP protects approximately 90 percent of suitable marbled murrelet habitat on Federal lands (USDI Fish and Wildlife Service 1997); it prohibits removal of occupied marbled murrelet habitat on Federal lands, including the Matrix where intensive timber harvest is otherwise allowed.

Non-Federal land makes an important contribution to marbled murrelet recovery where gaps occur in the distribution of suitable habitat (USDA Forest Service and USDI Bureau of Land Management 1994b, USDI Fish and Wildlife Service 1997). Removal of some occupied marbled murrelet habitat on non-Federal land is likely and potentially permissible, assuming sufficient high quality habitat is protected throughout the listed range to maintain well distributed, viable subpopulations. On non-Federal lands in California, the California Forest Practice Rules and California Endangered Species Act protect occupied marbled murrelet habitat and a 300-foot buffer around the occupied habitat during the breeding season. Non-Federal landowners who propose to harvest occupied habitat may incidentally take the marbled murrelet in known or likely occupied habitat, in accordance with section 7 or section 10 of the Act. The Service applies recommendations of the Recovery Plan when authorizing incidental take of marbled murrelets. These recommendations include the following (USDI Fish and Wildlife Service 1997): minimize the loss of occupied marbled murrelet habitat by evaluating and ranking various types of occupied habitat, and balance short-term risks with long-term tradeoffs.

Section 7 consultation on several HCPs and on tribal lands has authorized incidental take of the marbled murrelet. Each of these approved actions retained the highest quality marbled murrelet habitat as part of a management strategy that was consistent with the Recovery Plan.

<u>Current Condition</u>
The current condition of the species incorporates the effects of all past human and natural activities or events that have led to the present-day status of the species (USDI Fish and Wildlife and USDC National Marine Fisheries Service 1998).

Marine environment
In the California Current, seabirds in general, have done poorly during the most recent El Niño. Response of the marbled murrelet to the El Niño is unknown, but it is likely that consistent with other seabird species, fewer marbled murrelets breed during an El Niño, and foraging effort is increased as birds have to disperse more widely in search of decreased prey (McShane et al.

2004). Threats from reduced prey availability due to over fishing are likely insignificant because marbled murrelets are opportunistic, feeding on a wide range of prey, and there is little geographic overlap between marbled murrelet distribution and areas of commercial harvest (McShane et al. 2004).

During the 1990s, oil tanker and shipping traffic into west coast ports grew, increasing the amount of oil that could be spilled. However, fewer spills have occurred since the U.S. Oil Pollution Act was instated in 1990, and a moratorium on oil development offshore of northern California, Oregon and Washington was enacted in 1992. Though marbled murrelets continue to be killed by oil spills, the overall threat has been reduced since the early 1990s (McShane et al. 2004).

In the mid 1990s, a series of fisheries restrictions and changes were implemented to address mortality of all species of seabirds, resulting in a lower mortality rate of marbled murrelets. Fishing effort has also decreased since the 1980s because of lower catches, fewer fishing vessels, and greater restrictions; although a regrowth in gill net fishing is likely to occur if salmon stocks increase. In most areas, the threat from gill net fishing has been reduced or eliminated since 1992. However, threats to adult and juvenile marbled murrelets are still present in Washington Zones 1 and 2 (McShane et al. 2004). In central California gill-net fishing is currently prohibited in waters less than 60 fathoms deep. This restriction protects the diving zone used by marbled murrelets, thus eliminating the threat of entanglement.

The Service considers disturbance in the marine environment to be a concern for marbled murrelets, particularly in areas of high human activity.

Terrestrial Environment

Habitat Amount The precise amount of suitable marbled murrelet habitat within the listed range is unknown at this time. However, based on recent agency estimates and the Service's internal files, the best estimate of potentially suitable habitat for the marbled murrelet within the listed range is approximately 2.2 million acres of which approximately 155,000 acres or 7 percent are classified as remnant habitat (USDI Fish and Wildlife Service 2003). Approximately 93 percent of the suitable habitat occurs on Federal land. Suitable habitat is distributed among the three States as follows: Washington, approximately 1 million acres; Oregon, approximately 800,000 acres; and California, approximately 400,000 acres (USDI Fish and Wildlife Service 2003). Though our ability to quantify suitable habitat has improved recently, the current estimates likely overestimate the amount in many areas because of the lack of detail on the presence of nesting structure. In fact, northern spotted owl habitat was used as a surrogate for marbled murrelet habitat in some areas. Marbled murrelet habitat quality depends on its proximity to marine waters, landscape context, and stand size. This information is needed to refine estimates of total suitable habitat. Quality habitat must meet basic nesting requirements, provide refuge from predators, and be relatively stable against catastrophic disturbances. It is not possible at this time to estimate the amount of high quality habitat which contributes to long-term nesting success.

The NWFP protects marbled murrelet habitat on Federal land by prohibiting timber harvest of occupied murrelet habitat, regardless of the land allocation (USDA Forest Service and USDI

Bureau of Land Management 1994a). In addition, the system of Federal reserves protects currently suitable marbled murrelet habitat and allows currently unsuitable habitat to develop into larger blocks of suitable habitat. Currently there are approximately 56,000 acres of old-growth redwood forest remaining in California, representing about 2.5 percent of the original old-growth redwood forest. More detailed descriptions of suitable marbled murrelet habitat throughout its listed range are given in Nelson (1997) and USDI Fish and Wildlife Service (1997) and are incorporated herein by reference.

Occupied habitat is defined as that portion of potentially suitable habitat which is occupied by nesting marbled murrelets (Evans Mack et al. 2003), or expected to be occupied, based on survey history in the area and the application of an occupancy index to unsurveyed areas. At least 483,919 acres of potentially occupied marbled murrelet habitat exist within the listed range of the species (Table 2); data are not available for Washington. Marbled murrelets may not occupy a large portion of potentially suitable habitat, due to the absence of nesting structure or its spatial configuration. As a result, the 2.2 million acres of suitable habitat likely overestimates the amount of actual occupied marbled murrelet habitat (USDI Fish and Wildlife Service 2003). For example, although about 100,000 acres of late-seral forests occur on the Siskiyou and Rogue River National Forests and the Medford District of the Bureau of Land Management. Survey results in the area closest to the coast suggest that marbled murrelets actually occupy approximately 26 percent of the suitable habitat, based on existing survey data and assumptions about areas not adequately surveyed. Where published data were lacking, the Service solicited professional judgments from agency biologists and considers these simple estimates as the best available information (USDI Fish and Wildlife Service 2003).

Approximately 68,000 acres of occupied marbled murrelet habitat occur in the California portion of Zone 4 (Table 2). The agencies were unable to separate habitat estimates for Zones 3 and 4 in Oregon. In general, much of the habitat varies in quality. In California, high quality habitat occurs primarily in unmanaged redwood forests which are found close to the coast. Lower quality habitat occurs inland in managed Douglas-fir forests. In California, the estimated 360,000 acres of potentially suitable habitat far exceeds the estimated 68,000 acres of occupied habitat (USDI Fish and Wildlife Service 2003). This discrepancy exists largely as a result of our incomplete understanding of the inland distribution of the marbled murrelet. For example, most habitats previously thought to be suitable on Forest Service lands in California are likely not occupied (Hunter at al. 1998). Comparisons or analyses using the larger amount of suitable habitat may underestimate the potential impacts of a proposed action and, therefore, should not be used to analyze the impacts of a proposed action.

The Service estimates that marbled murrelets likely occupy approximately 430 acres of habitat in Zone 5 and 7,250 acres of habitat in Zone 6. Most suitable habitat in these Zones was historically harvested; suitable habitat which remains is of lower quality and found in scattered, small patches in State and County Parks and on private lands.

<u>Habitat Trend</u> Historically, the amount of suitable habitat has declined throughout the range of the marbled murrelet, due primarily to commercial timber harvest. Some habitat loss is attributed to natural disturbance, such as fire and windthrow. Timber harvest has eliminated most suitable habitat on private lands within Washington, Oregon, and California (USDI Fish

and Wildlife Service 1997). In the early to mid-1800s, Western Washington and Oregon contained 14 to 20 million acres of old-growth forest, compared to about 3.4 million acres in 1991. This loss of habitat represents a reduction of 82 percent (USDI Fish and Wildlife Service 1997). About 1.3 million to 3.2 million acres of old-growth Douglas-fir/mixed conifer and 2.7 million acres of old-growth redwood forests occurred in northwestern California during the early to mid-1800s (USDI Fish and Wildlife Service and USDC National Marine Fisheries Service 1999).

Between 1992 and 2003, the loss of suitable marbled murrelet habitat totaled 22,398 acres over the 3-state area, of which 5,364 acres resulted from timber harvest and 17,034 acres resulted from natural events (McShane et al. 2004). Habitat loss and fragmentation is expected to continue in the near future, but at an uncertain rate (McShane et al. 2004). Gains in suitable nesting habitat are expected to occur on Federal lands over the next 40-50 years, but due to the extensive historic habitat loss and the slow replacement rate of marbled murrelets and their habitat, the species is potentially facing a severe reduction in numbers in the coming 20 to 100 years (Beissinger 2002).

Habitat Distribution Breeding populations of marbled murrelets are not currently distributed continuously throughout the forested portions of Washington, Oregon, and California. A gap of 100 miles in the north/south distribution of suitable habitat exists in southwestern Washington and northwestern Oregon, and a north/south gap of 300 miles exists in central California in the southernmost portion of the species' range. These gaps consist of areas of second-growth and remnant older forests where marbled murrelets occur in low numbers. The inland distribution is greatest in Washington at about 50 miles from the marine environment; it narrows down in Oregon; and it declines to as close as 10 to15 miles from the coast in California.

Habitat Quality Overall, the quality of existing marbled murrelet habitat has diminished, compared to conditions which existed prior to logging (USDI Fish and Wildlife Service 1997). Total habitat area is greatly reduced, and remaining habitat is often fragmented and located further from the marine environment. In California, a large amount of remaining habitat occurs on National, State, and County Park lands which are subject to a high degree of recreation and its associated effects on marbled murrelet populations.

Habitat quality varies on a range-wide basis. Some excellent old-growth habitat remains on Federal lands in each of the three states. However, habitat quality has declined throughout the marbled murrelet's range, compared to historic times. Habitat occurs in smaller patch sizes, consists of smaller trees, and contains more roads and clearcut openings. Predation has likely increased at the local level, due to increased numbers of predators which find food sources associated with human recreational activities. At a landscape level, the abundance of avian predators has probably increased. Ongoing research should shed more light on specific factors which affect marbled murrelet nest predation and stand size preferences. The best available information strongly suggests forest fragmentation may adversely affect the reproductive success of marbled murrelets (USDI Fish and Wildlife Service 1997).

Population Numbers, Trend, and Distribution

Population Numbers The size of the listed population of the marbled murrelet in Washington, Oregon and California was initially estimated at 18,550-32,000 birds (Ralph et al. 1995b). Two largely divergent population estimates in Oregon account for the wide range in the estimated population size.

Monitoring to determine a trend in marbled murrelet populations began in 2000 and has continued annually since, as part of effectiveness monitoring for the NWFP (Bentivoglio et al. 2002; Huff ed. in press) (Table 3). A separate population monitoring effort is conducted each year in Zone 6, which is not part of the NWFP area. The population point estimates from the effectiveness monitoring are as follows: 2000, 18,571 birds; 2001, 22,180 birds; 2002, 23,673 birds; 2003, 22,217 birds; 2004, 20,578 birds; and 2005, 20,223 birds (Table 3). It is premature to determine if biologically meaningful trends in population size exist, given that we only have 6 years of population monitoring data. Depending on the desired minimum power (80 or 95 percent) to detect annual decreases, at least 8 to 10 years of surveys are required for an overall population estimate (Huff ed. in press).

Four of the six Zones must be functional to effectively recover and maintain a well-distributed, viable marbled murrelet population, both in the short- and long-term (USDI Fish and Wildlife Service 1997). Based on the new estimates of population size it appears that Zones 1 through 4 contain relatively robust numbers of marbled murrelets (Table 3). However these robust populations continue to be affected. For example, both Zones 3 and 4 have experienced oil spills within the last 5 years, resulting in significant murrelet mortality. Recent radio telemetry work in Zone 4 indicates nest success is very low (Hebert et al. 2003a).

Population Trend Since 1995, four demographic modeling efforts provide the best available information on predicting population trends, and in one case, extinction probabilities of marbled murrelets into the future: Population Trends of the Marbled Murrelet Projected from Demographic Analyses (Beissinger 1995 in Ralph et al. 1995a); Population Trends of the Marbled Murrelet Projected from Demographic Analyses (Beissinger and Nur 1997 in USDI Fish and Wildlife Service 1997); a subsequent analysis by Beissinger and Peery in 2003: and the Evaluation Report for the 5-Year Status Review of the Marbled Murrelet in Washington, Oregon, and California by McShane et al. 2004.

These efforts employed a Leslie Matrix modeling structure using estimates for demographic parameters such as survival and fecundity. Estimates of survival were derived from life history analyses of similar species. Estimates of fecundity (i.e., number of female young produced per adult female) were generated from estimates of nest success, either from radio-telemetry studies or from juvenile-to-adult ratios obtained in the marine environment. Table 4 lists the four latest murrelet Leslie Matrix models and the values for common demographic parameters used in each.

In 1995, juvenile-to-adult ratios for murrelets ranged between 0.01 and 0.14, while fecundity was estimated at less than 0.2, a value well below the level of productivity needed to sustain stable populations (Beissinger1995). Fecundity would have to range from 0.2 to 0.46 to sustain stable populations. Marbled murrelet populations in California, Oregon, and Washington may be declining at a rate of 4 to 7 percent per year, and perhaps as much as 12 percent per year (Beissinger and Nur 1997 in USDI Fish and Wildlife Service 1997).

In 2003, juvenile-to-adult ratios were once again reviewed, based on 8 additional years of survey data collected at-sea (Beissinger and Peery 2003). Juvenile-to-adult ratios varied from 0.038 to 0.089, depending on Zone. Fecundity estimates were developed for 4 Zones, but unlike the analysis in 1995, fecundity estimates were compared to reproductive histories of individual birds, based on recent radio-telemetry studies. Using a stage-based Leslie matrix model with a range of values for adult survival, fecundity derived from juvenile-to-adult ratios was too low to maintain stable populations in most zones. Rates of population decline ranged from 2.0 to 15.8 percent per year, depending upon the recovery zone and the values used for survival. A downward trend of this magnitude means that the population could be less than one-half to one-twelfth its current size in 20 years. A comparison of fecundity values derived from juvenile-to-adult ratios, to fecundity values from individual reproductive histories resulted in good agreement between the estimates. Both techniques support the assertion that fecundity is too low to maintain viable populations of marbled murrelets in the listed range (Beissinger and Peery 2003).

In 2004, radio telemetry data were used to estimate nest success (McShane et al. 2004). Using a stochastic Leslie Matrix model for each Zone with estimates for immigration, a range of values for survival, and what was considered higher estimates of nest success from radio telemetry data rather than juvenile/adult ratio data, McShane et al. (2004) found all zone populations were declining at a mean annual rate of between 2.1 and 6.2 percent per decade (McShane et al. 2004). McShane et al. (2004) predict the highest rate of decline for Zone 6 and the lowest rate of decline for Zone 2.

In summary, all sources concluded that the listed population apparently exhibits a long-term downward trend.

Population Distribution The historic distribution of the marbled murrelet within its listed range was probably relatively continuous in near-shore waters and in coniferous forests near the coast from the Canadian border south to Monterey County, California (USDI Fish and Wildlife Service 1997). Current breeding populations are discontinuous and generally concentrated at-sea in areas adjacent to remaining late successional coniferous forests near the coast (Nelson 1997). At-sea observations of marbled murrelets are rare between the Olympic Peninsula in Washington and Tillamook County, Oregon, a gap of approximately 100 miles.

Off the California coast, marbled murrelets are concentrated in two areas at-sea that correspond to the three largest remaining blocks of older, coastal forest. These forest blocks are separated by areas of little or no habitat, which correspond to locations at-sea where few marbled murrelets occur. A 300-mile gap occurs in the southern portion of the marbled murrelet's breeding range, between populations in Humboldt and Del Norte counties in the north and populations in San Mateo and Santa Cruz counties to the south. Marbled murrelets likely occurred in this gap prior to extensive logging of redwood forests (USDI Fish and Wildlife Service 1997).

Threats in the terrestrial environment

Habitat Loss McShane et al. (2004) found that the annual rate of habitat loss has slowed since the marbled murrelet was federally listed as threatened; however, habitat loss remains a threat to the species due to the continued permitted loss of habitat, and in particular occupied sites.

Predation Losses of eggs and chicks to avian predators have been determined to be the most important cause of nest failure Nelson and Hamer 1995a, McShane et al. 2004). Furthermore, McShane et al. (2004) conclude that since listing, threats from predation have actually increased. The abundance of several corvid species has increased dramatically in western North America as a result of forest fragmentation, increased agriculture, and urbanization (McShane et al. 2004). As predator abundance has increased, predation on murrelet chicks and eggs has also increased resulting in decreased reproductive success. This trend is likely to continue as forest fragmentation, agriculture, and urbanization continues to dominate the landscape.

Disturbance Although detecting effects of sub-lethal noise disturbance at the population level in marbled murrelets is difficult, the potential for effects of noise disturbance on marbled murrelet fitness and reproductive success remains a concern and should not be discounted (McShane et al. 2004). As such, the Service has concluded in recent biological opinions that the potential for injury associated with visual and auditory disturbance to marbled murrelets in the terrestrial environment includes flushing from the nest, aborted feeding, and postponed feedings. These responses by individual marbled murrelets to disturbance stimuli may reduce productivity of the nesting pair, as well as the entire population (USDI Fish and Wildlife Service 1997).

Disease Though little is known about the potential impact of diseases and biotoxins on marbled murrelets, there is a possibility that marbled murrelets will be negatively affected in the near future because of the cumulative effects of stressors such as oceanic temperature changes, overfishing, and habitat loss (McShane et al. 2004).

Current condition of each conservation zone

Zone 1 Based on 3 years of survey, Zone 1 apparently contains the largest, most robust population in the listed range. Most of the marbled murrelet population in Washington occurs in Zone 1 (Bentivoglio et al. 2002; Jodice et al. 2002; USDI Fish and Wildlife Service 1997).

Effects to marbled murrelet population in Zone 1 occur in both the marine and terrestrial environments. Mortality due to net fisheries is most prevalent in Zone 1, compared to other zones, and a high threat of oil spills and other marine pollution exists in this zone (USDI Fish and Wildlife Service 1997). Between 1984 and 1991 three moderate oil spills occurred in this Zone resulting in an estimated 30 to 60 marbled murrelet mortalities (McShane et al. 2004).

Most suitable marbled murrelet habitat in Zone 1 occurs in northwest Washington primarily on Forest Service and National Park Service lands, and to a lesser extent on State lands. The majority of historic habitat along the eastern and southern shores of Puget Sound has been replaced by urban development resulting in the remaining suitable habitat being farther inland from the marine environment than what occurred historically (USDI Fish and Wildlife Service

1997). Lands considered essential for the recovery of the marbled murrelet within Zone 1 include any suitable habitat in a LSR; all suitable habitat located in the Olympic Adaptive Management Area; suitable habitat on State lands within 40 miles of the coast; and habitat within occupied marbled murrelet sites on private lands (USDI Fish and Wildlife Service 1997).

Zone 2 Point estimates of population size in Zone 2 are difficult to interpret, due to the high degree of variation. However, Zone 2 contains the fourth largest marbled murrelet population in the listed range.

Effects to the marbled murrelet population in Zone 2 have occurred both in the terrestrial and marine environment. Two large oil spills occurred in 1988 and 1991 resulting in estimated marbled murrelets mortalities ranging from 205 to 630 birds (McShane et al. 2004).

Suitable marbled murrelet habitat north of Gray's Harbor in Zone 2 occurs largely on State, Forest Service, National Park Service, and Tribal lands, and to a lesser extent on private lands. Alternatively, the majority of habitat in the southern portion of Zone 2 occurs primarily on State lands, with a small amount on privately owned lands. These lands were extensively harvested in the last century (USDI Fish and Wildlife Service 1997). Some of the privately owned lands were purchased and put into the Federal refuge system. The absence of Federal lands in southwestern Washington dictates that conservation of the marbled murrelet is largely dependent on contributions from non-Federal lands in that area. Lands considered essential for the recovery of the marbled murrelet within Zone 2 include any suitable habitat in a Late Successional Reserve, suitable habitat located in the Olympic Adaptive Management Area, suitable habitat on State lands within 40 miles of the coast, and habitat within occupied marbled murrelet sites on private lands (USDI Fish and Wildlife Service 1997).

Zone 3 Along with Zone 1, Zone 3 appears to contain a larger, more robust population than Zones 5, or 6. Strong (2004) continues to assert that marbled murrelet population numbers have declined since the early 1990's, but they appear to have stabilized at a lower level in recent years. The highest marbled murrelet density occurs off the central Oregon coast or the southern portion of Zone 3. Alternatively, the northern Oregon coast and northern portion of Zone 3 contains much lower densities of marbled murrelets.

Effects to the marbled murrelet population in Zone 3 occur both in the marine and terrestrial environment. In February and March of 1999, the M/V New Carissa oil spill occurred in Zone 3 near Coos Bay, Oregon; an estimated 262 marbled murrelets were killed, about 4 percent of the population in Zone 3 (Ford et al. 2001a). Prior to 1999, four additional oil spills resulted in marbled murrelet mortalities (McShane et al. 2004).

High quality suitable marbled murrelet habitat in Zone 3 occurs primarily in central Oregon on Forest Service and Bureau of Land Management lands. These lands are currently protected in LSRs. Alternatively, northwest Oregon contains less suitable habitat that is generally of lower quality and is found in small scattered patches. The remaining suitable habitat is largely found on State and private lands; it has a long history of timber harvest and wildfire.

Zone 4 Along with Zones 1, 2, and 3, Zone 4 appears to contain a larger, more robust population than Zones 5, or 6. However, new information from a radio-telemetry study in this Zone indicates nesting success is very low (Hebert et al. 2003a).

Effects to the marbled murrelet population in Zone 4 occur both in the marine and terrestrial environment. Two oil spills, M/V Kure and Stuyvesant, have resulted in the deaths of marbled murrelets within this zone. The M/V Kure oil spill occurred in Humboldt Bay in November 1997. Ten dead marbled murrelets were recovered during cleanup and recovery efforts. Marbled murrelet mortality attributable to the Kure spill was "probably fifteen times higher than the known mortality of ten murrelets" (Ford et al. 2001b).

The Stuyvesant oil spill occurred in September 1999 at the entrance to Humboldt Bay. A total of 24 marbled murrelets were recovered during the cleanup and recovery efforts. Modeling efforts estimate that mortality of murrelets was approximately 135 birds (A. Brickey pers. comm.). In total, the M/V Kure and the Stuyvesant oil spills are estimated to have killed 300 birds in Zone 4. These estimated effects are for direct mortality only; oil can have a number of adverse effects on seabirds other than direct mortality (Burger and Fry 1993), but these effects have not been quantified for either oil spill.

Suitable marbled murrelet habitat in Zone 4 is fairly well distributed across the zone. Habitat in southwest Oregon is generally of high quality, occurring largely on Forest Service lands, and to a lesser extent on Bureau of Land Management lands. These lands are currently protected in LSRs. Northern California contains several large Parks and Reserves, and to a lesser extent some privately owned lands that are known to contain marbled murrelets. The Pacific Lumber Company HCP, located in northern California, permitted loss of nearly 5,000 acres of occupied marbled murrelet habitat. Though large amounts of habitat occur on Bureau of Land Management and Forest Service lands further inland, they contain few marbled murrelets.

Zone 5 The population in Zone 5 is extremely low. Recent surveys have confirmed the Recovery Plan's assumption that Zone 5 is not expected to substantially contribute to recovery (USDI Fish and Wildlife Service 1997).

Effects to the marbled murrelet population in Zone 5 have occurred largely in the terrestrial environment. A limited amount of suitable marbled murrelet habitat occurs in Zone 5. It is largely limited to State, County, and National Park lands. Most of the habitat that occurred historically in this Zone was harvested. The remaining habitat is of low quality and found in scattered small patches in Parks and on private lands.

Zone 6 Monitoring of the NWFP does not cover Zone 6, but independent research conducted in Zone 6 provides reliable population estimates. Like Zone 5, population size in Zone 6 is also quite low. New information from a radio-telemetry study in this Zone indicates the marbled murrelet population is highly endangered. A juvenile-to-adult ratio of 0.02 derived from surveys at sea is alarmingly low and further indicates a general failure in reproduction (Peery et al. 2002). Although Zone 6 is highly vulnerable, it was expected to contribute to recovery of the marbled murrelet in the short-term (i.e., 50-100 years) (USDI Fish and Wildlife Service 1997). Recent evidence in Peery et al. (2002) suggests this may not occur.

Effects to the marbled murrelet population in Zone 6 occur both in the marine and terrestrial environment. Since 1992, multiple oil spills have occurred in Zone 6 resulting in mortalities within the range of 1 to 5 percent of the zone population (McShane et al. 2004). Overall, oiling continues to have significant additive effects to the small population in Zone 6.

Suitable marbled murrelet habitat is restricted to small pockets of State and County Park lands and private lands in San Mateo and Santa Cruz Counties. Like Zone 5, most suitable habitat was harvested; remaining habitat is of lower quality, found in smaller patches, and highly affected by human recreational activity.

Environmental Baseline (in the Action Area)

Regulations implementing the Act (50 CFR §402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation process. As stated earlier, the action area for this consultation includes the Smith River NRA, and the Gasquet and Orleans Districts, Six Rivers National Forest. The action area is managed under the NWFP which established a system of Late-successional reserves (LSR) and intervening matrix areas. LSRs 304 and 305 are located on the Orleans District and LSRs 250, 302 and 303 are located on the Smith River NRA and Gasquet District. Management direction contained in the NWFP for listed species was incorporated into the Forest's Land and Resource Management Plan's land allocations and standards and guides.

Northern Spotted Owl

Conservation Needs of the Northern Spotted Owl in the Action Area

The Smith River NRA and Gasquet and Orleans Districts are located primarily in the California Klamath province. General objectives for northern spotted owls in the action area include protecting large blocks of habitat for spotted owl population clusters within the LSRs and maintaining connectivity on matrix lands located among LSRs.

Critical habitat is designated in 3 areas on the Smith River NRA and Gasquet District: Rowdy Creek (CA-18), Coon (CA-19), and Yurok (CA-46) watersheds; and in 3 areas on the Orleans District: Blue Creek (CA-20), Bluff/Slate/Camp Creek (CA-24), and Red Cap Creek (CA-30) watersheds. The primary objective of these critical habitat units is to provide large blocks of suitable habitat for multiple pairs of owls.

Current Condition in the Action Area

Habitat: Amount, Distribution, and Quality

The Smith River NRA and Gasquet District currently contain approximately 286,687 acres of suitable spotted owl habitat. This acreage includes 92,051 acres of nesting and roosting habitat and 194,636 acres of foraging and dispersal habitat. Habitat modeling indicates the LSRs have a high likelihood of northern spotted owl presence (Zabel et al. 2003).

The Orleans District currently contains approximately 307,999 acres of suitable spotted owl habitat. This acreage includes approximately 105,006 acres of nesting and roosting habitat and 202,992 acres of foraging and dispersal habitat. Habitat modeling indicates the LSRs have a high likelihood of northern spotted owl presence (Zabel et al. 2003).

Population: Numbers, Distribution, and Reproduction
No surveys have been conducted on the Smith River NRA, Gasquet and Orleans Districts for the proposed SRRMRD and OTRR projects. Past surveys have detected 58 activity centers on the Smith River NRA and Gasquet District and 77 activity centers on the Orleans District.

Marbled Murrelet
Conservation Needs of the Marbled Murrelet in the Action Area
The Smith River NRA and Gasquet and Orleans Districts are located in Zone 4. Under the NWFP all occupied habitat will be protected. One 0.5 mile LSR has been established on the Orleans District. On the Gasquet District and Smith River NRA, all known marbled murrelet sites are protected in the Rowdy Creek LSR 250 and the Myrtle Creek Botanical Area; therefore no 0.5 mile LSRs were created.

Critical habitat is designated in 5 areas on the Smith River NRA and Gasquet District: Rowdy Creek (CA-01-a), Coon Creek (CA-01-b), Bear Basin (CA-01-d), Monkey Creek (a portion of CA-01-e), and Yurok in the North Tributaries of Turwar-Klamath Estuary (a portion of CA-02-a); and in 2 areas on the Orleans District: Redcap Creek (CA-11-d), and Bluff and Blue Creek (CA-01-c) watersheds. The primary objective of these critical habitat units is to provide large, contiguous blocks of suitable nesting habitat for marbled murrelets. All critical habitat units are located within the boundaries of LSRs.

Current Condition in the Action Area
Habitat: Amount, Distribution, and Quality
The Smith River NRA and Gasquet Distrct currently contain approximately 84,325 acres of suitable marbled murrelet habitat. The Orleans Distrct currently contains approximately 79,458 acres of suitable marbled murrelet habitat.

Population: Numbers, Distribution, and Reproduction
Since 2000, monitoring to determine marbled murrelet population trend has occurred annually in Zone 4 as part of the effectiveness monitoring for the NWFP (Huff et al. 2003). For sampling purposes, Zone 4 was divided into two strata. The northern stratum includes the area from Coos Bay, Oregon to Big Lagoon, California and the southern stratum the area from Big Lagoon south to Shelter Cove, California. The northern stratum occurs offshore of National Forest lands in Oregon and the Redwood National and State Parks and National Forest lands in California. At-sea locations of radio-marked marbled murrelets captured offshore from the Redwood National and State Parks ranged from Punta Gorda, Mendocino County north to Newport, Oregon; however, most of the detections occurred in the northern strata (Hebert et al. 2003b). In 2000, the murrelet population point estimate for the northern strata of Zone 4 was 4,400 birds with a 95 percent CI of 3,000-8,700 (Huff et al. 2003). In 2001, the point estimate was 3,400 with a 95 percent CI of 2,400-5,900 and in 2002, 3,800 birds with a CI of 2,600-5,000 (Huff et al. 2003). In 2003, the point estimate was 3,700 with a 95 percent CI of 2,600-5,700 (Huff unpublished).

In 2004, the point estimate was 3,200 with a 95 percent CI of 2,000-7,800 (Huff unpublished). In 2005, the point estimate was 3,300 with a 95 percent CI of 2,200-5,400 (Huff unpublished). At this point these data are insufficient to estimate statistically valid population trends; however, they provide a useful baseline estimate of the marbled murrelet population (Huff et al. 2003).

In 2003, the rate of population change was estimated for Zone 4 with a stage-based Leslie matrix model (Beissinger and Peery 2003). The rate of population decline for this zone ranged from 2.5 to 13.2 percent per year depending on the values used for adult and juvenile survival. All combinations of adult and juvenile survival, even the most optimistic, produced a negative rate of population change indicative of a declining population (Beissinger and Peery 2003).

Murrelets have been detected at eight locations on the Forest, six on the Smith River NRA and four on the Orleans District. On the Smith River NRA, multiple birds were seen on multiple days in 1988 at the same Myrtle Creek location, during a distribution study at inland California sites conducted by Pacific Southwest Range and Experiment Station (Paton and Ralph 1988; Paton and Ralph 1990). Sightings were approximately 10 miles (18.5 km) inland. Vegetation in this drainage is predominantly old-growth Douglas-fir and Port Orford cedar. Nearby old-growth redwood stands at Jedediah Smith Redwoods State Park had higher activity levels. Surveys in the Myrtle Creek drainage were repeated in 1992, 1995, and 1996, with no detections. In 1992, an immature murrelet was found on the ground on private property near Panther Flat campground, approximately 15 miles (28 km) inland. There was no suitable nesting habitat in the vicinity of the bird. There were no other sightings on the Smith River NRA during survey efforts between 1992 and 1996. In 1997, 2 occupancy and 8 presence detections were documented in old-growth Douglas-fir and redwood forest in the Copper/Rowdy Creek drainage on the western edge of the Smith River NRA. Approximately 25,000 acres or 25 percent of the available suitable marbled murrelet habitat has been surveyed on the Smith River NRA, with no detections beyond the old-growth habitats on the western edge of the Forest.

In 1992, two detections of marbled murrelets were documented at two locations within the Bluff Creek drainage on the Orleans District during pre-sale surveys for the Panther and Nicker Timber Sales. Follow-up visits were unsuccessful. The detections were approximately 18 miles (33 km) inland near a ridgetop, in or near late mature/old-growth habitat. In 1995, at the same Nicker Timber Sale location, another murrelet was detected during a non-protocol survey. In 1998, a marbled murrelet detection was documented using radar in the Bluff Creek drainage.

Effects of the Action: Northern Spotted Owl

This section presents an analysis of the potential direct and indirect effects of the proposed action, including interrelated and interdependent actions, on the northern spotted owl.

<u>Scientific Basis for Evaluating Potential Effects of Habitat Modification</u>

Management practices have the potential to reduce the quantity and quality of northern spotted owl nest and roost sites. Spotted owls depend upon existing structures, such as cavities and broken treetops, for nest sites. Management activities which result in the removal of the oldest, most decadent trees or require removal of hazard trees and snags are likely to remove potential spotted owl nest sites (Blakesley et al. 1992). Further, activities designed to reduce ladder fuels or release the growth of co-dominant trees often simplify vertical structure in the understory, where spotted owls perch for hunting or roosting (Forsman et al. 1984).

Removing trees, snags, and downed wood can affect spotted owl prey composition and/or availability by altering characteristics of the habitat upon which prey species depend. Because the amount of snags and down material on the forest floor is positively correlated with densities of some prey species, a reduction in the abundance of these components may contribute to localized, short-term declines in prey (Williams et al. 1992). Reductions in populations of these prey species could lower spotted owl recruitment.

For the purposes of the following discussion, changes in habitat function are categorized as removal, downgrade, or degrade. R*emoval* represents a complete loss of habitat function following an action. For example, an area functioned as nesting/roosting habitat; after habitat modification, the area does not provide any habitat function. D*owngrad*e is a subset of the term *removal* and refers to a loss of habitat function and change from one habitat function to another. For example, an area functioned as nesting/roosting habitat; after habitat modification, the area is capable only of providing foraging habitat. This term could also be used to signify a change in function from foraging to dispersal as well. *Degrade*, to be distinguished from *downgrade*, indicates a reduction in habitat quality, but not habitat function. For example, an area that functioned as foraging habitat prior to an action still provides foraging habitat after the effect, but prey abundance may be reduced due to a reduction in some structural components or vegetation.

Removal or downgrading of habitat within home ranges, especially when located close to the nest site, can reasonably be expected to negatively affect northern spotted owls. A linear reduction in northern spotted owl productivity and survivorship occurs as the amount of suitable habitat within a spotted owl home range declines (Bart 1995). In northwestern California, survivorship of adult owls was greater where greater amounts of older forest were present around the activity center, but reproductive success increased where the amount of edge between older and younger forest was relatively high (Franklin et al. 2000).

Research indicates that spotted owls in northern California focus their activities in heavily-used "core areas" that ranged in size from about 167 to 454 acres, with a mean of about 409 acres (Bingham and Noon 1997). These core areas, which included 60 to 70 percent of the owl telemetry locations during the breeding season, typically comprised only 20 percent of the home range area. Therefore, habitat removal within core areas could have disproportionate effects on owls. Spotted owl abundance and productivity significantly decrease when the proportion of suitable habitat within 0.7 mile of an activity center falls below 500 acres, which represents 50 percent of the total 1,000 acres within 0.7 mile (O'Halloran 1989; Simon-Jackson 1989; Thomas et al. 1990). For the purpose of consultation, the Service identifies the following guidelines for the amount of suitable habitat needed to maintain essential behaviors, such as breeding, within the home range area: 500 acres within 0.7 mile of the activity center and 1,336 acres within 1.3 mile of the activity center.

Scientific Basis for Evaluating Potential Effects of Disturbance

Activities such as timber harvesting, road decommissioning, landslide rehabilitation, trail maintenance, and fire management may use motorized equipment such as helicopters, heavy equipment, or chainsaws, all of which introduce high levels of noise into the environment. The effects of noise on birds are extremely difficult to determine (Knight and Skagen 1988). Confounding factors include the tolerance level of individual birds, type and frequency of human activity, ambient sound levels, how sound reacts with topograpy and vegetation, and differences in how species perceive noise. Regardless of these difficulties, research conducted on a variety of bird species does suggest that disturbance can have a negative impact on their reproductive success (Tremblay and Ellison 1979; Belanger and Bedard 1989; Piatt et al. 1990; Henson and Grant 1991). Disturbance can affect productivity in a number of ways, including interference of courtship (Bednarz and Hayden 1988), nest abandonment (White and Thurow 1985), egg and hatchling mortality, due to exposure and predation (Drent 1972; Swensen 1979), and altered parental care (Fyfe and Olendorff 1976; Bortolotti et al. 1984).

The few studies which examined responses of northern and Mexican spotted owls to several disturbance sources, such as helicopters, small chainsaw, hikers, indicate that noise can disrupt owl behaviors, such as flushing from roosts and prey delivery rates) (Delaney et al. 1999; Delaney and Grubb 2001; Swarthout and Steidl 2001). However, owl sensitivity varies with stimulus distance, location (i.e., aerial or ground), type, and timing, as well as individual tolerance (Delaney et al. 1999; Delaney and Grubb 2001; Swarthout and Steidl 2001).

Effects of the Action- Habitat Modification

There will be no removal of suitable habitat. However, suitable habitat will be degraded as a result of the proposed SRRMRD project. Shrubs, tree limbs, and sapling trees less than 11 inches dbh may be removed during culvert removal. No down logs will be removed. The small sapling trees and shrubs provide potential habitat for owl prey species. Their removal may result in minor degradation of up to approximately 16 acres of suitable habitat. The impact of this degradation on northern spotted owls is expected to be insignificant for the following reasons: 1) no dominant or co-dominate trees or down logs will be removed; 2) habitat suitability and function will be maintained; 3) no conifers greater than 11 inches dbh will be removed; 4) overstory canopy will not be altered; 5) primarily minor stand components will be removed (e.g., small sapling trees, shrubs, and limbs) and 6) vegetation removal will occur at sites of 1/10 of an acre or less in size.

The biological assessment for the OTRR project stated that there would be no effect to suitable northern spotted owl habitat as a result of the proposed project.

Effects of the Action- Disturbance

Some of the proposed management activities may require the use of motorized equipment, such as bulldozers, or chainsaws, which introduce high levels of noise into the environment. The Service considers the use of motorized equipment during the breeding season (February 1 through July 31) to have the potential to significantly disrupt essential behaviors such as breeding, roosting, and foraging. For the purpose of consultation, the Service identifies a threshold of 500 feet as a minimum distance from suitable nesting and roosting habitat to avoid disturbance during the breeding season due to changes in these essential behaviors.

A limited operating period from February 1 through July 9 will be imposed for some of the projects utilizing motorized equipment in or within 500 feet of unsurveyed or occupied nesting and roosting habitat. Delaying project implementation until after July 9 will minimize the potential impacts on nesting spotted owls. The period from July 10 through July 31 is after the period when the majority of young owls have fledged from the nest. As a result, we would anticipate some change in the owl's behavior from noise generated during this period but would not expected it to result in abandonment of the breeding effort, disruption of nesting activities, or premature dispersal of juveniles.

Motorized equipment will be used during the breeding season along high priority roads. Approximately 1,773 acres of unsurveyed suitable nesting and roosting habitat occur within 500 feet of high priority roads in the proposed SRRMRD project, and 3,618 acres of unsurveyed suitable nesting and roosting habitat occur within 500 feet of high priority roads in the proposed OTRR project. This level of activity may disturb adult or juvenile spotted owls and could cause them to flush from their nest site, could cause a juvenile to prematurely fledge, or could interrupt foraging activity. The Service anticipates that this disturbance could result in harassment of an undertermined number of nesting spotted owls associated with these 5,391 acres of habitat. This amount of suitable nesting and roosting habitat represents approximately 2.7 percent of the available suitable nesting and roosting habitat (197,057 acres) in the action area.

Cumulative Effects: Northern Spotted Owl

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur within the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. The action area includes very little non-federal land. The Service currently reviews all commercial logging on non-federal land within northern California to ensure that unauthorized take of northern spotted owls will not occur.

Conclusion: Northern Spotted Owl

After reviewing the current status of the northern spotted owl, the environmental baseline for the action area, the effects of implementing the proposed SRRMRD and OTRR projects and the cumulative effects, it is the Service's biological opinion that the SRRMRD and OTRR projects, as proposed, are not likely to jeopardize the continued existence of the northern spotted owl. The Service reached the non-jeopardy conclusion based on the following factors:

1. The proposed actions will not remove suitable northern spotted owl habitat. Up to approximately 16 acres of nesting and roosting habitat will be degraded on the Smith River NRA and Gasquet District. However, the impacts will be insignificant because no conifers greater than 11 inches dbh and no down logs will be removed.

2. An unknown number of nesting spotted owls associated with 5,391 acres of unsurveyed nesting and roosting habitat will be subject to harassment through 2021. This amount of suitable nesting and roosting habitat represents a small percentage of the available nesting and roosting habitat (2.7 percent) in the action area.

3. The proposed projects contribute to the long-term conservation needs of the spotted owl by reducing road density across the action area which will in turn reduce fragmentation of habitat, increase patch size, and reduce disturbance.

The Service has determined that the adverse effects to northern spotted owls will not contribute to an appreciable reduction in the likelihood of survival and recovery of the northern spotted owl in the wild by significantly reducing spotted owl numbers, reproduction, or distribution.

Effects of the Action: Marbled Murrelet

This section presents an analysis of the potential direct and indirect effects of the proposed action, including interrelated and interdependent actions, on the marbled murrelet.

Scientific Basis for Evaluating Potential Effects of Habitat Modification

Habitat modification can directly or indirectly affect marbled murrelets at either site-specific or landscape scales, as discussed below. These effects may include a complete loss of habitat, degradation of habitat, and changes in habitat conditions which affect protection from the environment or predators. Examples of the latter include harvest of unsuitable habitat adjacent to and contiguous with suitable habitat, or harvest in unsuitable habitat that is not contiguous with suitable habitat but that is within 0.5 mile.

Site-Specific Effects

Effects of forest management activities on marbled murrelet habitat at the site-specific scale depend on the timber harvest prescriptions which are implemented and location of the timber harvest area relative to suitable habitat. Retention of habitat characteristics such as stand size, canopy closure, and horizontal structure may avoid or minimize impacts on nesting murrelets (U.S. Fish and Wildlife Service 1997). Activities that remove or degrade potential nesting platforms may result in a significant decrease in the value of the stand for future nesting. The removal or degradation of trees adjacent to potential nesting platforms may alter habitat elements essential to the suitability of the platform, such as trees providing cover from weather or predators (USDI Fish and Wildlife Service 1996).

Landscape-Level Effects

Any individual or suite of site-specific effects could change the habitat function that a forested stand provides for murrelets. For the purpose of the following discussion, the degree of change to habitat function is categorized as either removal or degradation. The term *removal* represents a complete loss of habitat function following an effect. For example, an area that functioned as nesting habitat for marbled murrelets before the action would no longer function as nesting habitat after the action. *Degradation*, indicates a reduction in habitat quality; however, habitat function is retained following an action. For example, an area that functioned as nesting habitat prior to an action would still function as such after the effect, however, the quantity, quality, or distribution of habitat attributes may be reduced as result.

General landscape condition may influence the degree to which marbled murrelets nest in an area. In Washington, detections of murrelets increased when old-growth/mature forests comprised more than 30 percent of the landscape (Hamer and Cummins 1990). The percentage of old-growth forest and large sawtimber was significantly greater within 0.5 mile of sites that murrelets occupied, compared to sites where they were not detected (Raphael et al.1995). Murrelets are more likely to occupy sites whose landscapes are comprised with greater than 35 percent old-growth and large sawtimber (Raphael et al. 1995). In California, the density of old-growth cover and the presence of coastal redwood were the strongest predictors of presence of murrelets (Miller and Ralph 1995).

On a landscape basis, forests with a canopy height of at least one-half the site potential tree height in proximity to potential nest trees are likely to contribute to the conservation of the marbled murrelet. These forests may reduce the differences in microclimate associated with forested and unforested areas, reduce potential for windthrow, and provide a landscape that has a higher probability of occupancy by murrelets (U.S. Fish and Wildlife Service 1997).

Scientific Basis for Evaluating Potential Effects of Disturbance

Management activities that require use of heavy equipment, chainsaws, helicopters, and large vehicles introduce noise, visual, and air disturbances into the environment. The effects of auditory and visual disturbances on birds are extremely difficult to determine (Knight and Skagen 1988). Confounding factors include the tolerance level of individual birds, type and frequency of human activity, ambient sound levels, how sound reacts with topography and vegetation, and differences in how species perceive noise and human presence. Regardless of these difficulties, research conducted on a variety of bird species does suggest that the effects of human disturbance can have a negative impact on reproductive success (Carney and Sydeman 1999; Frid and Dill 2002; Marzluff and Neatherlin In review). Disturbance can affect productivity in a number of ways, including interference of courtship (Bednarz and Hayden 1988), nest abandonment (White and Thurow 1985), egg and hatchling mortality, due to exposure and predation (Drent 1972; Swensen 1979), and altered parental care (Fyfe and Olendorrf 1976; Bortolotti et al. 1984).

Though largely inconclusive, Hebert and Golightly (2003c) examined the effects of operating chainsaw noise during incubation and chick rearing periods on nesting adult murrelets and chicks. Adult murrelets and chicks both spent less time motionless and resting and more time exhibiting "raised head" and "bill up" behaviors during the disturbance trial than pre- and post-trial. The relevance of these behaviors is unknown; however, a species that relies on being cryptic and motionless to avoid predation at the nest may risk being detected by a predator if it moves more often.

The relationship between the human caused disturbance events, predators, and fledging success remains unclear (Hebert and Golightly 2003c). However, predators can be attracted to human presence, noise and provisioning of food (Miller et al. 1998; Marzluff et al. 1999). Forest stands within 0.6 mile of human activity centers such as campgrounds, can experience greater nest predation because human food sources attract corvids (Marzluff et al. 2000). Furthermore, the probability of predation on simulated murrelet nests decreased from 95 percent to 50 percent when visitors and their food were not allowed into an area of the Olympic National Park (Marzluff and Neatherlin in review).

Disturbance is defined as noise in excess of ambient levels in or within 500 feet of suitable nesting habitat or as the reaction of nesting birds to human presence or activity, resulting in disruption of essential breeding behaviors. Disturbance during the breeding season may potentially disrupt the species' essential breeding behaviors by: 1) causing abandonment of the breeding effort by failure to initiate nesting or to complete incubation; 2) disrupting nesting activity such as feeding young; and 3) causing premature dispersal of juveniles.

Data on timing of various aspects of the breeding season indicate that murrelets in California have the longest breeding period in North America. Incubation commences as early as March 24 and ends as late as August 13; the nestling period may begin April 24 and end September 9 (Hamer and Nelson 1995). In California, we have defined the murrelet breeding season as the period from March 24 through September 15. The Service considers the use of motorized equipment during the breeding season (March 24 through September 15) to have the potential to significantly disrupt essential murrelet behaviors.

Effects of the Action- Habitat Modification

Marbled murrelet nesting habitat will not be removed or degraded by the proposed action. None of the trees to be removed are potential nest trees. All of the trees proposed to be removed in suitable murrelet habitat are less than one-half site potential tree height and their canopies do not extend high enough to provide cover for potential nesting platforms. Since all potential nest trees, potential nesting platforms, and trees providing protective cover around nesting platforms will be retained, impacts due to the proposed action do not reach the level of habitat degradation.

Effects of the Action- Disturbance

Some of the proposed management activities may require the use of motorized equipment, such as bulldozers or chainsaws, which introduce high levels of noise into the environment. The Service considers the use of motorized equipment during the breeding season (March 24 through September 15) to have the potential to significantly disrupt essential behaviors such as breeding. For the purpose of consultation, the Service identifies a threshold of 500 feet as a minimum distance from suitable nesting habitat to avoid disturbance during the breeding season due to changes in these essential behaviors.

A limited operating period from March 24 through August 5 will be imposed on all roads except for high priority roads scheduled for upgrades or decommissioning utilizing motorized equipment within 500 feet of unsurveyed *low-quality* suitable marbled murrelet nesting habitat. In addition, work from August 6 through September 15 will not begin until 2 hours after sunrise and stop 2 hours before sunset unless surveys determine the area is unoccupied. A limited operating period from March 24 through September 15 will be imposed on all roads except for high priority roads scheduled for upgrades or decommissioning utilizing motorized equipment within 500 feet of unsurveyed *high-quality* suitable marbled murrelet nesting habitat. On the Orleans District, a limited operating period from March 24 through September 15 will be imposed on Road 11N28 within 500 feet of known occupied marbled murrelet habitat. No disturbance to breeding marbled murrelets associated with the utilization of motorized equipment that implement these limited operating periods is anticipated.

Motorized equipment will be used along high priority roads during the breeding season. Approximately 1,479 acres of unsurveyed suitable nesting habitat occur within 500 feet of high priority roads in the proposed SRRMRD project, and 5,447 acres of unsurveyed suitable nesting habitat occur within 500 feet of high priority roads in the proposed OTRR project. The Service anticipates that disturbance could result in harassment of an undertermined number of nesting marbled murrelets associated with 6,926 acres of habitat. This amount of suitable nesting habitat represents approximately 4.2 percent of the available suitable nesting habitat (163,783 acres) in the action area.

Cumulative Effects: Marbled Murrelet

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur within the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. The action area includes very little non-federal land. The Service currently reviews all commercial logging on private land within northern California to ensure that unauthorized take of marbled murrelets will not occur.

Conclusion: Marbled Murrelet

After reviewing the current status of the marbled murrelet, the environmental baseline for the action area, the effects of implementing the SRRMRD and OTRR projects and the cumulative effects, it is the Service's biological opinion that the projects, as proposed, are not likely to jeopardize the continued existence of the marbled murrelet. The Service reached the non-jeopardy conclusion based on the following factors:

1. The proposed projects will not remove or degrade suitable marbled murrelet nesting habitat.

2. Nesting marbled murrelets associated with 6,926 acres of suitable habitat will be subject to harassment through 2021. This amount of suitable nesting habitat represents a small percentage of the available suitable nesting habitat (4.2 percent) in the action area.

3. The proposed projects contribute to the long-term conservation needs of the marbled murrelet by reducing road density across the action area which will in turn reduce fragmentation of habitat, increase patch size, and reduce disturbance.

The Service has determined that the adverse effects to marbled murrelets will not contribute to an appreciable reduction in the likelihood of survival and recovery of the marbled murrelet in the wild by significantly reducing marbled murrelet numbers, reproduction, or distribution.

INCIDENTAL TAKE STATEMENT

INTRODUCTION

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the taking of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by the Service as actions that create the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Forest so that they becomes binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Forest has a continuing duty to regulate the activity covered by this incidental take statement. If the Forest: (1) fails to assume and implement the terms and conditions; or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Forest must report the progress of the actions and their impact on the species to the Service as specified in the Incidental Take Statement [50 CFR § 402.12(I)(3)].

AMOUNT OR EXTENT OF TAKE

Northern Spotted Owl

The Service anticipates that an undetermined number of northern spotted owls could be taken as a result of activities proposed by the Forest. The incidental take is expected to be in the form of:

Harassment of northern spotted owls associated with a total of 1,773 acres of unsurveyed nesting and roosting habitat due to the use of mechanized equipment on the Smith River NRA and Gasquet District. This harassment may be spread over a 15-year period from 2007 through 2021 and is not expected to exceed 400 acres of nesting and roosting habitat in any one breeding season.

Harassment of northern spotted owls associated with a total of 3,618 acres of unsurveyed nesting and roosting habitat due to the use of mechanized equipment on the Orleans District. This harassment may be spread over a 15 year-period from 2007 through 2021 and is not expected to exceed 550 acres of nesting and roosting habitat in any one breeding season.

Marbled Murrelet

The Service anticipates that an undetermined number of marbled murrelets could be taken as a result of activities proposed by the Forest. The incidental take is expected to be in the form of:

Harassment of marbled murrelets associated with a total of 1,479 acres of unsurveyed nesting habitat due to the use of mechanized equipment on the Smith River NRA and Gasquet District. This harassment may be spread over a 15-year period from 2007 through 2021 and is not expected to exceed 400 acres of nesting habitat in any one breeding season.

Harassment of marbled murrelets associated with a total of 5,447 acres of unsurveyed nesting habitat due to the use of mechanized equipment on the Orleans District. This harassment may be spread over a 15-year period from 2007 through 2021 and is not expected to exceed 650 acres of nesting habitat in any one breeding season.

If during the course of the action, this level of incidental take is exceeded, then such incidental take represents new information requiring reinitiation of consultation. The Forest must immediately provide an explanation of the causes of the taking and review with the Service the need for possible reasonable and prudent measures.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the northern spotted owl or marbled murrelet, or destruction or adverse modification of critical habitat for the northern spotted owl or marbled murrelet.

REASONABLE AND PRUDENT MEASURES

Pursuant to 50 CFR 402.14 (I)(ii), reasonable and prudent measures are those the Service considers necessary to minimize the impact of the incidental taking. Impacts of the proposed action largely will be minimized by compliance with measures incorporated into the project design. Consequently, no reasonable and prudent measures are necessary.

TERMS AND CONDITIONS

In order to be exempt from the prohibitions of section 9 of the Act, the Forest must comply with terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

As mentioned above, the Service considers the measures incorporated into the project design to be sufficient to minimize take of northern spotted owls and marbled murrelets; therefore, no terms and conditions are necessary.

MONITORING REQUIREMENTS

In order to monitor the impacts of incidental take, each District must report the progress of the action and its impacts on the species to the Service as specified below:

> Each District must report the progress of the proposed actions and their impacts on the species to the Service in accordance with 50 CFR §13.45 and §18.27. Prior to January 31 of each year through 2021, each District shall provide an annual monitoring report as outlined in Appendix D of the OTRR biological assessment.

REPORTING REQUIREMENTS

Any dead or injured northern spotted owl or marbled murrelet must be reported to the Service's Law Enforcement Division (916-979-2987) or the Arcata Fish and Wildlife Office as soon as possible, and turned over to the Law Enforcement Division or a game warden or biologist of the California Department of Fish and Game for care or analysis. The Service is to be notified in writing within three working days of the accidental death of, or injury to, a northern spotted owl or marbled murrelet or of the finding of any dead or injured northern spotted owls or marbled murrelets during implementation of the proposed action. Notification must include the date, time, and location of the incident or discovery of a dead or injured northern spotted owl or marbled murrelet, as well as any pertinent information on circumstances surrounding the incident or discovery. The Service contact for this written information is the Field Supervisor for the Arcata Fish and Wildlife Office at (707) 822-7201.

COORDINATION OF INCIDENTAL TAKE WITH OTHER LAWS, REGULATIONS, AND POLICIES

The incidental take statement provided in this biological opinion satisfies the requirements of the Act. The Service will not refer the incidental take of any migratory bird or bald eagle for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §§ 668-668d), if such take is in compliance with the terms and conditions, including the amount and/or number specified herein.

CONSERVATION RECOMMENDATIONS

Sections 2(c) and 7(a)(1) of the Act direct Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species and the ecosystems upon which they depend. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. Conduct pre-project surveys for spotted owl and marbled murrelets in any suitable nesting habitat that may occur within 500 feet of areas where noise generating work is proposed.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed, proposed, or candidate species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINTIATION NOTICE

This concludes formal consultation on the proposed SRRMRD and OTRR projects. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation. If you have any questions regarding this biological opinion, please contact Ms. Robin Hamlin or Ms. Lynn Roberts of my staff at (707) 822-7201.

Sincerely,

Acting

Michael M. Long
Field Supervisor

LITERATURE CITED

Ainley, D.G., S.G. Allen, and L.B. Spear. 1995. Offshore occurrence patterns of marbled murrelets in central California. Pages 361-370 *in* C.J. Ralph, G.L. Hunt, M.G. Raphael, and J. F. Piatt (eds.). Ecology and Conservation of the Marbled Murrelet. General Technical Report. PSW-GTR-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

American Ornithologists' Union. 1957. Check-list of north American birds. Fifth edition. American Ornithologists' Union, The Lord Baltimore Press, Baltimore, MD.

Anthony, R.G., E.D. Forsman, A.B. Franklin, D.R. Anderson, K.P. Burnham, G.C. White, C.J. Schwarz, J. Nichols, J.E. Hines, G.S. Olson, S.H. Ackers, S. Andrews, B.L. Biswell, P.C. Carlson, L.V. Diller, K.M. Dugger, K.E. Fehring, T.L. Fleming, R.P. Gerhardt, S.A. Gremel, R.J. Gutiérrez, P.J. Happe, D.R. Herter, J.M. Higley, R.B. Horn, L.L. Irwin, P.J. Loschl, J.A. Reid, and S.G. Sovern. 2004. Status and trends in demography of northern spotted owls, 1985-2003. Final Report to the Interagency Regional Monitoring Program, Portland, Oregon. September 2004. 179pp.

Barrowclough, G.F., R.J. Gutiérrez, and J.G. Groth. 1999. Phylogeography of spotted owl (*Strix occidentalis*) populations based on mitochondrial DNA sequences; gene flow, genetic structure, and a novel biogeographic pattern. Evolution 53(3):919-931.

Bart, J. 1995. Amount of suitable habitat and viability of northern spotted owls. Conservation Biology 9 (4):943-946.

Becker, B.H., S.R. Beissinger, and H. R. Carter. 1997. At-sea density monitoring of marbled murrelets in central California: methodological considerations. Condor 99:743-755.

Bednarz, J. C. and T. J. Hayden. 1988. The Los Medanos Cooperative Raptor Research and Management Program. Final Report 1985-1987. Report for Department of Energy; USDI Bureau of Land Management; University of New Mexico. 112 pp.

Beissinger, S.R. 2002. Analysis of the effect of a 10 percent reduction of population size on marbled murrelet population dynamics in northern California. A report to the U.S. Fish and Wildlife Service, Arcata Field Office, California. April 5, 2002. 10 pp.

Beissinger, S.B. 1995. Population trends of the marbled murrelet projected from demographic analyses. Pages 385 - 393 *in* C.J. Ralph, G.L. Hunt, M.G. Raphael, and J. F. Piatt, technical editors, Ecology and Conservation of the Marbled Murrelet. Gen. Tech. Rept. PSW-GTR-152. Albany, California: Pacific Southwest Experiment Station, Forest Service. 420 pp.

Beissinger, S.B. and N. Nur. 1997. Population trends of the marbled murrelet projected from demographic analyses. Pages B-1 – B-35 *in* U.S. Fish and Wildlife Service. Recovery plan for the threatened marbled murrelet (*Brachyramphus marmoratus*) in Washington, Oregon, and California. Portland, Oregon. 203 pp.

Beissinger, S.B. and M.Z. Peery. 2003. Range-wide analysis of juvenile ratios from marbled murrelet monitoring programs: implications for demographic analyses. Report submitted to U.S. Fish and Wildlife Service, Arcata, California.

Belanger, L. and J. Bedard. 1989. Response of staging snow geese to human disturbance. Journal of Wildlife Management 53:713-719.

Bentivoglio, N., J. Baldwin, P.G.R. Jodice, D.E. Mack, T. Max, S. Miller, S.K. Nelson, K. Ostrom, C.J. Ralph, M. Raphael, C. Strong, C. Thompson, and R. Wilk. 2002. Northwest Forest Plan Marbled Murrelet Effectiveness Monitoring 2000 Annual Report. U.S. Department of Interior, Fish and Wildlife Service; U.S. Department of Agriculture, Pacific Northwest Research Station and Pacific Southwest Research Station; Oregon State University, Wildlife Cooperative Research Unit; Crescent Coastal Research; and Washington Department of Fish and Wildlife. April 2002. 73 pp.

Bigley, R. E., and J. F. Franklin. 2004. Habitat trends. Pages 6-2 to 6-35 in Courtney et al. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute, Portland, OR.

Bingham, B.B., and B.R. Noon. 1997. Mitigation of habitat "take": Application to habitat conservation planning. Conservation Biology 11 (1):127-138.

Blakesley, J. A., W. LaHaye, J. M. Marzluff, B. R. Noon, and S. P. Courtney. 2004. Demography. Pages 8-2 to 8-46 in Courtney et al. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute, Portland, OR.

Blakesley, J.A., Franklin, A.B., and R.J. Gutiérrez. 1992. Spotted owl roost and nest site selection in northwestern California. 1992. Journal of Wildlife Management, 56(2):388-392.

Bortolotti, G. R., J. M. Gerrard, P. N. Gerrard, and D. W. A. Whitfield. 1984. Minimizing investigator-induced disturbance to nesting bald eagles. In: J. M. Gerrard and T. M. Ingram, editors. The Bald Eagle in Canada. Proc. Bald Eagle Days, Winnipeg. Pages 85-103.

Bradley, J.E., and J.M. Marzluff. 2003. Rodents as nest predators: influences on predatory behavior and consequences to nesting birds. Auk 120:1180-1187.

Buchanan, J., E. Hanson, D. Hays, and L. Young. 1994. An evaluation of the Washington Forest Practices Board Wildlife Committee preferred alternative for a spotted owl protection rule. Washington Forest Practices Board Spotted Owl Scientific Advisory Group. Olympia, Washington.

Burger, A.E. 2002. Conservation assessment of marbled murrelets in British Columbia, a review of biology, populations, habitat associations and conservation. Pacific and Yukon Region, Canadian Wildlife Service. 168 pp.

Burger, A.E. 1995. Marine distribution, abundance and habitat of marbled murrelets in British Columbia. Pages 295-312 *in* C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds.). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Burger, A.E. and D.M. Fry. 1993. Effects of oil pollution on seabirds in the northeast Pacific. In: Vermeer, K.; K.T. Briggs; K.H. Morgan; and D. Siegel-Causey D., editors. The status, ecology, and conservation of marine birds of the North Pacific. Canadian Wildlife Service Special Publication. Ottawa, Canada. Pp. 254-263.

Burkett, E.E. 1995. Marbled murrelet food habits and prey ecology. Pages 223-246 *in* C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds.). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Burkett E.E., H.R. Carter, J.Y. Takekawa, S. Newman, R.T. Golightly, and J.L. Lanser. 1999. Marbled murrelet radio telemetry in central California in 1997 and 1998: a reduced effort noted in an El Nino year. Pacific Seabirds 26(1):32.

California Department of Forestry and Fire Protection. 2001. California Forest Practices Rules: 2001. Title 14, California Code of Regulations, Chapters 4, 4.5, and 10. Sacramento, CA.

Carey, A.B. 1993. Prey ecology and northern spotted owl diet. Abstract of presentation, Spotted Owl Symposium, annual meeting of the Raptor Research Foundation, Inc., Bellevue, Washington, November 11-15, 1992. Journal of Raptor Research 27(1):53-54.

Carey, A. B., S. P. Horton, and B. L. Biswell. 1992. Northern spotted owls: influence of prey base and landscape character. Ecological Monographs 62:223-250.

Carney, J. M., and W. J. Sydeman. 1999. A review of human disturbance effects on nesting colonial waterbirds. Waterbirds 22:68-79.

Carter, H.R., and R.A. Erickson. 1992. Status and conservation of the marbled murrelet in California, 1892-1987. *In*: H.R. Carter and M.L. Morrison (eds.). Status and conservation of the marbled murrelet in North America. Proceedings of the Western Foundation for Vertebrate Zoology 5.

Carter, H.R., and S.G. Sealy. 1990. Daily foraging behavior of marbled murrelets. Studies in Avian Biology 14:93-102.

Carter, H.R., and S.G. Sealy. 1986. Year-round use of coastal lakes by marbled murrelets. Condor 88:473-477.

Carter, H.R., and J.L. Stein. 1995. Molts and plumages in the annual cycle of the marbled murrelet. Pages 99-109 *in* C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds.). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Carter, H.R., M.L.C. McAllister, and M.E. Isleib. 1995. Mortality of marbled murrelets in gill nets in North America. Pages 271-283 *in* C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds.). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Courtney, S.P., J.A. Blakesley, R.E. Bigley, M.L. Cody, J.P. Dumbacher, R.C. Fleischer, A.B. Franklin, J.F. Franklin, R.J. Gutiérrez, J.M. Marzluff, L. Sztukowski. 2004. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute. Portland, Oregon. September 2004.

Cudahy, E. and W.T. Ellison. 2002. A review of the potential for in vivo tissue damage by exposure to underwater sound. Department of the Navy, Groton, Connecticut. 6 p.

Dark, S.J., R.J. Gutiérrez, and G.I. Gould, Jr. 1998. The barred owl (*Strix varia*) invasion in California. Auk 115(1):50-56.

Delaney, D.K. and T.G. Grubb. 2001. Effects of off-highway vehicle noise on northern spotted owls: sound data results. A report to the Mendocino National Forest, Contract # 43-91Z9-0-0055. Rocky Mountain Research Station.

Delaney, D.K., T.G. Grubb, P. Beier, L.L. Pater, and M.H. Reiser. 1999. Effects of helicopter noise on Mexican spotted owls. Journal of Wildlife Management 63(1):60-76.

Divoky, G.J., and M. Horton. 1995. Breeding and natal dispersal, nest habitat loss and implications for marbled murrelet populations. Pages 83-87 *in* C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds.). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Drent, R. 1972. The natural history of incubation. In: D. S. Farner, editor. Breeding Biology of Bird. Washington, D.C. National Academy of Science. Pages 262-311.

Dunbar, D.L., B.P. Booth, E.D. Forsman, A.E. Hetherington, and D.J. Wilson. 1991. Status of the spotted owl, *Strix occidentalis*, and barred owl, *Strix varia*, in southwestern British Columbia. Canadian Field Naturalist 105:464-468.

Evans Mack, D.M., W.P. Ritchie, S.K. Nelson, E. Kuo-Harrison, P. Harrison, and T.E. Hamer, compilers. 2003. Methods for surveying marbled murrelets in forests: a revised protocol for land management and research. Marbled Murrelet Technical Committee, Pacific Seabird Group. January 2, 2003. 76 pp.

Ford, R.G., G.K. Himes Boor, and J.C. Ward. 2001a. Final Report: Seabird mortality resulting from the *M/V New Carissa* oil spill incident, February and March 1999.

Ford, R.G., G.K. Himes Boor, B.E. Sharp, and J.L. Casey. 2001b. Final Draft Report: Estimates of bird impacts resulting from the *M/V Kure* Humboldt Bay oil spill of November 5, 1997. Unpublished Report. 79 pp.

Forsman, E. D. 1976. A prelimenary investigation of the spotted owl in Oregon. M. S. Thesis. Oregon State University, Corvalis, OR.

Forsman, E.D., R.G. Anthony, E.C. Meslow, and C.J. Zabel. 2004. Diets and foraging behavior of northern spotted owls in Oregon. Journal of Raptor Research 38(3):214-230.

Forsman, E.D., Anthony, R.G., Reid, J.A., Loschl, P. J., Sovern, S.G., Taylor, M., Biswell, B.L., Ellingson, A., Meslow, E.C., Miller, G.S., Swindle, K.A., Thrailkill, J.A., Wagner, F.F., and D.E. Seaman. 2002. Natal and breeding dispersal of northern spotted owls. Wildlife Monographs, No. 149. 35pp.

Forsman, E.D., I.A. Otto, S.G. Sovern, M. Taylor, D.W. Hays, H. Allen, S.L. Roberts, and D.E. Seaman. 2001. Spatial and temporal variation in diets of spotted owls in Washington. Journal of Raptor Research 35(2):141-150.

Forsman, E.D., Meslow, E.C., and H.M. Wight. 1984. Distribution and biology of the spotted owl in Oregon. Wildlife Monographs 87:1-64.

Franklin, J. and S. Courtney. 2004. Evolution and effectiveness of strategies for conservation of northern spotted owls. Pages 9-2 to 9-23 in Courtney et al. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute, Portland, OR.

Franklin, A.B., D.R. Anderson, R.J. Gutiérrez, and K.P. Burnham. 2000. Climate, habitat quality, and fitness in northern spotted owl populations in northwestern California. Ecological Monographs 70(4):539-590.

Franklin, A.B., K.P. Burnham, G.C. White, R.J. Anthony, E.D. Forsman, C. Sanchez, J.D. Nicols and J. Hines. 1999. Range-wide status and trends in northern spotted owl populations. Colorado Coop. Fish and Wildl. Res. Unit, Fort Collins, Colorado and Oregon Coop. Fish and Wildl. Res. Unit, Corvallis, Oregon. Unpublished report.

Franklin, A. B., R. J. Gutiérrez, B. R. Noon, and J. P. Ward, Jr. 1996. Demographic characteristics and trends of northern spotted owl populations in northwestern California. Pages 83-91 in E. D. Forsman et al., editors. Demography of the northern spotted owl. Studies in Avian Biology No. 17. Cooper Ornithological Society, Camarillo, CA.

Frid, A., and L. Dill. 2002. Human-caused disturbance stimuli as a form of predation risk. Conservation Ecology 6(1)11.

Friesen, V.L., T.P. Birt, J.F. Piatt, R.T. Golightly, S.H. Newman, P.N. Hebert, B.C. Congdon, and G.Gissing. In press. Population genetic structure and conservation of marbled murrelets (*Brachyramphus marmoratus*).

Fry, M. 1995. Pollution and fishing threats to marbled murrelets. Pages 257-260 *in* C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds.). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Fyfe, R. W. and R. R. Olendorff. 1976. Minimizing the dangers of nesting studies to raptors and other sensitive species. Can. Wildl. Serv. Occas. Paper 23. 17pp.

Glenn, E.M, M.C. Hansen, and R.G. Anthony. 2004. Spotted owl home-range and habitat use in young forests of western Oregon. Journal of Wildlife Management 68(1):33-50.

Gremel, S. 2000. Spotted owl monitoring in Olympic National Park: 2000 annual report. U.S. Department of the Interior, National Park Service, Olympic National Park, Port Angeles, Washington.

Gutiérrez, R.J. 1996. Biology and distribution of the northern spotted owl. Pages 2-5 *in* E.D. Forsman, S. DeStefano, M.G. Raphael, and R.J. Guiterrez (eds). Studies in Avian Biology No. 17.

Gutiérrez, R.J. 1994. Changes in the distribution and abundance of spotted owls during the past century. Studies in Avian Biology 15:293-300.

Gutiérrez, R. J., M. L. Cody, S. P. Courtney, and D. Kennedy. 2004. Assessment of the potential threat of the northern barred owl. Pages 7-2 to 7-51 in Courtney et al. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute, Portland, OR.

Gutiérrez, R.J., A.B. Franklin, and W.S. LaHaye. 1995. Spotted owl (*Strix occidentalis*) *in* A. Poole and F. Gill (eds). The birds of North America, No. 179. The Academy of Natural Sciences and The American Ornithologists' Union, Washington, D.C. 28pp.

Gutiérrez, R.J., A.B. Franklin, W. La Haye, V.J. Meretsky, and J.P. Ward. 1985. Juvenile spotted owl dispersal in northwestern California: preliminary analysis. Pages 60-65 *in* R.J. Gutiérrez, and A.B. Carey (eds). Ecology and Management of the Spotted Owl in the Pacific Northwest. USDA Forest Service GTR-PNW-185. Portland, Oregon.

Haig, S.M., T.D. Mullins, E.D. Forsman, P. Trail, and L. Wennerberg. 2004. Genetic identification of spotted owls, barred owls, and their hybrids: legal implications of hybrid identity. Conservation Biology 18:1347-1357.

Haig, S.M., Wagner, R.S., Forsman, E.D., and T.D. Mullins. 2001. Geographic variation and genetic structure in spotted owls. Conservation Genetics 2(1):25-40.

Hamer, T. E. 1988. Home range size of the northern barred owl and northern spotted owl in western Washington. M.S. Thesis. Western Washington University, Bellingham, WA.

Hamer, T.E. and E.B. Cummins. 1990. Forest habitat relationships of marbled murrelets in northwestern Washington. Unpubl. Report, Nongame Program, Washington Dept. of Wildlife, Olympia, WA. 51 pp.

Hamer, T.E. and S.K. Nelson. 1995. Characteristics of marbled murrelet nest trees and nesting stands. In: C. J. Ralph, G. L. Hunt, M. G. Raphael, and J. F. Piatt, technical editors. Ecology and Conservation of the Marbled Murrelet. Gen. Tech. Rept. PSW-GTR-152. Albany, California: Pacific Southwest Experiment Station, Forest Service, U.S. Dept. of Agriculture; 420 pp.

Hamer, T.E., S.K. Nelson, and T.I. Mohagen II. 2002. Nesting chronology of the marbled murrelet in North America. Final report submitted to U.S. Fish and Wildlife Service, Portland, Oregon.

Hamer, T.E., D.L. Hays, C.M. Senger, and E.D. Forsman. 2001. Diets of northern barred owls and northern spotted owls in an area of sympatry. Journal of Raptor Research 35(3):221-227.

Hamer, T.E., S.G. Seim, and K.R. Dixon. 1989. Northern spotted owl and northern barred owl habitat use and home range size in Washington: preliminary report. Washington Department of Wildlife, Olympia, Washington.

Hanson, E., Hays, D., Hicks, L. Young. L., and J. Buchanan. 1993. Spotted Owl Habitat in Washington: A Report to the Washington Forest Practices Board. Washington Forest Practices Board, Spotted owl Advisory Group. Final Report: December 20, 1993. Olympia, Washington. 116 pages.

Hebert, P.N., R.T. Golightly, HR Carter, and DL Orthmeyer. 2003a. The breeding biology of marbled murrelets nesting in Redwood National and State Parks, California. In: Hebert, P.N. and R.T. Golightly. Breeding biology and human-caused disturbance to nesting of marbled murrelets (*Brachyramphus marmoratus*) in northern California. Progress report 2002. Progress report submitted to U.S. Fish and Wildlife Service, Arcata, California.

Hebert, P.N., R.T. Golightly, HR Carter, and DL Orthmeyer. 2003b. At-sea distribution and movements of nesting and non-nesting marbled murrelets in northern California. In: Hebert, P.N. and R.T. Golightly. Breeding biology and human-caused disturbance to nesting of marbled murrelets (*Brachyramphus marmoratus*) in northern California. Progress report 2002. Progress report submitted to U.S. Fish and Wildlife Service, Arcata, California.

Hebert, P.N., R.T. Golightly, HR Carter, and DL Orthmeyer. 2003c. Evaluation of human-caused disturbance on the breeding success of marbled murrelets (*Brachyramphus marmoratus*) in Redwood National and State Parks, California. In: Hebert, P.N. and R.T. Golightly. Breeding biology and human-caused disturbance to nesting of marbled murrelets (*Brachyramphus marmoratus*) in northern California. Progress report 2002. Progress report submitted to U.S. Fish and Wildlife Service, Arcata, California.

Henke, A.L., T.Y. Chi, J. Smith, C. Brinegar. *Unpublished Draft*. Microsatellite Analysis of Northern and California Spotted Owls in California. Conservation Genetics Laboratory, Department of Biological Sciences, San Jose State University, San Jose, California.

Henson, P. and T.A.Grant. 1991. The effects of human disturbance on trumpeter swan breeding behavior. Wildlife Society Bulletin 19(3):248-257.

Herter, D.R., and L.L. Hicks. 2000. Barred owl and spotted owl populations and habitat in the central Cascade Range of Washington. Journal of Raptor Research 34(4): 279-286.

Hobson, K.A. 1990. Stable isotope analysis of marbled murrelets: evidence for fresh water feeding and determination of trophic level. Condor 92:897-903.

Huff, M.H., ed. [In press]. Northwest Forest Plan: the first ten years (1994-2003): status and tend of populations and nesting habitat for the marbled murrelet. Gen. Tech. Rep. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Huff, M., P. Jodice, J. Baldwin, S. Miller, R. Young, K. Ostrom, C.J. Ralph, M.G. Raphael, C. Strong, C. Thompson, and G. Falxa. 2003. Marbled murrelet effectiveness monitoring. Northwest Forest Plan 2002 Annual Summary Report (version 2). U.S. Department of Interior, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Pacific Southwest Research Station, Oregon State University, Crescent Coastal Research, Washington Department of Fish and Wildlife. September 2003. 27 pp.

Hull, C.L., G.W. Kaiser, C. Lougheed, L. Lougheed, S. Boyd, and F. Cooke. 2001. Intraspecific variation in commuting distance of marbled murrelets (*Brachyramphus marmoratus*): ecological and energetic consequences of nesting further inland. Auk 118:1036-1046.

Hunter, J.E., K.N. Schmidt, H.B. Stauffer, S.L. Miller, C.J. Ralph, and L. Roberts. 1998. Status of the marbled murrelet in the inner North Coast ranges of California. Northwestern Naturalist 79:92-103.

Jodice, P.G.R., and M.W. Collopy. 1999. Diving and foraging patterns of marbled murrelets (*Brachyramphus marmoratus*): testing predictions from optimal-breathing models. Canadian Journal of Zoology 77:1409-1418.

Jodice, P.G.R., J. Baldwin, D. Mack, T. Max, S. Miller, K. Nelson, K. Ostrom, C.J. Ralph, M. Raphael, C. Strong, C. Thompson, and R. Wilk. 2002. Marbled Murrelet Effectiveness Monitoring, Northwest Forest Plan, 2001 Annual Summary Report. U.S. Department of Interior; U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station and Pacific Southwest Research Station; Oregon State University; Crescent Coastal Research, Washington Department of Fish and Wildlife. March 2002. 18 pp.

Kelly, E.G. 2001. Range expansion of the northern barred owl: an evaluation of the impact on spotted owls. M.S. Thesis, Oregon State University, Corvallis, Oregon.

Kelly, E.G. and E.D. Forsman. 2004. Recent records of hybridization between barred owls (*Strix varia*) and northern spotted owls (*S. occidentalis caurina*). Auk 121:806-810.

Kelly, E.G., E.D. Forsman, and R.G. Anthony. 2003. Are barred owls displacing spotted owls? Condor 105:45-53.

King, G. M., G. S. Sargeant, D. R. McCullough, and E. E. Hanson. 1993. Habitat characteristics of northern spotted owls in eastern Washington. Final report for Cooperative Agreement PNW-90-684 between the USDA Forest Service and the Yakima Indian Nation.

Knight, R. L. and S. K. Knight Skagen. 1988. Effects of recreational disturbance on birds of prey: a review. In: R.L. Glinski et al., technical editors. Proceedings of the Southwest Raptor Management Symposium and Workshop. National Wildlife Federation Washington, D.C. Pages 355-359.

Kuletz, K.J., and J.F. Piatt. 1999. Juvenile marbled murrelet nurseries and the productivity index. Wilson Bulletin 111(2):257-261.

LaHaye, W.S. and R.J. Gutiérrez. 1999. Nest sites and nesting habitat of the northern spotted owl in northwestern California. Condor 101(2):324-330.

Leskiw, T. and R.J. Gutiérrez. 1998. Possible predation of a spotted owl by a barred owl. Western Birds 29:225–226.

Lint, et al. 2005. Northwest Forest Plan – The First Ten Years (1994-2003): Status and trend of northern spotted owl populations and habitat, PNW Station Edit Draft (Lint, Technical Coordinator, 2005). USDA Forest Service, PNW Research Station, PNW-GTR-____2005. Draft. Portland, OR 230pp

Long, L.L., and C.J. Ralph. 1998. Regulation and observations of human disturbances near nesting marbled murrelets. U.S. Forest Service, Pacific Southwest Research Station, Redwood Sciences Laboratory, Arcata, California. June 1998. 35 pp.

Luginbuhl, J.M., John M. Marzluff, Jeffrey E. Bradley, Martin G. Raphael, and Daniel E. Varland. 2001. Corvid survey techniques and the relationship between corvid relative abundance and nest predation. Journal of Field Ornithology 72(4): 556-572.

Mahon, T.E., G.W. Kaiser, and A.E. Burger. 1992. The role of marbled murrelets in mixed species feeding flocks in British Columbia. Wilson Bulletin 104:738-743.

Marshall, D.B. 1988. Status of the marbled murrelet in North America: with special emphasis on populations in California, Oregon, and Washington. Biological Report 88(30) USDI Fish and Wildlife Service, Portland, OR. 19pp.

Marzluff, J.M. and E. Neatherlin. In review. Corvid response to human settlement and recreation: causes, consequences, and challenges for managers. 51pp.

Marzluff, J.M., J.G. Raphael, and R. Sallabanks. 2000. Understanding the effects of forest management on avian species. Wildlife Society Bulletin 28:1132-1143.

Marzluff, J. M., M. G. Raphael, J. E. Bradley, J. M. Luginbuhl, and D. E. Varland. 1999. Diverse communities of nest predators: implications for murrelet breeding success. Pacific Seabirds Conference 26(1):40.

Mathews, N.J.C., and A.E. Burger. 1998. Diving depth of a marbled murrelet. Northwestern Naturalist 79:70-71

McShane, C., T. Hamer, H. Carter, G. Swartzman, V. Friesen, D. Ainley, R. Tressler, K. Nelson, A. Burger, L. Spear, T. Mohagen, R. Martin, L. Henkel, K. Prindle, C. Strong, and J. Keaney. 2004. Evaluation report for the 5-year status review of the marbled murrelet in Washington, Oregon, and California. Unpublished report. EDAW Inc., Seattle, Washington. Prepared for the US Fish and Wildlife Service, Region 1, Portland Oregon.

Meyer, C.B., S.L. Miller, and C.J. Ralph. 2002. Multi-scale landscape and seascape patterns associated with marbled murrelet nesting areas on the U.S. west coast. Landscape Ecology 17:95-115.

Miller, S.L. and C.J. Ralph. 1995. Relationships of marbled murrelets with habitat and vegetation characteristics at inland sites in California. *In* C.J. Ralph, G.L. Hunt, M. Raphael, and J.F. Piatt (Tech eds.). Ecology and conservation of the marbled murrelet.

Gen. Tech. Rept. PSW-GTR-152. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Dept. of Agriculture. 420 pp.

Miller, S. G., R. L. Knight, and C. K. Miller. 1998. Influences of recreational trails on breeding bird communities. Ecological Applications 8: 162-169.

Miller, G.S. 1989. Dispersal of juvenile spotted owls in western Oregon. M.S. Thesis. Oregon State University, Corvallis, Oregon.

National Research Council. 1995. Science and the Endangered Species Act. National Academy Press, Washington, D.C. 271 pp.

Nelson, S.K. 2005. Surveys for marbled murrelets in potential habitat in the Oregon coast range: Draft final report prepared for The Trustees Council of the New Carissa Oil Spill and the U.S. Fish and Wildlife Service. Oregon Cooperative Fish and Wildlife Research Unit, Oregon State University, Department of Fisheries and Wildlife, Corvallis, Oregon. 26 pp.

Nelson, S.K. 1997. Marbled murrelet (*Brachyramphus marmoratus*). In: Poole, A. and F. Gill, editors. The Birds of North America. Number 276. The Academy of Natural Sciences. Philadelphia, PA, and the American Ornithologist's Union, Washington, D.C. 32pp.

Nelson, S.K. and T.E. Hamer. 1995a. Nest success and the effects of predation on marbled murrelets. Pages 89-97 *in* C.J. Ralph, G.L. Hunt, M.G. Raphael, and J. F. Piatt, technical editors. Ecology and Conservation of the Marbled Murrelet. Gen. Tech. Rept. PSW-GTR-152. Albany, California: Pacific Southwest Experiment Station, Forest Service, U.S. Dept. of Agriculture; 420 pp.

Nelson, S.K., and T. Hamer. 1995b. Nesting biology and behavior of the marbled murrelet. Pages 57-67 *in* C. J. Ralph, G. L. Hunt, M. G. Raphael, and J. F. Piatt, technical editors. Ecology and Conservation of the Marbled Murrelet. Gen. Tech. Rept. PSW-GTR-152. Albany, California: Pacific Southwest Experiment Station, Forest Service, U.S. Dept. of Agriculture; 420 pp.

Nelson, S.K., and R.W. Peck. 1995. Behavior of marbled murrelets at nine nest sites in Oregon. Northwestern Naturalist 76:43-53.

Nelson, S.K., and A.K. Wilson. 2002. Marbled murrelet habitat characteristics on state lands in western Oregon. Final report, Oregon Cooperative Fish and Wildlife Research Unit, Oregon State University, Department of Fisheries and Wildlife, Corvallis. 151pp.

O'Halloran, K. 1989. Spotted owl inventory and monitoring: annual report for 1989. U.S. Forest Service, Pacific Northwest Region, Portland, Oregon. Unpublished report.

Olson, G.S., R.G. Anthony, E.D. Forsman, S.H. Ackers, P.J. Loschl, J.A. Reid, K.M Dugger, E.M. Glenn, and W.J. Ripple. 2005. Modeling of site occupancy dynamics for northern spotted owls, with emphasis on the effects of barred owls. Draft manuscript. OCWRU, OSU, Corvallis, OR. 45pgs.

Olson, G.S., E. Glenn, R.G. Anthony, E.D. Forsman, J.A. Reid, P.J. Loschl, and W.J. Ripple. 2004. Modeling demographic performance of northern spotted owls relative to forest habitat in Oregon. Journal of Wildlife Management. 68(4):1039-1053.

Oregon Department of Forestry. 2000. Forest Practices Administrative Rules and Forest Practices Act. Salem, OR.

Paton, W.C and C.J. Ralph. 1988. Geographic distribution of the marbled murrelet in California at inland sites during the 1988 breeding season. Pacific Southwest Forest and Range Experiment Station, Redwood Sciences Laboratory, 1700 Bayview Dr., Arcata, CA. Unpubl. document. 35pp.

Paton, W.C and C.J. Ralph. 1990. Surveying marbled murrelets at inland forested sites: a guide. Pacific Southwest Forest and Range Experiment Station, Redwood Sciences Laboratory, 1700 Bayview Dr., Arcata, CA. Unpubl. document. 9pp.

Pearson, R.R., and K.B. Livezey. 2003. Distribution, numbers, and site characteristics of spotted owls and barred owls in the Cascade Mountains of Washington. Journal of Raptor Research 37(4):265-276.

Peery, Z., S.R. Beissinger, B. Becker, and S. Newman. 2003a. Post-breeding season movements and distribution of marbled murrelets in central California. Unpublished preliminary report.

Peery, Z., S.R. Beissinger, B. Becker, and S. Newman. 2003b. Marbled murrelet (*Brachyramphus marmoratus*) demography in central California: 2002 progress report. Preliminary draft unpublished report.

Peery, Z., S.R. Beissinger, B. Becker, and S. Newman. 2002. Marbled murrelet (*Brachyramphus marmoratus*) demography in central California: 2001 progress report. Unpublished report, 21pp.

Piatt, J.F., B.D. Roberts, W.W. Lidster, J.L. Wells, and S.A. Hatch. 1990. Effects of human disturbance on breeding least and crested auklets at St. Lawrence Island, Alaska. Auk 107:342-350.

Popper, A.N. 2003. Effects of Anthropogenic Sounds of Fishes. Fisheries 28(10):24-31.

Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt, technical editors. 1995a. Ecology and conservation of the marbled murrelet. Gen. Tech. Rep. PSW-GTR-152. Albany, California.: Pacific Southwest Experiment Research Station, Forest Service, U.S. Department of Agriculture; 420 pp.

Ralph, C.J., G.L. Hunt, Jr., MG. Raphael, and J.F. Piatt. 1995b. Ecology and conservation of the marbled murrelet in North America: An overview. Pages 3-22 *in* C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt, technical editors. Ecology and Conservation of the Marbled Murrelet. Gen. Tech. Rept. PSW-GTR-152. Albany, California: Pacific Southwest Experiment Station, Forest Service, U.S. Dept. of Agriculture; 420 pp.

Raphael, M.G., D.E. Evans Mack, and B.A. Cooper. 2002. Landscape-scale relationships between abundance of marbled murrelets and distribution of nesting habitat. Condor 104:331-342.

Raphael, M.G., J.A. Young, and B.M. Galleher. 1995. A landscape-level analysis of marbled murrelet habitat in western Washington. Pages 177-189 *In* C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (Tech, eds.), Ecology and Conservation of the Marbled Murrelet. Gen. Tech. Rept. PSW-GTR-152. Albany, California: Pacific Southwest Experiment Station, Forest Service, U.S. Dept. of Agriculture. 420 pp.

Rosenberg, D.K., K.A. Swindle, and R.G. Anthony. 2003. Influence of prey abundance on northern spotted owl reproductive success in western Oregon. Canadian Journal of Zoology 81:1715-1725.

Ross, B.P., J. Lien, and R.W. Furness. 2001. Use of underwater playback to reduce the impact of eiders on mussel farms. Journal of Marine Science 58:517-524.

Simon-Jackson, T. 1989. Spotted owl inventory and monitoring program: annual report for 1989. USDA Forest Service, Pacific Southwest Region, San Francisco, CA. Unpublished report.

Sovern, S.G., E.D. Forsman, B.L. Biswell, D.N. Rolph, and M. Taylor. 1994. Diurnal behavior of the spotted owl in Washington. Condor 96(1):200-202.

Speckman, S.G. 1996. Marbled murrelet distribution and abundance in relation to the marine environment. Master's Thesis, University of Alaska, Fairbanks, Alaska. August 1996.

Speckman, S.G., J.F. Piatt, and A.M. Springer. 2003. Deciphering the social structure of marbled murrelets from behavioral observations at sea. Waterbirds 26(3):266-274.

Strachan, G., M. McAllister, and C.J. Ralph. 1995. Marbled murrelet at-sea foraging behavior. Pages 247-254 *in* C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds.). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp

Strong C. 2004. Marbled murrelet abundance and reproductive indices in or during 2003. Final report submitted to U.S. Fish and Wildlife Service, Portland, Oregon.

Strong, C.S., B.K. Keitt, W.R. McIver, C.J. Palmer, and I. Gaffney. 1995. Distribution and population estimates of marbled murrelets at sea in Oregon during the summers of 1992 and 1993. Pages 339-352 *in* C.J. Ralph, G.L. Hunt, M.G. Raphael, and J.F. Piatt (eds.). Ecology and conservation of the marbled murrelet. General Technical Report. PSW-GTW-152. Pacific Southwest Experimental Station, U.S. Forest Service, Albany, California. 420 pp.

Swarthout, E. C. H. and R. J. Steidl. 2001. Flush response of Mexican spotted owls to recreationists. Journal of Wildlife Management **65**:312-317.

Swenson, J. E. 1979. Factors affecting status and reproduction of ospreys in Yellowstone National Park. Journal of Wildlife Management 43:595-601.

Sztukowski, L., and S. P. Courtney. 2004. Prey. Pages 4-2 to 4-32 in Courtney et al. Scientific evaluation of the status of the northern spotted owl. Sustainable Ecosystems Institute, Portland, OR.

Thomas, J.W., and M.G. Raphael (Eds.) 1993. Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. Report of the Forest Ecosystem Management Assessment Team (FEMAT). July 1993. Portland, Oregon: USDA Forest Service and the USDI Bureau of Land Management.

Thomas, J.W., M.G. Raphael, R.G. Anthony, E.D. Forsman, A.G. Gunderson, R.S. Holthausen, B.G. Marcot, G.H. Reeves, J.R. Sedell, and D.M. Solis. 1993. Viability assessments and management considerations for species associated with late-successional and old-growth forests of the Pacific Northwest. USDA Forest Service, Portland, Oregon.

Thomas, J.W., E.D. Forsman, J.B. Lint, E.C. Meslow, B.R. Noon, and J. Verner. 1990. A conservation strategy for the northern spotted owl. Report of the Interagency Scientific Committee to address the conservation of the northern spotted owl. Unpublished interagency document. 458pp.

Tremblay, J. and L.N. Ellison. 1979. Effects of human disturbance on breeding black-crowned night herons. Auk 96:364-369.

USDA Forest Service, and USDI Bureau of Land Management. 1994a. Final supplemental environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. Portland, Oregon. 2 vols. and appendices.

USDA Forest Service, and USDI Bureau of Land Management. 1994b. Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl; standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. Portland, Oregon.

USDI Fish and Wildlife Service. 2004a. Marbled murrelet 5-year review process: overview. Portland, Oregon. 28 pp.

USDI Fish and Wildlife Service. 2003. Current estimates of marbled murrelet in 2003. Compiled for the 5-year review. Portland, Oregon.

USDI Fish and Wildlife Service. 1997. Recovery plan for the threatened marbled murrelet (*Brachyramphus marmoratus*) in Washington, Oregon, and California. Portland, Oregon. 203 pp.

USDI Fish and Wildlife Service.1996. Endangered and threatened wildlife and plants; Final designation of critical habitat for the marbled murrelet; final rule. Fish and Wildlife Service. Federal Register 102:26256-26320.

USDI Fish and Wildlife Service. 1995. Endangered and threatened wildlife and plants; proposed special rule for the conservation of the northern spotted owl on non-federal lands. Federal Register 60:9484-9495.

USDI Fish and Wildlife Service. 1994. Biological Opinion for the Preferred Alternative (9) of the Supplemental Environmental Impact Statement on Management of Habitat for Late Successional and Old-Growth Forest Within the Range of the Northern Spotted Owl. 53pp.

USDI Fish and Wildlife Service. 1992a. Draft final recovery plan for the northern spotted owl. USDI Fish and Wildlife Service. 2 Volumes. Portland, Oregon.

USDI Fish and Wildlife Service. 1992b. Endangered and threatened wildlife and plants; Determination of threatened status for the Washington, Oregon, and California population of the marbled murrelet. Final rule. Fish and Wildlife Service. Federal Register 191:45328-45337. October 1, 1992.

USDI Fish and Wildlife Service. 1990a. Endangered and Threatened Wildlife and Plants; determination of threatened status for the northern spotted owl. Federal Register Vol. 55. No. 123: 26114-26194. June 26, 1990.

USDI Fish and Wildlife Service. 1990b. The 1990 status review: northern spotted owl: *Strix occidentalis caurina*. Report to the U.S. Fish and Wildlife Service, Portland, Oregon. 95pp.

USDI Fish and Wildlife Service and USDC National Marine Fisheries Service. 1999. biological and conference opinions regarding issuance of an incidental take permit to the Pacific Lumber Company, Scotia Pacific Company LLC and Salmon Creek Corporation. February 24, 1999.

USDI, Fish and Wildlife Service and USDC National Marine Fisheries Service. 1998. Endangered Species Consultation Handbook Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act. U.S. Government Printing Office, Washington, D.C.

Ward, J.W. Jr., R.J. Gutiérrez, and B.R. Noon. 1998. Habitat selection by northern spotted owls: the consequences of prey selection and distribution. Condor 100:79-92.

Washington Forest Practices Board. 1996. Permanent rules for the northern spotted owl. Washington Department of Natural Resources, Olympia, Washington.

Wasser, S.K., K. Bevis, G. King, and E. Hanson. 1997. Noninvasive physiological measures of disturbance in the northern spotted owl. Conservation Biology 11:1019-1022.

Weathers, W.W., P.J. Hodumand, and J.A. Blakesley. 2001. Thermal ecology and ecological energetics of California spotted owls. Condor 103:678-690.

Weidemeier, D.J. and S.P. Horton. 2000. Trends in spotted owl and barred owl detections in the Olympic Experimental State Forest from 1991 to 1999. Northwestern Naturalist 81(3):63.

White, C. M., and T. L. Thurow. 1985. Reproduction of ferruginous hawks exposed to controlled disturbance. The Condor **87**:14-22.

Williams, D. F., J. Verner, H. F. Sakai, and J. R. Waters. 1992. General biology of major prey species of the California spotted owl. General technical report. PSW-133. USDA Forest Service, Pacific Southwest Research Station, Arcata, CA.

Yelverton, J.T., and D.R. Richmond. 1981. Underwater explosion damage risk criteria for fish, birds, and mammals. 19 pages *in* Proceedings of the 102nd meeting of the Acoustic Society of America, December 4, 1981, Miami Beach, Florida.

Zabel, C.J., J.R. Dunk, H.B. Stauffer, L.M. Roberts, B.S. Mulder, and A. Wright. 2003. Northern spotted owl habitat models for research and management application in California (USA). Ecological Applications 13(4):1027-1040.

Zabel C.J., S.E. Salmons, and M. Brown. 1996. Demography of northern spotted owls in southwestern Oregon. Studies in Avian Biology 17:77-82.

Zabel, C.J., K.M. McKelvey, and J.P. Ward, Jr. 1995. Influence of primary prey on home-range size and habitat-use patterns of northern spotted owls (*Strix occidentalis caurina*). Canadian Journal of Zoology 73:433-439.

PERSONAL COMMUNICATIONS

Accord, B. 2004. Humboldt State University, Arcata, California. March 8, 2004.

Brickey, A. 2004. US Fish and Wildlife Service, Arcata, California. November 22, 2004.

Huff, M. 2005. US Fish and Wildlife Service, Portland, Oregon. July 7, 2005.

Peery, Z. 2004. University of California Berkeley, Berkeley, California. March 30, 2004.

Table 1. Suitable NSO habitat removed or downgraded (1994-December 20, 2005) due to Federal management actions and natural events by physiographic province.

		Habitat Removed/Downgraded 1994-2005						
Physiographic Province	Estimated acres of habitat in 1994	Management[1]	Fire[2]	Wind	Insect/ disease	Total	%	Proportion of Total Range-wide Habitat Loss (%)
WA								
Olympic Peninsula	560,217	-91	-299	0	0	-390	<0.1	<0.1
East Cascades	706,849	-5,991	-5,754	0	0	-11,745	1.7	2.8
West Cascades	1,112,480	-12,181	0	0	-250	-12,431	1.1	3.0
Western Lowlands	0	0	0	0	0	0	0	0
OR								
Coast Range	516,577	-4,544	-66	0	0	-4,478	0.9	1.1
Klamath Mountains	786,298	-82,735	-117,622	0	0	-200,357	25.5	48.5
Cascades East	443,659	-10,595	-4,008	0	-55,000	-69,603	15.7	16.7
Cascades West	2,045,763	-55,453	-25,583	0	0	-81,036	4.0	19.6
Willamette Valley	5,658	0	0	0	0	0	0	0
CA								
Coast Range	51,494	-250	-100	0	0	-350	0.7	<0.1
Cascades	88,237	-4,808	0	0	0	-4,808	5.5	1.2
Klamath Mountains	1,097,866	-11,080	-15,869	-100	-390	-27,439	2.5	6.6
Total	7,397,098	-187,728	-168,301	-100	-55,640	-412,637	5.6	NA

[1] Habitat removed/downgraded from management related actions is from a December 20, 2005, query of the NWFP and section 7 consultation effects tracker. Reported acres represent acres that action agencies have consulted-on with the Service. Therefore, these acres include both realized and expected habitat modification through consulted-on federal actions.
[2] Habitat removed/downgraded from natural events is from Courtney et al. (2004). Because the data are not yet available, habitat effects from fires occurring since 2003 are not included in this table.

Table 2. Estimated acreage of potentially occupied marbled murrelet nesting habitat at various landscape scales within the species' listed range (USDI Fish and Wildlife Service 2003).

Landscape scale[1]	Acres
Washington	
MMCZ1	No estimate available
MMCZ2	No estimate available
TOTAL	No estimate available
Oregon	
MMCZ3 and 4	408,621
TOTAL	408,621
California	
MMCZ4(CA)	67,618[2]
MMCZ5	430
MMCZ6	7,250
TOTAL	75,298
2 State (Oregon and California)	
OR	408,621
CA	75,298
TOTAL	**483,919**

1 MMCZ = Marbled Murrelet Conservation Zone.

2 Recently adjusted to include Humboldt Redwoods State Park acres: 8,672 from USDI Fish and Wildlife Service and USDC National Marine Fisheries Service 1999.

Table 3. Marbled murrelet population point estimates and associated 95 percent confidence intervals (CI) by Zone within the listed range.

	2000 Population Point Estimate	95 % CI	2001 Population Point Estimate	95 % CI	2002 Population Point Estimate	95 % CI	2003 Population Point Estimate	95 % CI	2004 Population Point Estimate	95% CI	2005 Population Point Estimate	95% CI
Zone 1[1]	5,600	2,700 – 8,900	8,900	5,800 – 11,900	9,700	6,000 – 13,800	8,500	5,700 – 11,700	5,500	3,000-7,400	8,000	4,800-11,600
Zone 2[1]	800	500 – 1,200	1,700	500 – 3,800	2,600	800 – 3,800	3,300	2,000 – 5,000	3,100	1,700-4,600	2,500	1,600-3,600
Zone 3[1]	6,700	4,000 – 10,100	7,500	5,500 – 9,300	6,300	4,000 – 10,000	5,900	3,900 – 7,600	7,800	5,900-9,800	5,800	3,600-7,300
Zone 4[1]	4,900	3,800 –9,500	3,900	3,000 – 6,700	4,900	3,500 – 6,400	4,500	3,400 – 6,700	4,200	3,100-9,200	3,600	2,700-6,000
Zone 5[1]	100	0 – 300	100	18 - 300	300	30 - 400	50	0 - 90	80	20-200	300	100-500
Zone 6[2]	474	337 - 668	615	515 - 733	619	476 - 805	699	567-860	---	---		---
TOTAL	18,571		22,180		23,673		22,217		20,578		20,223	

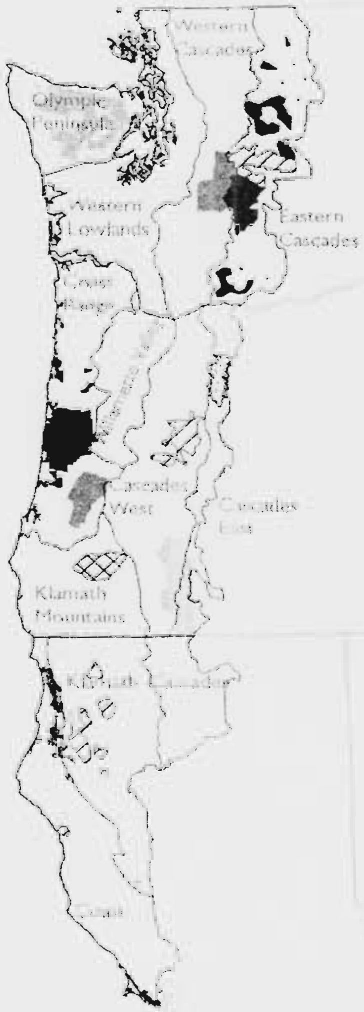
[1] Data for Zones 1 through 5 as follows: years 2000 through 2002 from Huff et al. 2003. Year 2003 from Huff ed. in press. Year 2004 from Huff, pers. comm. Numbers are rounded to nearest 100.

[2] Data for Zone 6 as follows: years 2000 and 2001 from Peery et al. 2002; year 2002 from Peery et al. 2003b; year 2003 from Z. Peery, pers. comm. 2004. No survey in 2004 and 2005.

Table 4. The estimated values for demographic parameters used in four population models for the murrelet.

Demographic Parameter	Beissinger 1995	Beissinger and Nur 1997–cited in USDI[1] 1997	Beissinger and Peery 2003	McShane et al. 2004
Juvenile to Adult Ratio	0.10367	0.124 or 0.131	0.089	0.02 - 0.09
Annual Fecundity	0.11848	0.124 or 0.131	0.06-0.12	(See nest success)
Nest Success			0.16-0.43	0.38 - 0.54
Maturation	3	3	3	2 - 5
Estimated Adult Survivorship	85 - 90%	85 - 88%	82 - 90%	83 - 92%

[1]Fish and Wildlife Service



	Demographic Study Area	Land Ownership	# Owls Banded	Fecundity	Apparent Survival	λ_{RJS}	Population Trend Based on $\Delta\lambda$
	Washington						
■	Wenatchee (WEN)	Private	1,200	Stable	Declining	0.917	Declining
■	Rainer (RAI)	USFS	217	Stable	Declining	0.896	Declining
■	Olympic (OLY)	NPS & USFS	985	Stable	Declining	0.956	Declining
▨	Cle Elum (CLE)	USFS	724	Declining[1]	Declining?[2]	0.938	Declining
	Oregon						
■	Oregon Coast Range (COA)	USFS & BLM	1,025	Declining?[1]	Stable	0.968	Declining
■	Tyee (TYE)	BLM & Private	1,032	Increasing	Stable	1.005	Stationary
■	South Oregon Cascades (CAS)	USFS & BLM	881	Declining	Stable	0.974	Stationary
▨	H.J. Andrews (HJA)	USFS	1,095	Stable?[3]	Stable	0.978	Declining
⊠	Klamath (KLA)	BLM & Private	1,147	Stable	Stable	0.997	Stationary
▒	Warm Springs (WSR)	Tribal	381	Stable	Stable	0.908	Declining
	California						
■	Marin (MAR)	NPS	96	Stable	Stable	NA	NA
■	Simpson (SIM)	Private	1,344	Declining[1]	Stable	0.970	Declining
■	Hoopa (HUP)	Tribal	279	Increasing	Stable	0.980	Stationary
▨	NW California (NWC)	USFS	1,026	Declining	Declining	0.985	Declining?[4]

[1] Best model included age and even-odd year effects, but a competing model had a negative time effect on productivity.
[2] Variable among years, but with a declining trend.
[3] Decreasing in early years, increase in last 5 years, stable overall.
[4] Gradual declines in fecundity and apparent survival, plus estimates of realized population change suggest a decline in last 8 years.

Figure 1. Physiographic provinces, northern spotted owl demographic study areas, and demographic trends. (Anthony *et al.* 2004).

KARUK TRIBE OF CALIFORNIA

DEPARTMENT OF NATURAL RESOURCES
P.O. Box 282 ? Orleans, California 95556

WATER QUALITY ASSESSMENT REPORT

(CWA Section 305(b) Reporting)

APRIL 2001

Printed on partially recycled paper.

Cover photograph: **Traditional dip net fishing at Ishi Pishi Falls on the Klamath River.**

Pictured are Ron Reed (fishing) and Scott Quinn (the clubber).

ACKNOWLEDGMENTS

The principal authors of this Clean Water Act Section 305(b) Tribal water quality assessment report are listed below:

Stephen W. Johnson, Ph.D., Water Quality Hydrologist, Water Quality Technology, Inc.
Terry A. Geiselman, R.G. Registered Geologist, Water Quality Technology, Inc.

This report has been produced under the direction and guidance of Scott Quinn, Water Quality Coordinator for the Karuk Tribe of California's Department of Natural Resources.

The following individuals and agencies provided valuable information used to produce this report:

- Willis and Florence Conrad
- Bill Tripp, KTOC Department of Natural Resources
- Sandi Tripp, KTOC Department of Natural Resources
- Harold "Little Man" Tripp, KTOC Department of Natural Resources
- Ron Reed, Fisheries Biologist, KTOC Department of Natural Resources
- Bob Rohde, Previously with the KTOC Department of Natural Resources
- Leaf Hillman, Director KTOC Department of Natural Resources
- Paul Zedonis, Arcata U.S. Fish & Wildlife Service
- John Hannum, Klamath National Forest Service
- Jan Peterson, Wildlife Biologist, Fort Collins, Colorado

CONTENTS

Page

1.0 Executive Summary/Overview 1-1

2.0 Background 2-1
- 2.1 Resources Overview 2-2
- 2.2 Total Waters 2-2
- 2.3 Water Pollution Control Program 2-3
- 2.4 Cost/Benefit Assessment 2-6
- 2.5 Special Concerns and Recommendations 2-8

3.0 Surface Water Assessment 3-1
- 3.1 Current Surface Water Monitoring Program 3-1
- 3.2 Plan for Achieving Comprehensive Assessments 3-1
- 3.3 Assessment Methodology and Summary Data 3-2
- 3.4 Rivers and Streams Water Quality Assessment 3-5
- 3.5 Lakes Water Quality Assessment 3-14
- 3.6 Estuary and Coastal Assessment 3-24
- 3.7 Wetlands Assessment 3-24
- 3.8 Public Health/Aquatic Life Concerns 3-32

4.0 Ground Water and Assessment 4-1
- 4.1 Summary of Ground Water Contaminant Sources 4-1
- 4.2 Summary of Ground Water Protection Programs 4-1
- 4.3 Summary of Ground Water Quality 4-4
- 4.4 Summary of Ground Water - Surface Water Interaction 4-4

5.0 References 5-1

APPENDIX A Photographs of Tribal Waters

TABLES

Table **Page**

2-1 Atlas of Tribal Resources for the KTOC Trust Lands 2-3
3-1 Summary of Fully Supporting, Threatened, and Impaired Streams and Rivers 3-7
3-2 Individual Use Support Summary for Rivers and Streams 3-8
3-3 Total Sizes of Rivers and Streams Impaired by Various Cause/Stressor Categories ... 3-9
3-4 Total Sizes of Rivers and Streams Impaired by Various Source Categories 3-10
3-5 Summary of Fully Supporting, Threatened, and Impaired Lakes 3-15
3-6 Individual Use Support Summary for Lakes 3-17
3-7 Total Sizes of Lakes Impaired by Various Cause/Stressor Categories 3-18
3-8 Total Sizes of Lakes Impaired by Various Source Categories 3-19
3-9 Trophic Status of Significant Publicly Owned Lakes 3-22
3-10 Acid Effects on Lakes 3-23
3-11 Existing and Needed Wetlands Protection Mechanisms 3-29
3-12 Summary of Contaminants Used in the Drinking Water Use Assessment 3-34
4-1 Major Potential Sources of Ground Water Contamination 4-2
4-2 Summary of Tribal Ground Water Protection Programs 4-5

FIGURES

Figure

1-1 Karuk Tribe of California Trust Lands Location Map 1-2
1-2 Degree of Use Support for Waterbodies within the KTOC Trust Lands 1-3

1.0 EXECUTIVE SUMMARY/OVERVIEW

This Clean Water Act (CWA) Section 305(b) Tribal water quality assessment report constitutes the Karuk Tribe of California's (KTOC) first water quality assessment of Tribal waters on the Karuk Tribe of California's Trust Lands (KTOC Trust Lands) under the KTOC's Department of Natural Resources CWA Section 106 Water Pollution Control Program. It is the primary means by which the Karuk Tribe, the U.S. Environmental Protection Agency (USEPA), the U.S. Congress, and the public will evaluate Tribal waters on the KTOC Trust Lands with respect to (1) the quality of rivers and streams, lakes, wetlands, and ground water; (2) pollutants and pollutant sources causing water quality impairment; (3) the need for and success of water quality management programs; and (4) the need for comprehensive monitoring and assessment plans. This water quality assessment report is an important first step in the process of proactively monitoring, assessing, protecting, and restoring the quality of Tribal waters.

The Karuk Tribe of California (Karuk Tribe) is a federally recognized Indian Tribe (Federal Register, Vol. 51, No. 132, July 10, 1986) occupying tribal and individual trust lands along the middle course of the Klamath and Salmon rivers in northern California (**Figure 1-1**). The KTOC Trust Lands constitute disconnected land areas scattered along the Klamath River between Yreka and Orleans, California, with Tribal centers and administrative facilities located in Happy Camp, Orleans, and Yreka.

A map displaying the degree of beneficial use support for rivers and streams and lakes is provided in ***Figure 1-2***. Tribal rivers and streams, lakes, wetlands, and ground water are assessed in this report with respect to water quality impairment based on beneficial use support of each water resource. Overall use support is not supporting for rivers and streams and supporting but threatened for lakes, wetlands and ground water. Major causes/stressors contributing to impairment of Tribal waters include: pesticides, metals, nutrients, habitat alterations, and flow alterations. Major sources of impairment to Tribal waters are hydromodification, agricultural crop-related (agricultural irrigation return flows), resource extraction, and septic releases. The predominant sources of use support impairment to Tribal waterbodies are located upstream or upgradient of the KTOC Trust Lands.

2.0 BACKGROUND

The objective of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. One goal of the CWA is to protect surface waters so that they may provide beneficial uses, such as fishing and swimming. Beneficial uses for fishing include aquatic life support and fish consumption. Beneficial uses for swimming include swimming, wading, boating, and other recreational uses on and in the water. An additional goal of KTOC is to protect cultural beneficial uses and the beneficial uses of ground water, especially drinking water and other domestic uses. The primary objective for water resources on the KTOC Trust Lands is to protect potential and existing beneficial uses of Tribal waters.

2.1 Resources Overview

A resource overview for the KTOC Trust Lands is provided in ***Table 2-1***. The 1,168 acres of KTOC Trust Lands are most often situated along water courses, especially the Klamath River and its tributary streams. The single lake on the KTOC Trust Lands is the Sacred Pond at Katimin, which is located at a spring source. The acreage of wetlands on the KTOC Trust Lands was estimated using streambed acreages combined with the following riparian widths for each side of the stream: Klamath River (150 foot), Salmon River (100 foot), and all other creeks and gulches (50 foot). For the Sacred Pond at Katimin, the riparian area was determined to be twice the acreage of the pond or twice 0.16 acres for a total wetlands area of 0.32 acres.

Much of the KTOC Trust Lands are located along the Klamath River. The main stem of the Klamath River and many of its tributary streams are used by spring and fall Chinook salmon, Coho, and spring and fall steelhead. Pacific lamprey and green sturgeon also use the main stem Klamath River. The main stem Klamath River is a migration corridor between the ocean and tributary streams, though Chinook are known to spawn in the main stem. The overall temporal trend in anadromous fish for the Klamath River basin reflect long-term declines.

The KTOC Trust Lands are located in the central Klamath Mountains. In this area, the coastal climatic influence is moderated by the mountains to the west. Summers are warm and dry, winters are cool and wet. Summer high temperatures are approximately 90ºF, and low temperatures are approximately 55ºF. Winter high temperatures are approximately 40 to 55ºF while raining, and are cooler under clear skies. The annual precipitation during the period of record (1904 to present) at Orleans ranges from 26 to 84 inches. The average annual precipitation is approximately 50 inches. Approximately 90% of the precipitation occurs from October through May from north Pacific cyclonic storms. The distribution of precipitation over time influences the behavior of erosion and land sliding processes, water quality, and the structure of stream channels.

The majority of the Klamath River Basin lies in the older, geologically diverse Klamath Mountains. Rocks range from granites to metamorphics (including serpentine), and range in age from the pre-Silurian to late Jurassic periods. The geology of the area is complicated by multiple fold systems and numerous faults of varying magnitudes.

On steep slopes, the upland soils tend to be unstable, and slope stability hazards are common throughout the Klamath River Basin. Canyon lands along all major drainages contribute to the high incidence of mass wasting and subsequent potential for erosion. Mass wasting commonly occurs as debris slides but can occur as landslides, affecting large acreages and causing major destruction. These effects are increased by the high density of roads within the middle portion of the Klamath River basin. Regardless of the form, much of the displaced material often enters a stream course and can block streams, destroy riparian vegetation, degrade potential juvenile salmonid rearing habitat, and cover potential spawning gravels. The west side of the Klamath Basin is more subject to mass wasting because of higher annual rainfalls and higher intensity precipitation.

2.2 Total Waters

Major Tribal waters on the KTOC Trust Lands are as follows:

- Ishi Pishi Falls
- Sacred Pond at Katimin
- Klamath River and tributary reaches
- Salmon River and tributary reaches
- Ground water underlying KTOC Trust Lands

The Karuk Tribe would like to maintain and protect the quality of ground water underlying the KTOC Trust Lands. The protection of recharge zones is a priority under the Karuk Tribe's Water Pollution Control Program.

Table 2-1. Atlas of Tribal Resources for the KTOC Trust Lands

Topic	Value
Trust lands population (enrolled Tribal members)	359
Trust lands surface area (acres)	1,168
Total miles of rivers and streams	11.37
– Miles of perennial rivers/streams (subset)	11.06
– Miles of intermittent (nonperennial) streams (subset)	0.31
– Miles of ditches and canals (subset)	?
– Border miles of shared rivers/streams (subset)	8.68
Number of lakes/reservoirs/ponds	1
Number of significant tribally owned lakes/reservoirs/ponds (subset)	1
Acres of lakes/reservoirs/ponds	0.16
Acres of significant tribally owned lakes/reservoirs/ponds (subset)	0.16
Square miles of estuaries/harbors/bays	0
Miles of ocean coast	0
Miles of Great Lakes shore	0
Acres of freshwater wetlands	194.2
Acres of tidal wetlands	0

2.3 Water Pollution Control Program

The KTOC Department of Natural Resources administers the Karuk Tribe's Water Pollution Control Program (WPCP) and is responsible for protecting the environment and public health on the KTOC Trust Lands. Under the WPCP, the KTOC Department of Natural Resources is developing water quality standards, monitoring the quality of Tribal waters, and assessing water quality conditions.

2.3.1 Watershed Approach

The KTOC Trust Lands are located entirely within the Klamath River watershed. The approach used for watershed protection is to identify potential contaminant sources to waterbodies within the KTOC Trust Lands and develop strategies for the protection of Tribal waters. There are land uses outside of the KTOC Trust Lands that have the potential to adversely affect the quality of Tribal waters. These land uses have generally been tied to natural resource development, including fisheries, logging, mining, and agriculture. There are only two public water systems (PWS) (one at Happy Camp and the other at Orleans) located nearby the KTOC Trust Lands, so most residents rely on individual wells or surface water for domestic use. Most homes rely on septic systems for wastewater treatment; however, a non-discharging wastewater treatment plant has been constructed to serve the community of Happy Camp. The treatment plant uses constructed wetlands for passive treatment. It is located adjacent to the Klamath River floodplain and discharges to the ground water system as opposed to a point source discharge to the river.

2.3.2 Water Quality Standards Program

KTOC has developed proposed water quality standards for both surface and ground waters. The KTOC Department of Natural Resources is the lead Tribal agency responsible for developing and enforcing water quality standards on the KTOC Trust Lands. At a minimum, all Tribal waters must have designated uses that meet the goals of Section 101 (a) (2) of the CWA unless the results of a use attainability analysis (UAA) show that the CWA

Section 101 (a) (2) goals cannot be achieved. These goals include providing for the protection and propagation of fish, shellfish, and wildlife and for recreation in and on the water.

Designated uses of Tribal waters, including wetlands, are listed below:

- Agricultural Supply (AGR)
- Aquaculture (AQUA)
- Aesthetic Quality (ASQ)
- Preservation of Areas of Special Biological Significance (BIOL)
- Cold Freshwater Habitat (COLD)
- Cultural Contact Water (CUL-1)
- Cultural Non-Contact Water (CUL-2)
- Fish Consumption (FC)
- Freshwater Replenishment (FRSH)
- Groundwater Recharge (GWR)
- Industrial Service Supply (IND)
- Livestock Watering (LIV)
- Migration of Aquatic Organisms (MIGR)
- Municipal and Domestic Supply (MUN)
- Navigation (NAV)
- Hydropower Generation (POW)
- Industrial Process Supply (PROC)
- Rare, Threatened, or Endangered Species (RARE)
- Water Contact Recreation (REC-1)
- Non- Contact Water Recreation (REC-2)
- Spawning, Reproduction, and/or Early Development (SPWN)
- Warm Freshwater Habitat (WARM)
- Wildlife Habitat (WILD)

The following general water quality objective is proposed to apply to all Tribal waters of the KTOC Trust Lands:

> *Whenever the existing quality of water is better than the water quality objectives established herein, such existing quality shall be maintained unless otherwise provided by the provisions of tribal law.*

The following proposed water quality standard would apply to listed and unlisted outstanding waters:

> *There shall be no degradation of water quality caused by a point or non-point source discharge. Public land managers are accountable for water quality protection. No exemption is allowed for logging or grazing as part of the accountability of public land managers for water quality protection.*

The following two Tribal waters are proposed for classification as outstanding waters:

- Ishi Pishi Falls
- Sacred Pond at Katimin

2.3.3 Point Source Program

There are no NPDES (National Pollutant Discharge Elimination System) outfalls within the KTOC Trust Lands.

2.3.4 Nonpoint Source Program

The Karuk Tribe has a Section 319 Nonpoint Source Control Program. The pollutant sources of concern potentially affecting Tribal waters are entirely derived from nonpoint sources which are not quantifiable, but are related to water quality impairment conditions, such as road building and herbicide spraying on Forest Service lands, acid mine drainage from abandoned mines, damming and dam releases by the U.S. Bureau of Reclamation, and nutrient loading upstream and outside of the KTOC Trust Lands on the Klamath River.

When the only sources of water quality impairment to a waterbody are from nonpoint sources, these “pollutants” are more appropriately referred to as “indicators” of water quality impairment in need of best management practices (BMPs). BMP implementation can then be evaluated with respect to its effectiveness using nonpoint source “pollution reduction targets”, not waste loads or loads using the TMDL process. An example of a traditional BMP followed by the Karuk people is the practice of cleaning salmon in a side channel at Katimin, as opposed to the main river course in an effort to ensure that fish cleaning wastes do not contaminate the river water quality or alert downstream fish to the presence of upstream fishermen.

In response to nonpoint sources of pollution, the Department of Natural Resources has invested substantial resources in a state-of-the-art geographic information system (GIS) that is currently being used to compile existing data obtained from federal, state, and other sources to enable comprehensive assessment of the environmental conditions that currently affect its Tribal Trust Land resources.

2.3.5 Coordination with Other Agencies

A Memorandum of Understanding (MOU) exists between the USDA-Forest Service (Klamath National Forest and Six Rivers National Forest) and the Karuk Tribe of California in a government to government agreement. Klamath and Six Rivers National Forests have co-management responsibilities throughout the Karuk Tribe's Aboriginal Territory - a federally-recognized sovereign government. The Tribe feels that the MOU agreement recognizes the need for the two groups to "formalize the processes of communication for land and resource management decision making." It also believes that "improving our relationship is the best course in achieving our common goal of wisely managed and sustainable natural resources." In addition, the Karuk Tribe's Department of Natural Resources has also worked with federal, state, county, and other Tribal agencies in evaluating water quality degradation and fisheries decline in the Klamath River Basin, as well as the development of beneficial forest management practices.

2.4 Cost/Benefit Assessment

The cultural structure of the Karuk Tribe was developed around the once productive fishery and forest resources of the middle Klamath River Basin. The costs associated with these adversely affected natural resources are unknown, but of significant importance to the Karuk Tribe. A legitimate responsibility of the Karuk Tribe as a sovereign aboriginal government is to ensure that the natural resources within its ancestral territory are managed so that they will benefit Karuk people through employment, services, and preservation of traditional ways and lifestyles. The Klamath River Basin anadromous (salmon and steelhead trout) fishery has been declining steadily for many decades. Despite public and private efforts to understand or reverse this trend, the number of fish returning to the Klamath River system has diminished to the point that some native anadromous fish stocks now face extinction. While efforts are continuously underway to understand the causes of fishery decline and address the symptoms of fish habitat degradation, no one agency or organization has adequately represented the interests of the Karuk Tribe or the resources upon which the Karuk Tribe depends.

2.4.1 Socioeconomics

The Karuk Tribe places great cultural, social, and economic value on the subsistence and commercial fisheries associated with the Klamath River basin. As a result of declining fisheries and resultant declining recreational opportunities, the Karuk Tribe has been economically repressed and many Tribal members have left the KTOC Trust Lands for better employment opportunities. A majority of the natural resources upon which the tribe depends, such as land, timber, and water, are co-managed and controlled by the federal government. In addition, the State of California and the Karuk Tribe have concurrent jurisdiction with the federal government over water, game, and fisheries. Federal and state resource management decisions affecting the Klamath River Basin, both past and present, have had a profound effect on the Karuk Tribe and its members.

In an effort to address and effectively influence agency resource management decisions and policies, the Karuk Tribe developed an Ancestral Lands Forest (forestry and fisheries)

Management Plan in 1989. The Tribe has long recognized the need to directly and actively participate in resource decision making processes that affect it and its members. As a result of this recognition, the Tribe vigorously pursued and obtained the necessary resources to establish a Tribal Department of Natural Resources.

Currently, the Tribe's Department of Natural Resources is working cooperatively with various federal and state agencies to evaluate the causes of water quality degradation and fishery decline in the Klamath River Basin. The Karuk Tribe, through its Department of Natural Resources, has also actively participated in the development process for President Clinton's Forest Ecosystem Management Plan. Furthermore, the Karuk Tribe is currently represented on the Provincial Executive Committee which provides recommendations for implementing the Presidents forest plan throughout the entire Klamath River Basin. Potential environmental contamination that affect the Karuk Tribe, are past mining, forest management, abandoned mill sites, storage tanks, and septic systems, that need to be thoroughly evaluated.

2.4.2 Costs and Benefits Associated with Achieving CWA Actions

The benefits of implementing best management practices (BMPs) to enhance the water quality of waterbodies would include (1) improving and protecting fish, riparian, and wildlife habitats; (2) providing additional recreational opportunities; (3) improving Tribal accessibility to Tribal waters; (4) protecting drinking water supplies; and (5) reducing upstream nutrient loading to the Klamath River. Over the long-term, protecting water quality would be less expensive than remediating water quality problems. All of these benefits would translate into improving the quality of life for Tribal members.

2.5 Special Concerns and Recommendations

In 1990 the California State Water Resource Control Board found that the beneficial uses of water for cold water fish in the Klamath River and its Shasta, Scott, and Salmon river tributaries were not being adequately protected. In addition, the USEPA has requested the

State Water Resource Control Board (1992) to evaluate whether the Shasta, Scott, Salmon, and Klamath rivers should be listed as water bodies that cannot meet applicable water quality standards under Section 303(d) of the CWA. The Oregon Department of Environmental Quality has determined that levels for the following water quality constituents have resulted in the Klamath River (upstream of the California border) being included on the 303(d) list: toxics, dissolved oxygen, chlorophyll *a*, pH, and temperature. The Karuk Tribe realizes the importance of its involvement in evaluating water quality conditions that affect the long-term survival of Klamath River anadromous fish stocks.

The Tribe's Department of Natural Resources has previously monitored the water temperatures in the main stem Klamath River since 1995 and has come to realize that the agencies that have been responsible for protecting water quality conditions throughout the entire Klamath River Basin have not invested the time and resources necessary to scientifically evaluate past and present water resource conditions. Water temperatures in the main stem Klamath River constrain summer rearing and fall spawning and during the summer months, water temperatures often reach levels lethal to juveniles and eggs of most salmonid species (Balance Hydrologics, Inc. 1996). Since around 1962, instream flows for the Klamath River as it passes through the KTOC Trust Lands has been regulated by the minimum flow regime specified at Iron Gate Dam and all other dams upstream except Link River Dam under PacifiCorp's license issued by the Federal Energy Regulatory Commission (FERC). The FERC license does not consider the flow needs of aquatic resources in the main stem Klamath River in its minimum instream flow regime in which the flow regime predominately determines the water temperature regime. A study on the historical flow regime for the main stem Klamath River found that the persistence and reliability of historic flows sustained the instream anadromous fishery even during the summer month and during dry years (Balance Hydrologics, Inc. 1996). PacifiCorp's license will undergo a renewal process in 2006.

The Karuk Tribe would like the opportunity to develop the infrastructure necessary to conduct a thorough assessment of all environmental conditions that affect the Tribe and to increase the capability to implement comprehensive environmental protection programs. To accomplish this goal, the Karuk Tribe has focused its efforts on providing adequate staff for its Department of Natural Resources and has applied and received Financial Assistance Application Packages for a CWA Section 106 Water Pollution Control Program. Following a review of the Tribe's existing environmental conditions, there will be a need for assistance in conducting environmental assessments in other key resource areas, as well as acquiring resource and legal assistance to develop and implement tribal environmental regulatory standards and ordinances.

Traditionally the principal organizational unit of Karuk society was the village, of which there were more than one hundred, each containing several households. Many of these villages are situated in relatively isolated areas along the Klamath, with more than ninety percent (90%) being located at or near mouths of lesser streams and tributaries. At certain sites there are clusters of villages which form larger settlements including Incm, Katimin, Ameckiyarum, and Panamnik--the greatest of which is Katimin, which once contained 40 or more houses. These settlements are the cultural and spiritual centers of the Karuk Tribe.

Prehistorically there was no one political organization within the villages or between the villages. Each village had Head Men who met at Ameckiyarum to make important decisions. Within each village, kinship ties were strong, family elders were the most revered members of a household and their influence extended over family members of neighboring villages. Wealth was regarded as a symbol of prestige, and the rich men of the village were accorded due respect. Wealth was measured by the amount of ceremonial regalia a person had and the amount of resources they controlled, such as fishing spots and their good luck. Despite the absence of a formal government structure, tribal members adhered to a set of unwritten tribal laws and shared a common set of values that governed the affairs of day-to-day life, as well as the conduct of business. People were expected to pay restitution when they wronged somebody. Restitution was usually in the form of Ishpuk (Indian money, small shells measured in strands).

The focal point of interaction between members of different villages and of different tribes, is the performance of religious ceremonies. The most important of these ceremonies is the pick-ya-wish, or world renewal ceremony, which the Karuk Tribal members continue to perform annually at three different locations: Inam, Katimin, and Panamnik. The purpose of the world renewal ceremony is to ensure an abundance of food and freedom from sickness in the coming year. The ceremony, as performed by the Karuk, is somewhat similar to those performed by the Yurok and Hupa, with the major difference being the performance of esoteric rites by the Karuk priest or fot-i-wa-non, (commonly referred to as medicine man), the exact nature and sequence of which is known only to him and those who went before him. This knowledge is passed on verbally only to those who are chosen to be medicine man.

3.0 SURFACE WATER ASSESSMENT

3.1 Current Surface Water Monitoring Program

The surface water monitoring program currently being implemented by the KTOC Department of Natural Resources focuses on the collection of water quality data for Indian Creek and Elk Creek stream courses in addition to the main stem Klamath River. The monitoring plan was implemented in 1998 as a watershed study within the Karuk Aboriginal Territory. Water quality constituents include pH, dissolve oxygen (DO), and water temperature. Indian Creek and Elk Creek have also been measured for major anions and cations, metals, nutrients, total dissolved solids (TDS), total suspended solids (TSS), cyanide, and discharge. The current surface water monitoring program does not adequately cover Tribal waters within the KTOC Trust Lands. The Karuk Department of Natural Resources is in the process of developing a comprehensive surface water monitoring program. The comprehensive plan will be designed to adequately cover all Tribal waters and would generate a baseline water quality database for all rivers and streams, the lake, wetlands, and ground water within the KTOC Trust Lands.

3.2 Plan for Achieving Comprehensive Assessments

A long-term goal of the Karuk Tribe is to implement a comprehensive monitoring and assessment plan for Tribal waters. This plan is anticipated to incorporate the following:

- Identification of all potential contaminant sources, both within and outside of KTOC Trust Lands, that could adversely affect Tribal waters

- Surface water monitoring for both beneficial use support and temporal trend analysis for the lake and wetlands and at stream reaches, both upstream and downstream of KTOC Trust Lands

- Ground water monitoring of individual domestic supply wells

- A goal to implement the comprehensive monitoring plan by summer 2001

- All Tribal waters (rivers, streams, the lake, wetlands, and ground water) georeferenced by GIS (geographic information system) technology using ARC/INFO and ArcView Software

- Use of the Karuk Tribe's traditional indicator of good water quality, the presence of the Poof Poof or Pacific Giant Salamander (*Dicamptodon tenebrosus*) for surface water quality evaluations. The use of amphibians, such as the salamanders as indicators of water quality conditions is supported in the scientific literature (Mason 1991).

Water sampling techniques will consistently follow EPA-approved methods of water sample collection, preservation, and handling as described in the KTOC QAPP. Samples will consist of surface and ground waters. The sampling network will be designed to (1) determine the quality of surface waters both on and upstream of the KTOC Trust Lands, (2) determine the quality of the ground water used by KTOC Trust Land residents, and (3) determine the mechanisms for and extent of surface/ground water interactions.

3.3 Assessment Methodology and Summary Data

3.3.1 Assessment Methodology

Water quality assessments for determining use support status are based either on monitored waters or evaluated waters. The criteria for distinguishing between evaluated and monitored waters are provided below.

Monitored Waters - Waterbodies for which use support decisions are based on current data that accurately describe water quality conditions using the following information as a guide:

- Monitoring data less than 5 years old
  (unless data are from remote areas with no known pollutant sources)
- Fixed-station chemical/physical monitoring on at least a quarterly sampling frequency
- Short-term intensive water quality monitoring
- Toxicity testing conducted at least annually
- Biosurveys conducted at least annually

Evaluated Waters - Waterbodies for which use support decisions are based on data that are either not current but are useful or are useful but less reliable than if they met the criteria stated above for monitored waters using the following information as a guide:

- Monitoring data older than 5 years
- Sediment or fish tissue data compared to applicable criteria
- Reliable information on conditions causing impairment, such as algae blooms and fish kills
- Reliable information on non-compliance of narrative water quality standards
- Questionnaire surveys conducted by Fishery Biologists and other qualified staff

Assessments are based on monitored waters whenever possible to provide a more accurate description of Tribal water quality conditions; however, when available information on water quality does not meet the monitored waters criteria, then efforts are made to provide useful water quality determinations based on evaluated waters.

There are five categories of use support for designated uses of waterbodies: Fully Supporting, Fully Supporting but Threatened, Partially Supporting, Not Supporting, and Not Attainable. Definitions of each of these designated use support categories are provided below.

Fully Supporting - No impairment is indicated by all data types.

Fully Supporting but Threatened - No impairment is indicated by all data types, and there is an apparent decline in water quality over time or there are potential water quality problems requiring additional data or verification, or other information suggests a threatened determination.

Partially Supporting - Impairment is indicated by one or more, but not all, data types.

Not Supporting - Impairment is indicated by all data types.

Not Attainable - A UAA has been conducted providing reliable information that the designated use of a waterbody cannot be feasibly met because of natural, economic, physical, or hydrologic modification conditions.
Data types are levels of water quality information for a waterbody, such as habitat; toxicological, biological, or numeric criteria exceedances; MCL violations; or bathing, drinking, and fish consumption restrictions.

The following types and sources of water quality information were used to assess data for conducting use support determinations:

- Short-term intensive water quality monitoring
- Biosurveys conducted at least annually
- Monitoring data less than 5 years old
- Monitoring data more than 5 years old
- Sediment or fish tissue data compared to applicable criteria

- Reliable information on conditions causing impairment, such as algae blooms and fish kills
- Reliable information on non-compliance of narrative water quality standards

3.3.2 Maps

To improve the usefulness of water quality information, a map of waterbodies and associated use support determinations is provided using GIS technology (**Figure 1-2**). In addition, the following maps are planned for use by the KTOC Department of Natural Resources for assessment purposes and to illustrate the distribution of the following Tribal water resources:

- Individual domestic supply wells
- Ishi Pishi Falls
- Klamath River and its tributaries
- Sacred Pond at Katimin
- Salmon River and its tributaries
- Springs
- Watershed boundaries
- Wetlands

The computer software applications used to maintain and revise water resource information are ARC/INFO and ArcView.

3.3.3 Section 303(d) Waters

CWA Section 303(d) requires tribes and states to identify 303(d) waters and establish a priority ranking for waters that do not or are not expected to achieve or maintain water quality standards with existing or anticipated required controls.

Because the Karuk Tribe's water quality standards are proposed, an analysis evaluating whether Tribal waters meet water quality standards and whether they should be included on the Section 303(d) list is not possible at this time. After Tribal and USEPA approval of the Karuk Tribe's water quality standards, a Section 303(d) analysis will be conducted, and TMDLs (total maximum daily loads) for water-quality-limited Tribal waters will be established and prioritized according to USEPA guidelines. Only potential nonpoint sources of pollutants are present within the KTOC Trust Lands. The Oregon Department of Environmental Quality is issuing TMDLs for the Upper Klamath River in response to low dissolve oxygen levels and high unionized ammonia concentrations. TMDLs for nutrients, dissolved oxygen, and water temperature are to be issued during 2004 for the main stem Klamath River in California.

At present, there are no NPDES outfalls within the KTOC Trust Lands. However, an unknown number of NPDES outfalls exists in upstream waters. One exists at the Iron Gate Dam Fish Hatchery. Considering this, the portion of pollutant loads from point sources (FWLA) for all Tribal waters is currently unknown. Pollutant loads from nonpoint sources and background sources (YLA) occur in waters upstream of the KTOC Trust Lands, but have not been determined; therefore, no Total Maximum Daily Loads have been calculated at this time. The Karuk Tribe will address Total Maximum Daily Load calculations following the promulgation of water quality standards for Tribal waters.

3.4 Rivers and Streams Water Quality Assessment

The degradation of riverine systems associated with the stream-riparian system are evident on the KTOC Trust Lands. Stream pollution and habitat degradation are issues that will be addressed to derive cause/source linkages. In general, as the Klamath River flows through areas containing KTOC Trust Lands there is a slight dilution of total dissolved solids and nutrients (nitrate and total phosphorus). The water quality in the main stem Klamath River improves in a downstream direction as its passes through the KTOC Trust Lands due to dilution by higher quality tributary inflows. Without these high quality tributary inflows the Klamath River would not have a salmon fishery. The Karuk children often avoid the main stem Klamath River in favor of tributary streams for swimming during the summer months due to the extent of algal mats and other unsightly aquatic vegetation in the main stem Klamath River.

3.4.1 Designated Use Support

Information on the degree of use support for rivers and streams is presented in ***Table 3-1***. Individual use support for rivers and streams is summarized in ***Table 3-2.***

3.4.2 Causes/Stressors and Sources of Designated Use Impairment

Information on cause/stressor categories (***Table 3-3***) and source categories (***Table3-4***) is provided for Tribal waters that are not fully supporting their designated uses. Causes/stressor are pollutants or conditions that stress uses of Tribal waters, such as flow alterations. Source categories are facilities that include U.S. Forest Service road building, logging and herbicide spraying as well as upstream abandoned acid mine drainage (Grey Eagle Mine Superfund Site), wastewater discharges, or activities, such as agricultural irrigation return flows, that contribute pollutants or stressors to a water thereby causing impairment of use support.

It has been determined that the water quality of the Klamath River is affected more by dam releases, upstream nutrient loading in the Upper Klamath River basin (extending into Oregon), and poor management practices by the U.S. Forest Service than by any other land uses. Impacts include water quality and riparian habitat degradation, anthropogenic eutrophication, increased erosion, and potential herbicide residues.

In addition, de la Fuente and Haessig (1994) concluded that constructed roads in sensitive areas increased landslide production by a factor of approximately 100, and timber harvest by approximately five times undisturbed rates in the Salmon River sub-basin.

Table 3-1. Summary of Fully Supporting, Threatened, and Impaired Streams and Rivers
(Reported in Miles)

Degree of Use Support	Assessment Category		Total Assessed Size
	Evaluated	Monitored	
Fully supporting all *assessed* uses			
Size fully supporting all *assessed* uses but threatened for at least one use	1.29		1.29
Size impaired for one or more uses	1.4		1.4
Size not attainable for any use and not included in the line items above			
TOTAL ASSESSED	2.69		2.69

Table 3-3. Total Sizes of Rivers and Streams Impaired by Various Cause/Stressor Categories (Reported in Miles)

Cause/Stressor Category	Size of Waters by Contribution to Impairment	
	Major	Moderate/Minor
Cause Stressor unknown		
Unknown toxicity		0.16
Pesticides		1.29
Priority organics		
Nonpriority organics		
PCBs		
Dioxins		
Metals		1.4
Ammonia	1.4	
Cyanide		
Sulfates		
Chlorine		
Other inorganics		
Nutrients	1.4	
pH		1.4
Siltation		2.69
Organic enrichment/low DO	1.4	
Salinity/TDS/chlorides		
Thermal modifications		
Flow alterations	1.4	
Other habitat alterations		
Pathogen indicators		
Radiation		
Oil and grease		
Taste and odor		
Suspended solids		
Noxious aquatic plants (macrophytes)	1.4	
Excessive algal growth		
Total toxics		
Turbidity		
Exotic species		
Other (specify)		

Legend
asterisk (*) = category not applicable
dashes (---) = category applicable, no data available
zero (0) = category applicable, but size of waters in the category is zero

Table 3-4. Total Sizes of Rivers and Streams Impaired by Various Source Categories

(Reported in Miles)

Source Category	Contribution to Impairment	
	Major	Moderate/Minor
Industrial Point Sources	1.4	
Municipal Point Sources	1.4	
Combined Sewer Overflows		
Collection System Failure		
Domestic Wastewater Lagoon		
Agriculture		
Crop-related sources	1.4	
Grazing-related sources		
Intensive Animal Feeding Operations		
Silviculture		2.69
Construction		
Urban Runoff/Storm Sewers		
Resource Extraction		
Land Disposal		0.16
Hydromodification	1.4	
Habitat Modification (non-hydromod)		
Marinas and Recreational Boating		
Erosion from Derelict Land		
Atmospheric Deposition		
Waste Storage/Storage Tank Leaks		
Leaking Underground Storage Tanks		
Highway Maintenance and Runoff		
Spills (Accidental)		
Contaminated Sediments		
Debris and Bottom Deposits		
Internal Nutrient Cycling (primarily lakes)		
Sediment Resuspension		
Natural Sources		
Recreational and Tourism Activities		
Salt Storage Sites		
Groundwater Loadings		
Groundwater Withdrawal		
Other'		
Unknown Source		
Sources Outside Reservation Jurisdiction Borders		

Legend
asterisk (*)= category not applicable
dashes (---) = category applicable, no data available
zero (0) = category applicable, but size of waters in the category is zero

Relative Assessment of Causes/stressors - The following causes/stressors have been identified as contributing to the actual or threatened impairment of rivers and streams:

Unknown Toxicity **–** Leachate from the old USFS Oak Bottom Dump site is a toxicity concern based on Karuk Tribal personnel's verbal information on buried drums that contained herbicides. The old dump site, which is upgradient of a KTOC Trust Land, has since been covered with soil and replanted.

Pesticides **–** USFS and county herbicide spraying on clear cuts, road sides and other forest vegetation is a concern because stormwater runoff from these areas enters salmonid stream habitats and these forest service lands are often located in recharge zones for KTOC Trust Lands individual domestic supply wells.

Metals **–** The old Grey Eagle Mine tailings were discharging acid mine drainage into Indian Creek as recently as the Fall 2000 when a water quality survey was conducted by the KTOC Department of Natural Resources and Water Quality Technology, Inc. The Grey Eagle Mine's acid mine drainage flows of approximately 0.25 cfs to Indian Creek were found to contain elevated levels of arsenic (0.027 mg/L), iron (101 mg/L), nickel (0.15 mg/L), and zinc (0.91 mg/L), and had a pH of 2.8 standard units. The recent presence of acid mine drainage to Indian Creek is especially noteworthy since this site was a superfund site that has been "cleaned up". The engineering design for the Grey Eagle Mine Superfund Site appears to have been flawed in that a cap with a liner over the tailings and the establishment of vegetation on the regraded ground surface have done little to mitigate the subsurface contamination of ground water flows that discharge into Indian Creek. Metals from other old mines may continue to contaminate water resources.

Ammonia **–** Un-ionized ammonia is a toxic chemical in the main stem Klamath River, especially during the summer months when flows are low and both pH and water temperature are high resulting in elevated concentrations of this toxicant. Un-ionized ammonia has been implicated as one of many causes for fish kills of salmonids in the main stem Klamath river (Balance Hydrologics, Inc. 1996).

Nutrients – The nutrients, nitrogen and phosphorus, in the main stem Klamath River stimulate algal blooms, the formation of algal mats, and the growth of noxious aquatic plants. Photosynthetic activity during the day and the predominance of respiration at night results in fluctuations in pH and dissolved oxygen (DO), especially on warm days. These diel fluctuations, especially DO, often result in exceedances of acceptable ranges required for salmonid survival and direct mortality of salmonids may be expected and has been witnesses and documented by KTOC Fisheries Crews. The benthic macroinvertebrate population in the main stem Klamath River is characteristic of rivers with moderate to high levels of productivity (California Department of Water Resources 1986, 1987).

pH – Levels of pH are depressed below acceptable ranges in acid mine drainage at the Grey Eagle Mine's acid mine drainage and elevated above acceptable ranges as a result of diel fluctuations of nutrient-rich river water in the main stem Klamath River.

Siltation – Siltation of streambeds adversely affects the gravel spawning beds of salmonids. Siltation does not allow for adequate dissolved oxygen levels that are required for salmonid eggs.

Organic Enrichment/Low DO – Organic enrichment results in oxygen sags causing DO levels to dip below those necessary to support salmonids and physiological stress or mortality occurs, especially during early life stages.

Flow Alterations – Reductions in summer flows and increased fall and early-winter peak flows disrupt the natural flow regime of salmonid spawning and contribute to poorer water quality (DO, un-ionized ammonia, and water temperature) as discussed above.

Noxious Aquatic Plants (Macrophytes) and Excessive Algal Growth – Noxious aquatic plants and excessive algal growth occur in the main stem Klamath River as a result of upstream nutrient loading and diminished base flows during the warmer summer months. As discussed above, diel fluctuations in DO, water temperature, pH, and the increased un-ionized ammonia production results in poorer water quality, stressed aquatic life, and oftentimes fish kills.

The Oregon water quality index (OWQI) level for the Upper Klamath River indicates that the Klamath River water upstream of the KTOC Trust Lands is of poor water quality throughout the year as a result of nutrients, BOD, total solids, and unionized ammonia. Although water temperature is most often considered the major water quality problem in the Klamath River, nutrient loading from upstream sources will continue to impair the fisheries and other aquatic life regardless of increased flows as a result of low dissolved oxygen levels during diel fluctuations.

Relative Assessment of Sources - The following sources have been identified as activities or pollutant sources contributing to the actual or threatened impairment of rivers and streams (Note: All sources are outside KTOC Trust Lands borders):

***Industrial Point Sources* –** The California Department of Water Resources (California Department of Water Resources 1986, 1987) and the Oregon Department of Environmental Quality have identified wood products factories as a major contributor to water quality impairment due to organic matter loading to the main stem Klamath River.

***Municipal Point Sources* –** The California Department of Water Resources (California Department of Water Resources 1986, 1987) and the Oregon Department of Environmental Quality have identified wastewater treatment plant discharges as a major contributor to water quality impairment due to nutrient and organic matter loading to the main stem Klamath River.

***Agriculture (Crop-Related Sources)* –** The California Department of Water Resources (California Department of Water Resources 1986, 1987) and the Oregon Department of Environmental Quality have identified irrigation return flows as a major contributor to water quality impairment due to nutrient and organic matter loading to the main stem Klamath River.

Silviculture **–** Silt from eroded Forest Service areas results from clear cuts through tributary stream courses and catastrophic fires on steep slopes.

Land Disposal **–** Leachate from the old USFS Oak Bottom Dump site is a toxicity concern based on Karuk Tribal personnel's verbal information on buried drums that contained herbicides. The old dump site, which is upgradient of a KTOC Trust Land, has since been covered with soil and replanted. The old Grey Eagle Mine tailings were discharging acid mine drainage into Indian Creek as recently as the Fall 2000 when a water quality survey was conducted by the KTOC Department of Natural Resources and Water Quality Technology, Inc.

Hydromodification **–** Flow alterations occur due to the regulated main stem of the Klamath River from dam releases and agricultural drains.

3.4.3 Cause/Source Linkage

A cause/source linkage combines cause/stressor categories with their pollutant source or activity. A cause/source linkage is provided to answer questions such as *Which rivers are impaired because of pesticides from upstream off-reservation agricultural crop runoff?* The following cause/source linkages have been identified as contributing to the actual or threatened impairment of rivers and streams on the KTOC Trust Lands.

- **Unknown Toxicity and Metals** *linked with* **Land Disposal**

- **Siltation and Pesticides** *linked with* **Silviculture and Agriculture (Crop-Related Sources)**

- **Nutrients, pH, Noxious Aquatic Plants, Excessive Algal Growth, and Ammonia** *linked with* **Municipal Point Sources and Agriculture (Crop-Related Sources) and Hydromodification**

- **Oxygen Enrichment/Low DO** *linked with* **Municipal Point Sources, Agriculture (Crop-related sources), and Industrial Point Sources and Hydromodification**

- **Flow Alterations** *linked with* **Hydromodification**

3.5 Lakes Water Quality Assessment

3.5.1 Background

There is one lake on the KTOC Trust Lands. The lake is considered to be significant tribally owned lake because of its cultural significance. A description of the significant tribally owned lake is provided below.

> **Sacred Pond at Katimin -** This 0.16 acre lake is located at a spring source. The lake is an important cultural surface water that requires the greatest protection measures.

3.5.2 Designated Use Support

Use support decisions have been made for the significant tribally owned lake; these designated uses are presented in ***Table 3-5***. Use support decisions for the lake is based on evaluated waters using a biosurvey and water quality information collected during Fall and winter 2000 as part of a short-term intensive water quality survey.

A summary of individual use support for the lake is provided in ***Table 3-6***. The fishable goal of the Clean Water Act using water quality information from Tribal members and trophic status as an indicator is: fully supporting at the Sacred Pond at Katimin. The swimmable goal of the Clean Water Act using swimming and secondary contact as indicators is unassessed because there is currently no routine bacterial monitoring at this lake.

Table 3-5. Summary of Fully Supporting, Threatened, and Impaired Lakes (Reported in Acres)

Degree of Use Support	Assessment Category		Total Assessed Size
	Evaluated	Monitored	
Size Fully Supporting All *Assessed* Uses	0.16		0.16
Size Fully Supporting All *Assessed* Uses but Threatened for at Least One Use			
Size Impaired for One or More Uses			
Size Not Attainable for Any Use and Not Included in the Line Items Above			
TOTAL ASSESSED	0.16		0.16

3.5.3 Causes/Stressors and Sources of Impairment of Designated Uses

Information on cause/stressor categories (***Table 3-7***) and source categories (***Table 3-8***) is provided for Tribal waters that are not fully supporting their designated uses. Causes/stressors are pollutants or

Table 3-7. Total Sizes of Lakes Impaired by Various Cause/Stressor Categories

(Reported in Acres)

Cause/Stressor Category	Size of Waters by Contribution to Impairment	
	Major	Moderate/Minor
Cause stressor unknown	*	*
Unknown toxicity	*	*
Pesticides	*	*
Priority organics	*	*
Nonpriority organics	*	*
PCBs	*	*
Dioxins	*	*
Metals	*	*
Ammonia	*	*
Cyanide	*	*
Sulfates	*	*
Chlorine	*	*
Other inorganics	*	*
Nutrients	*	*
pH	*	*
Siltation	*	*
Organic enrichment/low DO	*	*
Salinity/TDS/chlorides	*	*
Thermal modifications	*	*
Flow alterations	*	*
Other habitat alterations	*	*
Pathogen indicators	*	*
Radiation	*	*
Oil and grease	*	*
Taste and odor	*	*
Suspended solids	*	*
Noxious aquatic plants (macrophytes)	*	*
Excessive algal growth	*	*
Total toxics	*	*
Turbidity	*	*
Exotic species	*	*
Other (specify)	*	*

Footnotes
asterisk (*) = category not applicable
dashes (---) = category applicable, no data available
zero (0) = category applicable, but size of waters in the category is zero.

Table 3-8. Total Sizes of Lakes Impaired by Various Source Categories

(Reported in Acres)

Source Category	Contribution to Impairment	
	Major	**Moderate/Minor**
Industrial point sources	*	*
Municipal point sources	*	*
Combined sewer overflows	*	*
Collection system failure	*	*
Domestic wastewater lagoon	*	*
Agriculture	*	*
Crop-related sources	*	*
Grazing-related sources	*	*
Intensive animal feeding operations	*	*
Silviculture	*	*
Construction	*	*
Urban runoff/storm sewers	*	*
Resource extraction	*	*
Land disposal	*	*
Hydromodification	*	*
Habitat modification (non-hydromod)	*	*
Marinas and recreational boating	*	*
Erosion from derelict land	*	*
Atmospheric deposition	*	*
Waste storage/storage tank leaks	*	*
Leaking underground storage tanks	*	*
Highway maintenance and runoff	*	*
Spills (accidental)	*	*
Contaminated sediments	*	*
Debris and bottom deposits	*	*
Internal nutrient cycling (primarily lakes)	*	*
Sediment resuspension	*	*
Natural sources	*	*
Recreational and tourism activities	*	*
Salt storage sites	*	*
Groundwater loadings	*	*
Groundwater withdrawal	*	*
Other (septic releases)	*	*
Unknown source	*	*
Sources outside reservation jurisdiction borders	*	*

Footnotes
asterisk (*) = category not applicable
dashes (---) = category applicable, no data available
zero (0) = category applicable, but size of waters in the category is zero.

conditions that stress uses of a waterbody, such as flow alterations or introduction of exotic fish that out-compete native fishes. Source categories are facilities, such as mining operations and wastewater discharges, or activities, such as impounded water fluctuations, and agricultural irrigation return flows, that contribute pollutants or stressors to a waterbody and cause impairment of use support.

Relative Assessment of Causes/Stressors – There are no identified causes or stressors contributing to the actual or threatened impairment of the Sacred Pond at Katimin.

Relative Assessment of Sources – There are no identified activities or pollutant sources contributing to the actual or threatened impairment of the Sacred Pond at Katimin.

3.5.4 Cause/Source Linkage

A cause/source linkage combines cause/stressor categories with their pollutant source or activity. A cause/source linkage is provided to answer questions such as *Which lakes are impaired because of metals loading from upstream off-reservation mine drainage?* No cause/source linkages have been identified as contributing to the actual or threatened impairment of the Sacred Pond at Katimin.

3.5.5 Trophic Status

Trophic status is a classification system for lakes that is based on the nutrient concentrations (especially phosphorus) and the level of biological productivity (especially algae) in a lake. A trophic status provides a means of comparing and communicating lake conditions and is the most commonly used characterization of lakes today. Those lakes with low nutrient concentrations and a low level of biological productivity are termed oligotrophic, those with high nutrient concentrations and a high level of biological productivity are termed eutrophic (or hypereutrophic in an advanced eutrophic state), those lakes between oligotrophic and eutrophic are termed mesotrophic.

Trophic status is an index of water quality to the extent that a trophic condition can limit the beneficial uses of a lake, such as swimming and aquatic life support. Generally, as a lake becomes eutrophic, the negative effects of the eutrophication are considered to be especially accelerated by human activities. Negative effects include reduced dissolved oxygen to concentrations that can be lethal to most fish species. Eutrophication often leads to increased fish production but decreased species diversity, with a loss of species such as salmon.

A commonly used indicator of the nutrient status of lake water is the TP (total phosphorus) concentration because it is often considered the limiting nutrient controlling algal growth, though nitrogen species (nitrate, ammonia, and ammonium) also may be limiting nutrients. A commonly used indicator of biological productivity is water clarity as measured by a Secchi disc. Levels of algal growth are measured using chlorophyll *a* concentrations.

The most frequently used TSI (trophic state index) using only one variable is that of Carlson (1977). With this index, lakes can be classified on the basis of lake water surface TP, chlorophyll *a* concentration, or Secchi disc using the following equations:

$$\text{TSI CHL} = 8.23 \ln \text{CHL} + 33.3$$
$$\text{TSI TP} = 14.42 \ln \text{TP} + 4.15$$
$$\text{TSI SD} = 60 - 14.41 \ln \text{SD}$$

where:

TSI	=	trophic state index
ln	=	natural log
CHL	=	chlorophyll *a* (µg/L)
TP	=	total phosphorus (µg/L as P)
SD	=	Secchi disc depth transparency (meters)

The three variables provide three separate estimates of trophic state. The CHL TSI is given priority for classification because it is a biological variable indicating the amount of algae present in the water.

Data for the epilimnion (upper lake surface) is best collected during the mid-summer season (July and

August) for calculating the mean TP, CHL, and SD for lakes. Individual TSIs for each lake are compared to the categories presented below to determine an overall trophic status (Olem and Flock 1990).

TSI	TROPHIC STATUS
0-40	Oligotrophic
41-50	Mesotrophic
51-70	Eutrophic
>70	Hypereutrophic

When there were differences among individual TSIs (greater than 5 units) for a lake, they were averaged to obtain an overall TSI. Where SD equaled total lake depth (an indication of a shallow lake), or where TSIs were on a boundary between two trophic categories, the overall trophic category was selected by weighting in favor of the CHL TSI.

The Sacred Pond at Katimin on the KTOC Trust Lands has been assessed for trophic status (***Table 3-9***) using total phosphorus (200 ug/L as P) as the exclusive TSI indicator. The Sacred Pond at Katimin had a trophic status of eutrophic. A trophic status of eutrophic is considered to be indicative of unpolluted productive lakes in the Klamath River basin.

3.5.6 Control Methods

No control methods have been implemented for the lake on the KTOC Trust Lands. The assessment is intended to determine whether the lake is in need of control methods and which control methods are appropriate to restore and maintain good lake water quality. No water quality pollutants have been identified at this time.

Table 3-9. Trophic Status of Significant Publicly Owned Lakes

	Number of Lakes	Acreage of Lakes
Total	1	0.16
Assessed		
Oligotrophic		
Mesotrophic		
Eutrophic	1	0.16
Hypereutrophic		
Dystrophic		
Unknown		

3.5.7 Restoration/Protection Efforts

The development, implementation, and enforcement of BMPs would help to protect this waterbody form any potential bacterial or nutrient loading to the lake.

3.5.8 Lake Water Quality Standards

Water quality standards have been proposed for development for the KTOC Trust Lands which will apply to lakes. Lake designated uses, numeric and narrative water quality criteria, and an antidegradation provision are proposed for development in the water quality standards.

3.5.9 Acid Effects on Lakes

Acid sensitivity is primarily determined by the watershed bedrock geology and exposure to acid rain. The geologic materials underlying the KTOC Trust Lands appear to provide adequate acid neutralizing capacity to the lakes. Sources of atmospheric pollutants that could increase the acidity of rain are located outside the KTOC Trust Lands boundaries.

Information on the presence or extent of acid rain for the KTOC Trust Lands has not received much attention because it is not considered to be a problem. Alkalinity is a good indicator of the buffering or ANC (acid neutralizing capacity) of a lake and will be used as an index of acid sensitivity. Total alkalinity concentrations reported for lakes are converted from milligrams per liter as calcium carbonate (mg/L as $CaCO_3$) to ANC using the following equation (Hem 1985):

Total alkalinity (mg/L as $CaCO_3$) x 20 = ANC (µeq/L)

The following ANC classifications (Gibson *et al.* 1983) are used to assess the acid sensitivity of lakes:

Nonsensitive	:	ANC >= 200 µeq/L
Sensitive	:	ANC >= 100 and <200 µeq/L
Very sensitive	:	ANC >= 50 and <100 µeq/L
Extremely sensitive	:	ANC < 50 µeq/L

A water sample was collected from the Sacred Pond at Katimin on January 11, 2001, by Scott Quinn, and laboratory analyzed at a pH of 7.5 and a total alkalinity concentration of 185 mg/L as $CaCO_3$ or an ANC of 3,700 µeq/L. Based on these data, the lake is classified as nonsensitive, slightly alkaline, and has a high buffering capacity (***Table 3-10***).

Table 3-10. Acid Effects on Lakes

	Number of Lakes	Acreage of Lakes
Assessed for acidity	1	0.16
Impacted by high acidity	0	0
Vulnerable to acidity	0	0

3.5.10 Toxic Effects on Lakes

The lake on the KTOC Trust Lands has not been sampled for a full suite of toxic pollutants, such as metals and pesticides in fish tissue, sediment, and water.

3.5.11 Trends in Lake Water Quality

Because of a lack of long-term water quality data, a discussion of apparent trends in lake water quality is not possible at this time.

A lake water quality monitoring program is planned as part of the Water Pollution Control Program through USEPA Region IX. Trends in lake water quality would be detected through (1) changes in trophic status, (2) changes in the degree of designated use support, (3) changes in bacteria levels for lakes that are used for swimming (full body contact recreation) or wading (partial contact recreation), and (4) changes in levels of toxic pollutants in sediment and fish tissue.

3.6 Estuary and Coastal Assessment

A water quality assessment of estuarine and near-coastal waters is not provided because no estuaries, coastal waters, or Great Lakes shorelines are found on the KTOC Trust Lands.

3.7 Wetlands Assessment

As a means of providing an initial estimate of the extent and types of wetlands within the KTOC Trust Lands, National Wetlands Inventory maps (which use the Cowardin identification system - Table 13) produced by the U.S. Fish and Wildlife Service (1991) will be obtained. These maps are available in hardcopy as well as digital format so they can be used in a GIS application. The National Wetlands Inventory maps show the locations, shapes, and types of wetlands and deepwater habitats on USGS 1:24,000 topographic maps. National Wetlands Inventory maps are produced on USGS topographic maps after completion of the following steps: (1) preliminary field investigations of wetlands, (2) interpretation of aerial photographs, (3) review of existing wetland information for the area, (4) quality control protocols for aerial photographic interpretations, (5) production of draft maps, (6) interagency review of draft maps, and (7) final map production. The KTOC Trust Lands contains a vast amount of diverse wetland resources. These wetlands are associated with streams, rivers, and the lake.

Primary wetland ecosystems found within the Territory are the riparian zones. Riparian ecosystems are the interface between the aquatic and terrestrial ecosystems and encompass a wide range of environmental factors, ecological processes, and biotic communities. Riparian communities occur along rivers and streams and around the lake within the KTOC Trust Lands. Local slope, aspect, elevation, soil type, and geology influence the width, density, and diversity of riparian vegetation. The most important features supporting a wetland is a source of hydrology during the growing season.

The general problems with wetlands protection and management on the KTOC Trust Lands are (1) the lack of Tribal mechanisms for educating KTOC Trust Lands residents about preserving wetlands and the need for protecting wetlands; and (2) the lack of Tribal mechanisms for wetlands inventories, assessment, protection, and net gain in acreage, values, and functions over time.

3.7.1 Development of Wetland Water Quality Standards

In order to protect wetland resources, the Karuk Tribe proposes to develop wetland water quality standards. The purpose of the wetland water quality standards for the KTOC Trust Lands is to meet the federal provisions of the CWA as they relate to wetlands. Designated uses are determined for each wetland type: riverine, palustrine, or lacustrine.

One use of wetland water quality standards would be the CWA Section 401 water quality certification process, which would allow the Karuk Tribe to apply these standards as part of its review of federally licensed or permitted activities that may degrade water quality and aquatic habitat on the Aboriginal Territory, such as CWA Section 404 Dredge or Fill permits.

3.7.2 Integrity of Wetland Resources

A key beneficial use designated by the Karuk Tribe is the preservation of the cold-water fisheries. Riparian ecosystems play an important part in this area. Riparian vegetation is the benchmark criteria for ideal salmonid environments. Riparian vegetation is important to fish habitat in providing shade for temperature control, maintaining channel and bank stability, and providing cover through roots and overhangs. In addition, down woody debris accumulates in the riparian areas which provides for salmonid refuge and shade.

There is no current monitoring or assessment provision to evaluate whether Tribal wetland resources are jurisdictional and whether wetlands are being degraded or enhanced in function, value, or acreage. However, subjective information is available on probable causes and impairment of wetlands.

3.7.3 Causes/Stressors and Sources of Designated Use Impairment for Wetlands

Information on cause/stressor categories and source categories is provided for Tribal wetlands that are not fully supporting their designated uses.
Large woody debris, such as downed trees and limbs, is an important factor in influencing whether sediment inputs affect channel stability and aquatic habitat. A stream that is lacking in large woody debris tends to be more uniformly broad and shallow with fewer pools and spawning gravel accumulations, and is more prone to channel scour by flood flows. Riparian areas protect water quality by filtering sediment and providing vegetation needed to stabilize stream banks.

In addition to providing aquatic and wildlife habitats, riparian areas are also the focus of water-related recreation uses, such as fishing, hunting, camping, and hiking. Alteration of riparian areas has occurred from timber harvest, road construction, recreation, mining, and livestock grazing, as well as natural events, such as floods and landslides. As part of the Karuk's Wetland Protection Program, the Tribe will work with other agencies, such as the USDA-Forest Service, to identify and design protection plans for key riparian areas.

Relative Assessment of Causes/stressors - The following causes/stressors have been identified as contributing to the actual or threatened impairment of wetlands on the KTOC Trust Lands.

Flow Alterations **-** Flow alterations occur as a result of dam releases.

Pesticides **–** Herbicide spray drift is a potential contaminant source for wetland plants and is of important cultural significance for wetland plants used for basket material and medicine by Tribal members.

Other Habitat Alterations - Impairment of wetlands, including riparian and fish habitat, is widespread throughout the KTOC Trust Lands.

Relative Assessment of Sources - The following sources have been identified as activities or pollutant sources contributing to the actual or threatened impairment of wetlands.

Agriculture (Crop-Related Sources) - It appears that agricultural irrigation return flows have contributed to stream impairment through nutrient loading and resultant excessive algal growth in many areas.

Hydromodification - Dam building on the Klamath River and the resultant regulated flow of the main stem Klamath River results in a flow regime that adversely impacts riparian vegetation.

Cause/Source Linkage

A cause/source linkage combines cause/stressor categories with their pollutant source or activity. A cause/source linkage is provided to answer questions such as *Which wetlands are impaired because of habitat modification from grazing-related causes?* The following cause/source linkages have been identified as contributing to the actual or threatened impairment of rivers and streams:

- **Other Habitat Modification** *linked with* **Agriculture (Crop Related Sources)**
- **Flow Alterations** *linked with* **Hydromodification**
- **Herbicide applications** *linked with* **Wetland Plant Contamination (cultural)**

3.7.4 Extent of Wetland Resources

Wetlands on the KTOC Trust Lands are located largely within the riparian zones of rivers, streams and the lake shoreline. Because of the close association of wetlands and riparian areas the Karuk Tribe will consider riparian communities in its environmental conservation and restoration planning.

Inventory Methods

The wetland resources on the KTOC Trust Lands will be characterized by location, type, and acreage using the following available information.

U.S. Fish and Wildlife Service National Wetland Inventory Maps. NWI (National Wetland Inventory) maps produced by the USFWS are the current resource available for identifying wetlands on the KTOC Trust Lands. NWI maps use the Cowardin Classification System (Coward *et al*. 1979). The Cowardin Classification System describes the ecological taxa, arranges them in a system useful to resource managers, furnishes units for mapping, and provides uniformity of concepts and terms.

GIS Mapping Service. Wetlands delineated on the NWI maps for the KTOC Trust Lands will be digitized into the GIS system.

Delineation Methods. Wetlands delineation methods incorporate the general diagnostic environmental characteristics outlined in the U.S. Army Corps of Engineers Wetlands Delineation Manual (COE 1987) to delineate jurisdictional wetlands regulated under Section 404 of the CWA. However, unlike the 1987 manual's wetland determination, the Karuk Tribe will delineate as wetlands areas that may not meet the vegetation, soils, or hydrology criteria.

Additional Wetlands Protection Activities

As part of the CWA Section 104(b)(3) State Wetlands Protection Program the Karuk Tribe is planning on developing a State Wetland Conservation Plan. A State Wetland Conservation Plan is the primary mechanism for protecting Tribal wetland resources (including riparian areas). Through the aid of USEPA Region IX, the Tribe will initiate an inventory and assessment of the extent and types of wetlands within the Aboriginal Territory. In addition, a commitment within the Karuk's constitutional framework to restore and maintain the integrity of wetland resources on the Territory, with the goal of no net loss and long-term gain of wetlands, may be proposed. The Karuk Tribe is considering pursuing CWA Section 401 water quality certification as an additional wetland and water quality protection strategy. Section 401 water quality certification would allow the Tribe to impose water quality-based requirements on federally licensed or permitted projects (or exercise veto power) to protect the quality of Tribal waters, including wetlands.

Regulatory Mechanisms. A list of regulatory mechanisms, both Tribal and federal, considered for protecting wetlands on the KTOC Trust Lands is presented in ***Table 3-11***.

The Karuk Tribe will commit within its administrative framework to restoring and maintaining the integrity of wetlands on the KTOC Trust Lands through a wetlands and riparian area ordinance. The ordinance will contain a consistent definition of wetlands and riparian areas. The Karuk Tribe will pursue the NNL (no net loss and long-term gain) goal by compensating for past and future wetland losses in a manner that results in a net increase in wetland acreage and function without adversely affecting economic development on the KTOC Trust Lands. NNL can be achieved by compensating for wetland losses in the following ways:

- In-kind (i.e., the same wetland types in the same hydrologic settings)
- With equivalent values, functions, and area
- On or near the location (e.g., watershed) of the losses

Table 3-11. Existing and Needed Wetlands Protection Mechanisms

Mechanism	Administering Agency	Existing or Needed
Wildlife Management Program	US Fish and Wildlife Service	Needed
CWA Section 404	U.S. Army Corps of Engineers	Existing
CWA Section 401 (Federal)	USEPA	Existing
CWA Section 401 (Tribal)	KTOC Department of Natural Resources	Needed
Tribal Water Pollution Control Program	KTOC Department of Natural Resources	Existing
Fishery Management Plan	USFWS	Needed
Tribal Wetlands Water Quality Standards	KTOC Department of Natural Resources	Needed
GIS Reservation Wetlands Location and Type Map	KTOC Department of Natural Resources	Needed

The KTOC Department of Natural Resources will be responsible for determining losses or gains of wetlands and their associated functions and values. The Wetlands Protection Program will help the KTOC Department of Natural Resources evaluate current methods used to determine wetland losses. Criteria for evaluating the cultural functions and values associated with wetlands will be developed and incorporated into the method determined to be the most appropriate for the KTOC Trust Lands. A permanent monitoring and assessment program will be developed and implemented to provide the KTOC Department of Natural Resources with the data necessary to determine whether a loss or gain of wetlands has occurred.

Non-regulatory Mechanisms. Use of non-regulatory protection methods has the most potential for addressing the need to protect critical wetland and riparian areas on the KTOC Trust Lands.

The potential mechanisms being considered for use with the Wetlands Protection Program may include developing the programs outlined below.

Community Outreach/Education. In order to solicit input from the Karuk Tribe, public participation programs will be established. The programs will provide information regarding the wetlands assessment and management plans and will help solicit questions, comments, and concerns regarding proposed wetlands protection measures.

Additional wetlands awareness measures may include the following:

- A brochure describing wetlands protection measures
- Wetlands awareness and protection presentations for Tribal employees, high school and grade school students, and U.S. Forest Service personnel
- Input solicitation from Tribal members on pilot projects, such as wetlands protection projects

Tribal Wetlands Creation/Restoration Program. The Karuk Tribe will select locations to conduct pilot projects for re-establishing native vegetation.

Monitoring. A wetlands assessment and monitoring plan will be designed to meet wetlands jurisdiction, function, value, and acreage information needs. A wetlands assessment and monitoring program will be tested and refined, as needed, after it is incorporated into the Karuk Tribe's Wetlands Protection Program under the CWA.

The following components will be incorporated into the Karuk Tribe's wetlands assessment and monitoring plan:

- Wetland hydrology source(s)
- Reference wetland characteristics
- Wetland functions
- Existing sources of wetland degradation
- Potential sources of wetland degradation

- Cultural and traditional uses of wetlands
- Determination as to whether a wetland is jurisdictional

Partnerships. Increased participation in federal, Tribal, state, and local management forums for the cooperative management of the KTOC Trust Lands and surrounding areas will be pursued. Attendance at work group meetings with other entities, such as those listed below, are planned whenever funding is available. This will promote the importance of including the ecological value of maintaining wetland and riparian areas in any development plans proposed for this region.

- U.S. Bureau of Reclamation
- USFWS
- USEPA
- USGS
- U.S. Department of Agriculture (Natural Resources Conservation Service)
- U.S. Bureau of Land Management
- Local conservation groups

Resource Management. The goal of NNL for identified wetlands resources and riparian areas will be supported by any long-term resource management planning undertaken on the KTOC Trust Lands.

Restoration/Preservation Plan. The Karuk Tribe will establish critical habitat areas and pursue cooperative efforts with federal and state agencies to protect and restore wetland resources. This will help the Karuk Tribe ensure that future Tribal generations will have continued access to and knowledge of the traditional function and values of wetland and riparian areas on the KTOC Trust Lands. These areas can be developed with interpretive guides or material and will be open to the public to foster interest in conserving critical wetland areas.

3.8 Public Health/Aquatic Life Concerns

The Karuk Tribe is concerned about toxic and nontoxic contamination, and the following issues will be addressed in future water quality monitoring programs:

- The possibility of waterborne diseases in individual domestic water supply wells.
- Elevated levels of coliform bacteria in streams and other surface waters.
- The proximity of septic systems to streams and individual domestic water supply wells
- Resource extraction practices that may have mobilized toxic metals in streams and stream sediments, specifically at the Siskon and Grey Eagle Mines.
- Silviculture and resource extraction practices that have led to increased erosion and sediment loading in streams.
- Agricultural practices that have lead to (1) anthropogenic eutrophication, (2) choked aquatic vegetation from nutrient loading in streams; and (3) degraded riparian habitat.
- Herbicide residues form spraying by USFS personnel in the hills above Oak Bottom Dump since the 1970's. According to Karuk Tribal members, the 1970's herbicide spraying coincided with numerous birth defects and still births for families living in the area of potential exposure. Also according to Karuk Tribal members, Tribal families experiencing these birthing problems have since moved away from the KTOC Trust Lands.
- Foam or surfactants in the main stem Klamath River is unsightly and may pose a toxicity problem due to molds and potential pathogens feeding on decaying algal mats.

3.8.1 Size of Waters Affected by Toxicants

The Karuk Tribe has not conducted any sampling for toxicants on the KTOC Trust Lands. In addition, no information on toxicant studies conducted by other state or federal agencies was found (See Table -19).

The term *elevated levels of toxicants* is defined as an exceedance of any of the following criteria:

- Numeric Tribal water quality standards

- FDA action levels (FDA 1982) for human consumption of fish tissue

- International Joint Commission (IJC) levels (Shacklette and Boerngen 1984) for sediment

- National Academy of Sciences, National Academy of Engineering (1973) freshwater aquatic life and wildlife criteria for survival and reproduction of most fish species

- USFWS hazards criteria (Eisler 1985, 1986, and 1987) for survival and reproduction of fish-eating birds

The following water quality constituents are considered to be toxicants:

- Pesticides
- Priority organics
- Metals
- Un-ionized ammonia
- Chlorine

None off the toxicants listed above were assessed in Tribal waters on the KTOC Trust Lands.

3.8.2 Public Health/Aquatic Life Impacts

Information on public health and aquatic life impacts is assessed using fish kills and algal blooms. Fish kills and algal blooms in the Klamath River occur persistently each year as a result of nutrient loading and reduced stream flows in the summer as a result of upstream point and nonpoint source discharges and dam releases/diversions, respectively.

3.8.3 Public Water Supply/Drinking Water Use Reporting

A summary of contaminants used in the drinking water use assessment is provided in ***Table 3-12***. No levels of nitrate were detected at concentrations greater than the federal nitrate drinking water standard of 10 mg/L as N. Drinking water use designations for rivers and streams and as well as the lake are proposed for development in the Karuk Tribe's upcoming water quality standards for the KTOC Trust Lands.

Table-3-12. Summary of Contaminants Used in the Drinking Water Use Assessment

Rivers and Streams	Contaminants Included in the Assessment	Lakes and Reservoirs	Contaminants Included in the Assessment
Klamath River	nitrate	Sacred Pond at Katimin	nitrate
Salmon River	nitrate		

4.0 GROUND WATER ASSESSMENT

Ground water supplies almost all of the drinking water and other domestic water uses on the KTOC Trust Lands. Ground water occurs on the KTOC Trust Lands in two hydrogeologic units: (1) fractured granite and metamorphic bedrock, and (2) alluvial material along streams. According to the USEPA, a PWS (Public Water System) has 15 or more service connections, or regularly serves 25 people 60 or more days per year. USEPA currently has no record of PWSs on the KTOC Trust Lands. The majority of drinking water on the KTOC Trust Lands are provided through individual domestic supply wells and springs.

The KTOC would like to maintain and protect the quality of ground water underlying the KTOC Trust Lands. The protection of recharge zones is a top priority to pursue under the Water Pollution Control Program. Ground water quality concerns on the KTOC Trust Lands include herbicide spraying on adjacent Forest Service lands, septic system releases, and leachate from land-disposal areas.

4.1 Summary of Ground Water Contaminant Sources

Major potential sources of ground water contamination are presented in ***Table 4-1***. Potential contaminants in ground water on the KTOC Trust Lands are pesticides (especially herbicides), nitrate, and bacteria.

4.2 Summary of Ground Water Protection Programs

To protect ground water on the Reservation, the Tribe is developing a ground water quality monitoring plan under its Water Pollution Control Program. As part of this development plan, the Tribe will address the following issues:

- Inadequately mapped ground water aquifers for the Reservation and scattered or nonexistent ground water quality information

- Lack of a comprehensive KTOC Trust Lands-wide wellhead protection program that complies with the SDWA and ensures that the water being supplied by drinking supply wells is safe

Table 4-l. Major Potential Sources of Ground Water Contamination

Contaminant Source	Ten Highest-Priority Sources (✓)	Factors Considered in Selecting a Contaminant Source	Contaminants
Agricultural Activities			
Agricultural chemical facilities	✓	existing	unknown
Animal feedlots			
Drainage wells			
Fertilizer applications	✓	existing	nutrients
Irrigation practices	✓	existing	nutrients
Pesticide applications	✓	existing	herbicides
On-farm agricultural mixing and loading procedures			
Land application of manure (unregulated)			
Storage and Treatment Activities			
Land application (regulated or permitted)			
Material stockpiles	✓	existing	unknown
Storage tanks (above ground)			
Storage tanks (underground)			
Surface impoundments			
Waste piles	✓	existing	unknown
Waste tailings	✓	existing	unknown
Disposal Activities			
Deep injection wells			
Landfills	✓	existing	unknown
Septic systems	✓	existing	nitrate, bacteria
Shallow injection wells			
Other			
Hazardous waste generators			
Hazardous waste sites			
Large industrial facilities			
Material transfer operations			
Mining and mine drainage	✓	existing	pH, metals

Contaminant Source	Ten Highest-Priority Sources (✓)	Factors Considered in Selecting a Contaminant Source	Contaminants
Pipelines and sewer lines			
Salt storage and road salting			
Salt water intrusion			
Spills			
Transportation of materials			
Urban runoff			
Small-scale manufacturing and repair shops			
Other sources			

- Lack of a comprehensive ground water protection program (under the CWA) with the overall goal of preventing adverse effects on both human health and the environment

Table 4-2 summarizes Tribal ground water protection programs.

To protect ground water on the KTOC Trust Lands, the Karuk Tribe is planning to develop a ground water assessment program. This program will address the following issues:

- Inadequately mapped ground water aquifers for the KTOC Trust Lands and scattered or nonexistent ground water quality information

- Lack of the classification of ground water aquifers by use and quality to establish levels of protection and promulgation of ground water quality standards under the CWA

- Lack of a comprehensive wellhead protection program

- Lack of a comprehensive ground water protection program (under the CWA) with the overall goal of preventing adverse effects on both human health and the environment

Currently the Karuk Tribe does not have any ground water protection programs in place. As part of the ground water assessment program, a ground water sampling plan would be developed. A comprehensive ground water sampling program would involve sampling drinking water supply wells to characterize the ground water quality on the Aboriginal Territory and document any exceedances of federal primary and secondary maximum contaminant levels (MCLs). Primary MCLs are enforceable and are related to the protection of public health, but take into consideration technological and economic feasibilities. Secondary MCLs are not enforceable and are related to the protection of public welfare, such as the aesthetic qualities of taste and odor in drinking water. Ground water quality standards are proposed by the Karuk Tribe under the Water Pollution Control Program.

4.3 Summary of Ground Water Quality

Herbicides, nitrate, and bacteria are the major contaminants of concern. Herbicide spraying has been practiced by the U.S. Forest Service since the 1950's in areas that include drinking water recharge areas for Tribal domestic supply wells. Nitrate and bacteria are a concern for Tribal domestic supply wells located nearby septic systems.

4.4 Summary of Ground Water - Surface Water Interaction

The possibility exists that there may be some shallow drinking water supply wells located in the alluvium of the Klamath River or its tributaries. An effort to identify these wells will be made as part of the ground water assessment program.

Table 4-2 Summary of Tribal Ground Water Protection Programs

Programs or Activities	Check (✓)	Implementation Status	Responsible Tribal Agency
Active SARA Title III Program			
Ambient ground water monitoring system	✓	under development	Dept. of Nat. Res.
Aquifer vulnerability assessment			
Aquifer mapping			
Aquifer characterization			
Comprehensive data management system			
EPA-endorsed Core Comprehensive Tribal Ground Water Protection Program			
Ground water discharge permits			
Ground water Best Management Practices			
Ground water legislation	✓	proposed	Dept. of Nat. Res.
Ground water classification	✓	proposed	Dept. of Nat. Res.
Ground water quality standards	✓	proposed	Dept. of Nat. Res.
Interagency coordination for ground water protection initiatives			
Nonpoint source controls			
Pesticide Tribal Management Plan			
Pollution Prevention Program			
Resource Conservation and Recovery Act(RCRA) Primacy			
Source Water Assessment Program			
Tribal Superfund			
Tribal RCRA Program incorporating more stringent requirements than RCRA Primacy			
Tribal septic system regulations			
Underground storage tank installation requirements			
Underground Storage Tank Remediation Fund			
Underground Storage Tank Permit Program			
Underground Injection Control Program			
Vulnerability assessment for drinking water/wellhead protection			
Well abandonment regulations			
Wellhead Protection Program (EPA-approved)			
Well installation regulations			
Other programs or activities			

5.0 References

Balance Hydrologic, Inc. (Prepared by Barry Hecht and Gregory R. Kamman). 1996. Initial Assessment of Pre- and Post- Klamath Project Hydrology on the Klamath River and Impacts of the Project on Instream Flows and Fishery Habitat. Berkeley, California.

Carlson, R.E. 1977. A Trophic State Index for Lakes. Limnology 23.

California Department of Water Resources. 1986, 1987. Shasta/Klamath Rivers Water Quality Study. Sacramento, California.

COE (U.S. Army Corps of Engineers). 1987. U.S. Army Corps of Engineers Wetlands Delineation Manual. Technical Report Y-87-1. Vicksburg, Mississippi.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. KWS/OBS - 79/31. Washington, DC.

de la Fuente, J. and P.A. Haessig. 1994 (Revised). Salmon Sub-Basin Sediment Analysis. USDA Forest Service. Klamath National Forest. Yreka, California.

Eisler, R. 1987. Mercury hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildlife Service Biological Report 85 (1.10).

___. 1986. Chromium hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildlife Service Biological Report 85 (1.6).

___. 1985. Cadmium hazards to fish, wildlife, and invertebrates: a synoptic review. U.S. Fish and Wildlife Service Biological Report 85 (1.2).

FDA (U.S. Food and Drug Administration). 1982. Levels for poisonous or deleterious substances in human food and animal feed. Washington, DC.

Gibson, J. H., J.N. Gallaway, C. Schofield, W. McFee, R. Johnson, S. McCarley, N. Dise, and D. Herzog. 1983. Rocky Mountain Acidification Study. FWS/OBS 80/40.17. Air Pollution and Acid Rain Report No. 17. USFWS.

Hem. J.D. 1985. Study and Interpretation of the Chemical Characteristics of Natural Water. USGS Water-Supply Paper 2254. Third Edition.

International Joint Commission (IJC) United States and Canada. 1988. Great Lakes water quality agreement. Amended by protocol signed November 18, 1987. Ottawa, Canada.

The Klamath River Fisheries Task Force. 1991. Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program. USFWS Klamath River Fishery Resource Office. Yreka, California.

Mason, C.F. 1991. Biology of Freshwater Pollution. Second Edition. Longman Scientific & Technical. New York.

National Academy of Sciences, National Academy of Engineering. 1973. Section III-freshwater aquatic life and wildlife, water quality criteria. Ecological Research Series, EPA-R3-73-033: 106-213.

Olem, H., and G. Flock, eds. 1990. Lakes and Reservoir Restoration Guidance Manual. 2nd Edition. USEPA 440/4-90-006. Prepared by the North American Lake Management Society for the USEPA. Washington, D.C.

Schacklette, H.T., and J.G. Boerngen. 1984. Element concentrations in soils and other surficial materials of the conterminous United States. USGS Professional Paper 1270.

Schmitt, C.J. and W.G. Brumbaugh. 1990. National contaminant biomonitoring program: concentrations of arsenic, cadmium, copper, lead, mercury, selenium, and zinc in U.S. freshwater fish, 1967-1984. Arch. Environ. Contamin. Toxicol. 19: 731-747.

Schmitt, C.J., J.L. Zajicek, and P.H. Peterman. 1990. National contaminant biomonitoring program: residues of organochlorine chemicals in U.S. freshwater fish, 1976-1984. Arch. Environ. Contam. Toxicol. 19:748-781.

Trihey & Associates, Inc. 1996. Instream Flow Requirements for Tribal Trust Species in the Klamath River. Concord, California.

U.S. Environmental Protection Agency. 1998. Clean Water Action Plan: Restoring and Protecting America's Waters. Washington, D.C.

Water Quality Technology, Inc. 1999. Preliminary Draft Water Quality Standards for the Karuk Tribe of California Trust Lands. Fort Collins, Colorado.

STATE OF CALIFORNIA RESOURCES AGENCY DEPARTMENT OF FISH AND GAME

Recovery Strategy for California Coho Salmon

Report to the California Fish and Game Commission

PREPARED BY
The California Department of Fish and Game

Species Recovery Strategy 2004-1

FEBRUARY 2004

California Department of Fish and Game. 2004. Recovery strategy for California coho salmon. Report to the California Fish and Game Commission. 594 pp. Copies/CDs available upon request from California Department of Fish and Game, Native Anadromous Fish and Watershed Branch, 1416 9th Street, Sacramento, CA 95814, or on-line: http://www.dfg.ca.gov/nafwb.cohorecovery

Acknowledgments

We thank the Range-wide Coho Salmon Recovery Team and the Shasta-Scott Recovery Team for their assistance in the Department's development of this Recovery Strategy for coho salmon in California. Team members and alternates contributed valuable information and time to the process. We gratefully acknowledge Sandra Rennie, and Robert Barrett and Carolyn Penny for facilitating the Range-wide and Shasta-Scott recovery teams, respectively. Sandy Guldman, Barbara Leitner, and Doug Donaldson provided invaluable support for both teams. We would also like to thank the many others who provided information and knowledge to both recovery teams and to the Department during the development of the Recovery Strategy.

RECOVERY TEAM MEMBERS AND ALTERNATES

RANGE-WIDE COHO SALMON RECOVERY TEAM – MEMBERS/ALTERNATES, AND AFFILIATIONS:

Craig Bell/Richard Gienger
Sierra Club

Deborah McKee/Chris Collison
California Dept. of Transportation

Joe Blum/Greg Bryant and
Charlotte Ambrose
NOAA Fisheries

Leslie Friedman Johnson/Wendy Millet
The Nature Conservancy

Walter Duffy
Humboldt State University

Larry Moss/Bill Yeates
Smith River Alliance

Lawrence Dwight/William Thomas
California Cattlemen's Association

Gail Newton/Kevin Shaffer
California Dept. of Fish and Game

Dan Gale/Dave Hillemeier
Yurok Tribe

Peter Parker/Dan Weldon
Forest Landowners of California

Pam Giacomini/George Gomes
California Farm Bureau

Randy Poole/Jean Baldrige (Entrix)
Sonoma County Water Agency

Steve Herrera
State Water Quality Control Board

Mark Rentz/Dave Bischel
California Forestry Association

George Kautsky/Mike Orcutt
Hoopa Tribe

Jimmy Smith/Vivian Helliwell
Pacific Coast Federation of Fishermen's Association

Kallie Kull/Liz Lewis
FishNet 4C

Stephanie Tom-Coupe
California Dept. of Fish and Game

Dean Lucke/Jerry Ahlstrom and
Duane Shintaku
California Dept. of Forestry & Fire Protection

Tom Weseloh/Stan Griffin
CalTrout/California Trout Unlimited

Mark Lancaster
Five Counties Salmonid Conservation Plan Advisory Committee

SHASTA-SCOTT RECOVERY TEAM – MEMBERS/ALTERNATES, AND AFFILIATIONS:

Terry Anderson
Recreational Angling

Don Howell
Siskiyou Resource Conservation District

Martin Andreas
Save Our Shasta & Scott River Valleys & Towns

Craig Martz/Steve Burton
California Dept. of Fish and Game

William Bennett/Dwight Russell
California Dept. of Water Resources

R. Howard Moody/James DePree
Siskiyou County

Gary Black/Mike Bryan
Scott River Watershed Council

Mary Roehrich/Curtis Knight
Mt. Shasta Area Audubon/California Trout Unlimited

Greg Bryant/Don Flickinger
NOAA Fisheries

Lisa Thompson
U.C. Davis Cooperative Extension

Phillip Detrich/Jennifer Silveira
U.S. Fish and Wildlife Service

Dave Webb
Shasta River Coordinated Resource Management Plan

Blair Hart
Shasta Valley Resource Conservation District

In remembrance of Joseph R. Blum, NOAA Fisheries, who died suddenly on April 7, 2004, we would like to acknowledge his exceptional contributions to this Recovery Strategy. Joe brought a special blend of dedication, professionalism, and creativity to the Coho Recovery Team meetings. His dedication to the conservation of fish, wildlife, and the environment, was evident to all he worked with. His collaborative efforts will be missed at future Coho Recovery Team meetings.

Executive Summary

The California Department of Fish and Game (Department), with the assistance of recovery teams representing diverse interests and perspectives, created the *Recovery Strategy for California Coho Salmon (Oncorhynchus kisutch)* (Recovery Strategy), a guide for the process of recovering coho salmon on the north and central coasts of California. The Recovery Strategy is organized at three scales. The first is at a broad geographic, range-wide resolution; the second is at a large watershed scale; and the third is at a finer scale that identifies actions needed within specific sub-watersheds.

The Recovery Strategy emphasizes cooperation and collaboration at many levels, and recognizes the need for funding, public and private support for restorative actions, and maintaining a balance between regulatory and voluntary efforts. Landowner incentives and grant programs are some of the many tools available to recover coho salmon. However, the success of this Recovery Strategy will ultimately be determined by the long-term commitment and efforts of all who live in, or are involved with, coho salmon watersheds. The Department believes that the commitment is there and that the execution of this plan will ultimately lead to the recovery of coho salmon throughout its California range.

BACKGROUND

A citizen's group called the Salmon and Steelhead Recovery Coalition petitioned the Fish and Game Commission (Commission) to list coho salmon north of San Francisco as an endangered species under the California Endangered Species Act (CESA) (FGC §2050 *et seq.*). In response to the petition, the Department issued a report to the Commission describing the status of coho salmon north of San Francisco (April 2002), recommending that coho salmon from San Francisco north to Punta Gorda be listed as endangered and that coho salmon from Punta Gorda north to the Oregon border be listed as threatened pursuant to the provisions of CESA. The division of coho salmon in California at Punta Gorda follows the Federal designation of Evolutionarily Significant Units (ESU): the California Central Coast (CCC) Coho ESU and the Southern Oregon-Northern California Coasts (SONCC) Coho ESU. On August 30, 2002, the Commission found that coho salmon warranted listing per the Department's recommendations.[1]

The Department's recommendations and the Commission's decision were based on the best available information, which indicates coho salmon from San Francisco to the Oregon border have experienced a significant decline in the past 40 to 50 years. Coho salmon, including hatchery stocks, are currently six to 15 percent of their abundance during the 1940s. Coho salmon harvest decreased considerably in the late 1970s, despite a fairly stable rate of hatchery production. Recent abundance-trend information for several stream systems along the central and north coasts indicates an overall declining trend throughout California.

[1] Coho salmon south of San Francisco were previously listed as endangered by the State in 1994. The National Marine Fisheries Service (NMFS) listed coho salmon in the Central California Coast Evolutionarily Significant Unit (ESU) as threatened in 1996, and in the Southern Oregon/Northern California Coasts ESU as threatened in 1997, under the Federal Endangered Species Act of 1973.

In accordance with the Commission's direction and statutory requirements, the Department established a 21-member Coho Salmon Recovery Team (CRT) to focus on the species range-wide, and a 13-member local Shasta-Scott Recovery Team (SSRT) to focus on water and land use associated with agricultural practices in the Shasta and Scott river valleys in Siskiyou County. Tremendous effort, over a very constricted timeframe, was expended by both teams as members labored in good faith to find solutions to seemingly intractable problems. The Department is indebted to all team members for their creativity, perseverance, and valuable contributions to the completion of this critically important document. The teams provided numerous recommendations for the Department to consider in the development of this Recovery Strategy.

Rather than proceeding immediately with regulatory action to add the species to the threatened and endangered species lists, the Commission, pursuant to Fish and Game Code (FGC) §2114, deferred the regulatory action and directed the Department to prepare a recovery strategy for coho salmon within 12 months in accordance with FGC §2105 *et seq*. The Commission subsequently extended this deadline to February 2004. On February 4, 2004, the Commission adopted the Recovery Strategy, with amendments and inclusive of the selected timber management alternative.

RECOVERY GOALS

The primary objective of this Recovery Strategy is to return coho salmon to a level of sustained viability, while protecting the genetic integrity of both ESUs, so that they can be delisted and regulations or other protections under the CESA (FGC §2050 *et seq*.) will not be necessary. The Department defines sustained viability as a future condition when naturally producing coho salmon are adequately abundant and occupy a sufficient range and distribution to ensure against extinction due to environmental fluctuations, stochastic events, and human land- and water-use impacts.

A second objective of this Recovery Strategy is to achieve harvestable populations of coho salmon for Tribal, recreational, and commercial fisheries, so important to the cultural and economic well-being of California. The Department intends to continue its partnership with all stakeholders to implement appropriate portions of this plan to achieve this objective once the coho salmon has been delisted. Improving coho salmon populations and habitat is the means to achieve these two objectives.

Five goals have been identified to achieve delisting:

GOAL I Maintain and improve the number of key populations and increase the number of populations and cohorts of coho salmon.

GOAL II Maintain and increase the number of spawning adults.

GOAL III Maintain the range, and maintain and increase distribution of coho salmon.

GOAL IV Maintain existing habitat essential for coho salmon.

GOAL V Enhance and restore habitat within the range of coho salmon.

An additional goal[2] has been identified for the second objective, which is to:

GOAL VI Reach and maintain coho salmon population levels to allow for the resumption of Tribal, recreational, and commercial fisheries for coho salmon in California.

[2] This additional goal meets the requirements of FGC §2111(e), which was added by SB 216 (Statutes 2003 Chap. 854). This goal does not affect the first objective of the Recovery Strategy or the goals to achieve delisting.

RECOVERY IMPLEMENTATION

The causes for the decline of coho salmon are many and complex. In general, coho salmon require adequate flows, cold water, streamside shade, instream shelter and pools, and access to spawning gravels with a low fine sediment component. Protection of the best remaining habitat, especially in areas where coho salmon are still present, and improvements to degraded habitat are both necessary to recover coho salmon. Each of the recommendations addresses these two aspects of coho salmon recovery. On the whole, the strategy for recovery of coho salmon involves several approaches:

a. Interim and long-term actions;
b. Equitable apportionment of both public and private support and action;
c. Equitable apportionment of regulatory and nonregulatory obligations;
d. Scientifically, technologically, and economically reasonable means;
e. Best available scientific data;
f. Financial investments; and
g. Long-term commitment and efforts of all involved in coho salmon watersheds.

This document includes over 85 range-wide recommendations, 320 watershed recommendations for the SONCC Coho ESU, 205 watershed recommendations for the CCC Coho ESU, and 145 watershed recommendations for the Shasta-Scott Pilot Program (SSPP). Three alternative recommendations for timber management were presented to the Commission in February 2004. The timber alternative recommended by the Department and approved by the Commission (Alternative C, with amendments) has been incorporated into this document.

As an example of range-wide recommendations, the following was taken from Chapter 7:

7.3 FISH PASSAGE

RW-III-A-01	Continue and complete assessments and prioritizations for correction of fish passage barriers.
RW-III-A-02	Develop and maintain a database of barriers to fish passage.
RW-III-C-01	Encourage funding authorities to allocate adequate resources to construct new crossings and upgrade existing crossings (bridges, culvert and fills, other crossings) within the range of coho salmon to accommodate 100-year flows and associated bedload and debris. Priority for upgrading should be based upon the potential impact to coho salmon habitat.

As an example of watershed recommendations, the following was taken from Chapter 8 for the Albion River HSA:

8.2.1.1 Albion River HSA

MC-AR-01	Place instream structures to improve gravel retention and habitat complexity.
MC-AR-02	Provide technical assistance and incentives to landowners in developing and implementing sediment reduction plans to meet requirements of the CWA TMDL, making watersheds with an implementation schedule the highest priority.
MC-AR-03	Conduct collaborative evaluations of priorities for treatment of barriers such as Fish Passage Forum.

Implementation schedules (presented in Chapters 9 and 10) provide stakeholders with an easy manual for restoration; that is, they can find a watershed of interest and then consider implementing the tasks for that watershed according to the task-levels assigned, or they can find a high priority watershed and then propose implementing the tasks accordingly. The prioritization of watersheds and tasks will assist the recovery effort by ensuring that limited public and private funds are directed where they will likely contribute most to coho salmon recovery.

As an example of an implementation schedule, here are the table entries from Chapter 9 for the Albion River HSA:

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION
Albion River HSA					
5	C	MC-AR-01	Place instream structures to improve gravel retention and habitat complexity.	**Potential Lead:** CDFG **Others:** Landowners, CCC, CDF, Watershed Groups, Mendocino County, RCDs	Interim/ Continual
5	C	MC-AR-02	Provide technical assistance and incentives to landowners in developing and implementing sediment reduction plans to meet requirements of the CWA TMDL, making watersheds with an implementation schedule the highest priority.	**Potential Lead:** NCRWQCB **Others:** CDFG, EPA, NOAA Fisheries, RCDs, Mendocino County, CDF, DPR	Interim
5	C	MC-AR-03	Conduct collaborative evaluations of priorities for treatment of coho salmon passage barriers, such as the Fish Passage Forum.	**Potential Lead:** CDFG, NOAA Fisheries, Caltrans, Mendocino County Landowners, Watershed Groups.	Interim/ Continual

Successful implementation of even the highest priority tasks will require individuals, organizations, and agencies to work in concert and with a clear understanding of what must be done to complete the recommended tasks and the time frame within which the tasks should be completed. To establish and maintain the coordination necessary for coho salmon recovery, the Department will designate a range-wide coordinator and at least one regional coordinator for each of the Department's central and northern coastal regions. The coordinators will work with the appropriate Department personnel, representatives from other agencies, watershed groups, landowners, and private and non-profit entities to leverage resources and coordinate recovery tasks. These tasks address coho salmon population and habitat protection and restoration, cooperation and collaboration between public and private entities, education and outreach, implementation and enforcement of existing laws, improved land management, assessment, monitoring and research, and better coordination among funding agencies for grant programs.

RECOVERY COSTS

An economic evaluation estimated the costs required to implement the Recovery Strategy. The total cost of the Recovery Strategy is about 4.5 billion dollars. However, this figure does not account for the cost of water acquisition for areas outside of the Scott and Shasta valleys. If water acquisition costs in other areas of the SONCC Coho ESU and in the CCC Coho ESU are proportional to those in the SSPP (where water acquisition accounts for about 20 percent of the total), it is likely that the costs of Recovery Strategy implementation will be closer to 5 billion dollars.

Although coho salmon recovery will have significant costs, it will also provide economic benefits. While this report does not quantify the economic benefits, they will very likely exceed the cost of recovery. The recovery of coho salmon to the point where they can be delisted will provide an economic stimulus to the coastal economy due to the lifting of regulatory requirements associated with a listed species. Benefits associated with Federally reserved fishing rights, increased commercial land and water use activities, multiple species benefits, improved water quality, and watershed health will be realized. The process of conducting restoration projects will create local jobs, and the flow of restoration dollars will have significant direct and trickle-down benefits to economically depressed coastal communities. Recovering coho salmon to the point of sustained harvestable surpluses will provide economic expansion to the commercial and recreational fishing industries, and to the businesses and communities that depend on them. Harvestable surpluses will also provide direct economic benefit to Tribal fisheries.

Coho salmon recovery can also result in benefits associated with non-use values. These values include intrinsic values, which are based simply on the knowledge of the resource's existence, and bequest values which confer value to the resource for the benefit of future generations. For California coho salmon recovery, these could be significantly higher than the fiscal costs of recovery.

It should be clearly understood that coho salmon recovery will not require the identification of five billion dollars of "new" funds. Many sources of funds are already being directed at coho salmon recovery directly or at ecosystem restoration at the watershed level, which will likewise facilitate recovery. Examples of existing programs that address coho salmon recovery goals include the Department's Fisheries Restoration Grant Program, the California Coastal Conservancy's grant programs, and the various programs authorized by the Federal Farm Bill (Section 5.2). Many in-kind donations from the private sector of time, equipment, and expertise will continue to defray the total cost of recovery. The Recovery Strategy also identifies where existing local, State and Federal programs could be reprioritized and staff redirected to accomplish critical tasks.

Successful recovery of coho salmon will require a sustained long-term commitment of significant amounts of public and private funding, sufficient staff to provide technical assistance, and an accountable grant funding infrastructure. It is imperative that public funds spent on this effort are invested in scientifically sound projects that help coho salmon where they need it most. It is also important that the effort be coordinated among all agencies that fund watershed projects within the range of California coho salmon.

Table of Contents

1 Introduction

- **1.1 STATE OF CALIFORNIA COHO SALMON LISTING ACTIONS** . . . 1.1
- **1.2 FEDERAL COHO SALMON LISTING ACTIONS** . . . 1.2
- **1.3 STRATEGIC PLANNING FOR RECOVERY** . . . 1.2
  - 1.3.1 FISH AND GAME COMMISSION ACTION . . . 1.2
  - 1.3.2 DEPARTMENT OF FISH AND GAME ACTION . . . 1.3
  - 1.3.3 RANGE-WIDE COHO SALMON RECOVERY TEAM . . . 1.3
  - 1.3.4 SHASTA-SCOTT RECOVERY TEAM . . . 1.4
  - 1.3.5 FEDERAL TECHNICAL RECOVERY TEAMS . . . 1.4
- **1.4 RECOVERY STRATEGY FOR COHO SALMON IN CALIFORNIA** . . . 1.5
  - 1.4.1 GENERAL GOALS . . . 1.5
  - 1.4.2 ELEMENTS NECESSARY TO ACHIEVE RECOVERY GOALS . . . 1.6
  - 1.4.3 IMPLEMENTATION . . . 1.6
    - 1.4.3.1 Interim Actions . . . 1.7
    - 1.4.3.2 Long-term Actions . . . 1.7
  - 1.4.4 ADAPTIVE MANAGEMENT . . . 1.7

2 Biology

- **2.1 RANGE** . . . 2.1
- **2.2 EVOLUTIONARILY SIGNIFICANT UNITS** . . . 2.1
  - 2.2.1 SOUTHERN OREGON/NORTHERN CALIFORNIA COASTS COHO ESU . . . 2.2
  - 2.2.2 CENTRAL CALIFORNIA COAST COHO ESU . . . 2.5
- **2.3 PRESENT DISTRIBUTION** . . . 2.5
- **2.4 LIFE HISTORY** . . . 2.5
- **2.5 POPULATION STRUCTURE AND VIABILITY** . . . 2.9
  - 2.5.1 POPULATION STRUCTURE . . . 2.10
  - 2.5.2 POPULATION VIABILITY . . . 2.11
- **2.6 GENETICS** . . . 2.11
- **2.7 HABITAT REQUIREMENTS** . . . 2.13
  - 2.7.1 HABITAT REQUIREMENTS FOR ADULTS . . . 2.13
    - 2.7.1.1 Migration . . . 2.13
    - 2.7.1.2 Spawning . . . 2.17
  - 2.7.2 HABITAT REQUIREMENTS FOR JUVENILES . . . 2.18
    - 2.7.2.1 Eggs and Alevin Incubation . . . 2.18
    - 2.7.2.2 Fry Emergence . . . 2.18
    - 2.7.2.3 Juvenile Rearing . . . 2.19
    - 2.7.2.4 Emigration . . . 2.19
  - 2.7.3 ESTUARINE HABITAT . . . 2.20

2.7.4 SUMMARY OF ESSENTIAL HABITAT . . . 2.20
2.7.4.1 Stream Vegetation . . . 2.21
2.7.4.2 Large Woody Debris . . . 2.21
2.7.4.3 Sediment and Substrate . . . 2.21
2.7.4.4 Hydrological Regime . . . 2.21
2.7.4.5 Water Temperature . . . 2.23
2.7.4.6 Dissolved Oxygen . . . 2.23

3 Threats

3.1 CLIMATIC VARIATION . . . 3.1
3.1.1 DROUGHT . . . 3.1
3.1.2 FLOODING . . . 3.2
3.1.3 OCEAN CONDITIONS . . . 3.2
3.2 DISEASE . . . 3.3
3.3 PREDATION . . . 3.3
3.3.1 FRESHWATER PREDATION . . . 3.3
3.3.2 MARINE PREDATION . . . 3.4
3.4 HATCHERIES . . . 3.5
3.5 GENETIC DIVERSITY . . . 3.5
3.6 LAND USES . . . 3.8
3.6.1 FORESTRY ACTIVITIES . . . 3.8
3.6.2 WATER DIVERSIONS AND FISH SCREENS . . . 3.11
3.6.3 INSTREAM FLOWS . . . 3.12
3.6.4 ARTIFICIAL BARRIERS . . . 3.12
3.6.5 GRAVEL EXTRACTION . . . 3.13
3.6.6 SUCTION DREDGING . . . 3.14
3.6.7 STREAMBED ALTERATION . . . 3.15
3.6.8 WATER QUALITY . . . 3.15
3.6.9 AGRICULTURAL IMPACTS . . . 3.15
3.6.10 URBANIZATION AND URBAN IMPACTS . . . 3.19
3.6.10.1 Alteration of Natural Vegetation . . . 3.19
3.6.10.2 Disrupted Hydrological Processes and Reduced Stream Complexity . . . 3.19
3.6.10.3 Degradation of Soil Function . . . 3.20
3.6.10.4 Impaired Water Quality . . . 3.20
3.6.10.5 Barriers to Passage . . . 3.21
3.6.10.6 Degraded Biological Diversity and Habitat Suitability . . . 3.21
3.6.11 FISHING . . . 3.22
3.6.12 ILLEGAL HARVEST . . . 3.22

4 Recovery Goals and Delisting Criteria

4.1 FRAMEWORK FOR RECOVERY . . . 4.2
4.1.1 RECOVERY GOALS AND DELISTING CRITERIA . . . 4.3
4.1.1.1 Recovery Goals, Delisting Criteria, and Progress Evaluation . . . 4.4
4.1.1.2 Recovery Units . . . 4.6
4.1.2 DELISTING AND DOWNLISTING TARGETS . . . 4.9
4.1.2.1 Targets for Coho Salmon Populations: Goals I, II, and III . . . 4.9
4.1.2.2 Targets for Coho Salmon Habitat: Goals IV and V . . . 4.10

4.2 FISHERIES RESTORATION GOAL 4.11
4.2.1 RECREATIONAL FISHING 4.12
4.2.2 COMMERCIAL FISHING 4.13

5 Elements Necessary for Recovery

5.1 ROLE OF PUBLIC LANDS 5.1
5.1.1 FEDERAL LANDS 5.1
5.1.1.1 U.S. Forest Service 5.1
5.1.1.2 U.S. Bureau of Land Management 5.2
5.1.1.3 U.S. National Park Service 5.2
5.1.1.4 U.S. Department of Defense 5.2
5.1.1.5 U.S. Fish and Wildlife Service 5.5
5.1.1.6 U.S. Bureau of Reclamation 5.5
5.1.2 STATE LANDS 5.5
5.1.2.1 California Department of Parks and Recreation 5.5
5.1.2.2 California Department of Forestry and Fire Protection 5.5
5.1.2.3 California State Lands Commission 5.6
5.1.2.4 California Department of Fish and Game 5.6
5.1.3 COUNTY AND CITY LANDS 5.6
5.2 FUNDING FOR PRIVATE AND PUBLIC COOPERATION 5.6
5.2.1 EXISTING PROGRAMS 5.7
5.2.1.1 Fisheries Restoration Grants Program 5.7
5.2.1.2 California Department of Conservation Grant Program 5.8
5.2.1.3 Environmental Enhancement and Mitigation Program 5.8
5.2.1.4 Department of Water Resources Grant Program 5.9
5.2.1.5 California Coastal Conservancy Program 5.9
5.2.1.6 Watershed and Nonpoint Source Pollution Control Programs 5.9
5.2.1.7 Farm Bill Grants 5.10
5.2.1.8 NOAA Community-based Restoration Program 5.13
5.2.1.9 A Targeted Incentive Program 5.14
5.2.1.10 Other Programs 5.14
5.2.2 MINIMIZING SOCIAL AND ECONOMIC IMPACTS 5.14
5.2.3 VOLUNTARY INCENTIVES 5.14
5.3 OUTREACH AND EDUCATION 5.15
5.3.1 RECOVERY STRATEGY RECOMMENDATIONS 5.15
5.3.2 EDUCATION AND OUTREACH PLAN 5.15
5.3.2.1 School Curricula 5.15
5.3.2.2 Interpretive Media 5.16
5.4 ASSESSMENT, MONITORING, AND RESEARCH 5.16
5.4.1 PROGRAM FRAMEWORK 5.16
5.4.1.1 Scientific Planning and Prioritization 5.16
5.4.1.2 Evaluating Current Monitoring 5.17
5.4.1.3 Data Management 5.17
5.4.1.4 New Research 5.17
5.4.1.5 Program Reporting 5.19
5.4.2 ASSESSMENT 5.19

5.4.3 MONITORING . . . 5.19
5.4.3.1 Three-tiered Monitoring Framework . . . 5.20
5.4.3.2 Monitoring of Coho Salmon . . . 5.21
5.4.4 NEW RESEARCH . . . 5.22
5.4.5 ASSESSMENT, MONITORING, AND RESEARCH RECOMMENDATIONS . . . 5.22
5.5 REGULATORY ROLE IN RECOVERY . . . 5.22

6 Recovery Units and Watersheds

6.1 RECOVERY UNITS IN THE SONCC COHO ESU . . . 6.1
6.1.1 ROGUE RIVER AND WINCHUCK RIVER HYDROLOGIC UNITS . . 6.1
6.1.1.1 Illinois River HSA . . . 6.1
6.1.1.2 Winchuck River HSA . . . 6.1
6.1.2 SMITH RIVER HYDROLOGIC UNIT . . . 6.4
6.1.2.1 Mill Creek HSA . . . 6.4
6.1.2.2 Wilson Creek HSA . . . 6.4
6.1.3 KLAMATH RIVER HYDROLOGIC UNIT . . . 6.9
6.1.3.1 Klamath Glen HSA . . . 6.9
6.1.3.2 Orleans HSA . . . 6.10
6.1.3.3 Ukonom HSA . . . 6.10
6.1.3.4 Happy Camp HSA . . . 6.10
6.1.3.5 Seiad Valley HSA . . . 6.10
6.1.3.6 Beaver Creek HSA . . . 6.10
6.1.3.7 Hornbrook HSA . . . 6.10
6.1.3.8 Iron Gate HSA . . . 6.11
6.1.3.9 Copco Lake HSA . . . 6.11
6.1.4 SALMON RIVER HYDROLOGIC AREA . . . 6.11
6.1.4.1 Lower Salmon HSA . . . 6.11
6.1.4.2 Wooly Creek HSA . . . 6.11
6.1.4.3 Sawyers Bar HSA . . . 6.12
6.1.4.4 Cecilville HSA . . . 6.12
6.1.5 SHASTA VALLEY HYDROLOGIC AREA . . . 6.12
6.1.6 SCOTT RIVER HYDROLOGIC AREA . . . 6.12
6.1.7 TRINITY RIVER HYDROLOGIC UNIT . . . 6.15
6.1.7.1 Douglas City HSA . . . 6.16
6.1.7.2 Grouse Creek HSA . . . 6.16
6.1.7.3 Hyampom HSA . . . 6.16
6.1.7.4 Hayfork HSA . . . 6.16
6.1.8 MAD RIVER HYDROLOGIC UNIT . . . 6.16
6.1.9 REDWOOD CREEK HYDROLOGIC UNIT . . . 6.19
6.1.10 TRINIDAD HYDROLOGIC UNIT . . . 6.19
6.1.10.1 Big Lagoon HSA . . . 6.20
6.1.10.2 Little River HSA . . . 6.20
6.1.11 EUREKA PLAIN HYDROLOGIC UNIT . . . 6.20
6.1.12 EEL RIVER HYDROLOGIC UNIT . . . 6.23
6.1.12.1 Ferndale HSA . . . 6.24
6.1.12.2 Scotia HSA . . . 6.24
6.1.12.3 South Fork Eel River HA . . . 6.24

6.1.12.4 Weott HSA 6.24
6.1.12.5 Benbow HSA 6.24
6.1.12.6 Laytonville HSA 6.27
6.1.12.7 Outlet Creek HSA 6.27
6.1.13 CAPE MENDOCINO HYDROLOGIC UNIT 6.27
6.1.13.1 Northern Subbasin of Mattole HSA 6.28
6.1.13.2 Eastern Subbasin of Mattole HSA 6.28
6.1.13.3 Southern Subbasin of Mattole HSA 6.28
6.1.13.4 Western Subbasin of Mattole HSA 6.28
6.1.13.5 Estuary Subbasin of Mattole HSA 6.28
6.2 RECOVERY UNITS IN THE CCC COHO ESU 6.31
6.2.1 MENDOCINO COAST HYDROLOGIC UNIT 6.31
6.2.1.1 Albion River HSA 6.31
6.2.1.2 Big River HSA 6.34
6.2.1.3 Garcia River HSA 6.34
6.2.1.4 Navarro River HSA 6.34
6.2.1.5 Noyo River HSA 6.34
6.2.1.6 Ten Mile River HSA 6.34
6.2.1.7 Gualala River HSA 6.37
6.2.2 RUSSIAN RIVER HYDROLOGIC UNIT 6.37
6.2.2.1 Russian River Mainstem 6.38
6.2.2.2 Guerneville HSA 6.38
6.2.2.3 Austin Creek HSA 6.38
6.2.2.4 Warm Springs HSA 6.41
6.2.2.5 Mark West Creek HSA 6.41
6.2.2.6 Santa Rosa Creek HSA 6.41
6.2.2.7 Forsythe Creek HSA 6.42
6.2.2.8 Geyserville HSA 6.42
6.2.3 BODEGA AND MARIN COASTAL HYDROLOGIC UNITS 6.43
6.2.3.1 Salmon Creek HSA 6.43
6.2.3.2 Walker Creek HSA 6.43
6.2.3.3 Lagunitas Creek HSA 6.44
6.2.3.4 Bolinas HSA 6.44
6.2.4 SAN FRANCISCO BAY HYDROLOGIC UNITS 6.45
6.2.5 SAN MATEO HYDROLOGIC UNIT 6.45
6.2.5.1 San Gregorio Creek HSA 6.46
6.2.5.2 Año Nuevo (Gazos Creek) HSA 6.49
6.2.6 BIG BASIN HYDROLOGIC UNIT 6.49
6.2.6.1 Davenport HSA 6.50
6.2.6.2 San Lorenzo River HSA 6.50
6.2.6.3 Aptos-Soquel HSA 6.53
6.3 WATERSHED PRIORITIZATION 6.53
6.3.1 GENERAL PRINCIPLES 6.54
6.3.2 PRIORITIZATION PROCESS 6.55
6.3.2.1 Identify Refugia Watersheds and Risk of Extinction 6.55
6.3.2.2 Identify Restoration Potential 6.55
6.3.2.3 Identify Disconnected Habitats 6.56

7 Range-wide Recommendations

7.1 STREAM FLOW 7.1
7.2 WATER RIGHTS 7.2
7.3 FISH PASSAGE 7.3
7.4 POLLUTANTS 7.3
7.5 SEDIMENTS 7.4
7.6 WATER TEMPERATURE 7.4
7.7 LARGE WOODY DEBRIS 7.5
7.8 STREAM COMPLEXITY 7.5
7.9 REFUGIA 7.5
7.10 HABITAT FRAGMENTATION 7.6
7.11 COMPETITION 7.6
7.12 HATCHERY OPERATIONS, GENETICS, AND RELOCATION 7.6
7.13 RIPARIAN VEGETATION 7.6
7.14 ESTUARIES 7.7
7.15 LAND USE 7.7
7.16 PUBLIC OUTREACH 7.8
7.17 INTEGRATION WITH OTHER PLANS AND PROGRAMS 7.8
7.18 PERMITTING 7.10
7.19 WATERSHED PLANNING 7.11
7.20 ENFORCEMENT OF EXISTING LAWS 7.12
7.21 IMPLEMENTATION 7.13
7.22 INSTREAM GRAVEL MINING 7.14
7.23 ASSESSMENT, MONITORING, AND RESEARCH 7.14
7.24 TIMBER MANAGEMENT 7.15

8 Watershed Recommendations

8.1 SOUTHERN OREGON/NORTHERN CALIFORNIA COASTS ESU 8.1
8.1.1 ROGUE RIVER AND WINCHUCK RIVER HYDROLOGIC UNITS . . 8.1
8.1.1.1 Illinois River HSA 8.1
8.1.1.2 Winchuck River Hydrologic Unit/Winchuck River HSA 8.2
8.1.2 SMITH RIVER HYDROLOGIC UNIT 8.2
8.1.2.1 Mill Creek HSA 8.2
8.1.2.2 Wilson Creek HSA 8.3
8.1.2.3 Smith River Plain HSA 8.3
8.1.3 KLAMATH RIVER HYDROLOGIC UNIT 8.3
8.1.3.1 Klamath Glen HSA 8.4
8.1.3.2 Orleans HSA 8.7
8.1.3.3 Ukonom HSA 8.8
8.1.3.4 Happy Camp HSA 8.9
8.1.3.5 Seiad Valley HSA 8.11
8.1.3.6 Beaver Creek HSA 8.12
8.1.3.7 Hornbrook HSA 8.14
8.1.3.8 Iron Gate HSA 8.15
8.1.4 SALMON RIVER HYDROLOGIC AREA 8.16
8.1.4.1 Lower Salmon River HSA 8.16
8.1.4.2 Sawyers Bar HSA 8.17
8.1.5 SHASTA VALLEY AND SCOTT RIVER HYDROLOGIC AREAS 8.17

8.1.6 TRINITY RIVER HYDROLOGIC UNIT 8.19
8.1.6.1 Douglas City HSA 8.20
8.1.6.2 Grouse Creek HSA 8.20
8.1.6.3 Hyampom HSA 8.20
8.1.6.4 Hayfork HSA 8.20
8.1.7 MAD RIVER HYDROLOGIC UNIT 8.21
8.1.7.1 Blue Lake HSA and North Fork Mad HSA 8.22
8.1.7.2 Butler Valley HSA 8.23
8.1.8 REDWOOD CREEK HYDROLOGIC UNIT 8.23
8.1.9 TRINIDAD HYDROLOGIC UNIT 8.24
8.1.9.1 Big Lagoon HSA 8.24
8.1.9.2 Little River HSA 8.24
8.1.10 EUREKA PLAIN HYDROLOGIC UNIT 8.24
8.1.11 EEL RIVER HYDROLOGIC UNIT 8.27
8.1.11.1 Ferndale HSA 8.28
8.1.11.2 Van Duzen River HSA 8.28
8.1.11.3 Scotia HSA 8.28
8.1.11.4 South Fork Eel River HSA 8.28
8.1.11.5 Weott HSA 8.28
8.1.11.6 Benbow HSA 8.29
8.1.11.7 Laytonville HSA 8.29
8.1.11.8 Outlet Creek HSA 8.29
8.1.12 CAPE MENDOCINO HYDROLOGIC UNIT 8.30
8.1.12.1 Southern Subbasin Mattole River HSA 8.30
8.1.12.2 Western Subbasin Mattole River HSA 8.31
8.1.12.3 Northern Subbasin Mattole River HSA 8.32
8.1.12.4 Eastern Subbasin Mattole River HSA 8.32
8.2 CENTRAL CALIFORNIA COAST ESU 8.32
8.2.1 MENDOCINO COAST HYDROLOGIC UNIT 8.32
8.2.1.1 Albion River HSA 8.34
8.2.1.2 Big River HSA 8.35
8.2.1.3 Garcia River HSA 8.35
8.2.1.4 Navarro River HSA 8.36
8.2.1.5 Noyo River HSA 8.37
8.2.1.6 Ten Mile River HSA 8.38
8.2.1.7 Gualala River HSA 8.38
8.2.2 RUSSIAN RIVER HYDROLOGIC UNIT 8.39
8.2.2.1 Russian River Mainstem 8.41
8.2.2.2 Guerneville HSA 8.41
8.2.2.3 Austin Creek HSA 8.41
8.2.2.4 Warm Springs HSA 8.42
8.2.2.5 Mark West Creek HSA 8.42
8.2.2.6 Santa Rosa Creek HSA 8.42
8.2.2.7 Forsythe Creek HSA 8.42
8.2.2.8 Geyserville HSA 8.42
8.2.3 BODEGA AND MARIN COASTAL HYDROLOGIC UNITS 8.43
8.2.3.1 Salmon Creek HSA 8.44
8.2.3.2 Walker Creek HSA 8.44

8.2.3.3 Lagunitas Creek HSA 8.45
8.2.3.4 Bolinas HSA 8.46
8.2.4 SAN FRANCISCO BAY HYDROLOGIC UNITS 8.47
8.2.5 SAN MATEO HYDROLOGIC UNIT 8.47
8.2.5.1 San Gregorio Creek HSA and Pescadero Creek HSA 8.48
8.2.5.2 Año Nuevo (Gazos Creek) HSA 8.48
8.2.6 BIG BASIN HYDROLOGIC UNIT 8.49
8.2.6.1 Davenport HSA 8.49
8.2.6.2 San Lorenzo River HSA 8.50
8.2.6.3 Aptos-Soquel HSA 8.50

9 Implementation

9.1 AVAILABILITY OF FUNDS 9.1
9.2 WATERSHED PRIORITY 9.1
9.3 TASK LEVEL 9.1
9.4 TASK NUMBER 9.2
9.5 ACTION ENTITIES 9.2
9.6 ESTIMATED TIME 9.3
9.7 IMPLEMENTATION SCHEDULES 9.3

10 Shasta-Scott Pilot Program

10.1 FRAMEWORK FOR AGRICULTURAL ISSUES 10.1
10.2 ADMINISTRATION AND IMPLEMENTATION 10.2
10.3 SHASTA-SCOTT RECOMMENDATIONS AND IMPLEMENTATION SCHEDULE 10.3

11 Economics of Recovery

11.1 ECONOMIC BENEFITS 11.1
11.2 FISCAL COSTS AND SOCIOECONOMIC IMPACTS 11.1
11.2.1 UNIT COSTS 11.2
11.2.1.1 Fish Passage 11.3
11.2.1.2 Riparian Restoration 11.4
11.2.1.3 In-channel Restoration 11.4
11.2.1.4 Road Treatment and Decommissioning 11.4
11.2.1.5 Wetlands Restoration 11.4
11.2.1.6 Water Acquisition 11.5
11.2.1.7 Monitoring and Research 11.5
11.2.2 COST ESTIMATES 11.6

12 Process for Revising and Managing the Recovery Strategy

12.1 MANAGEMENT AND COORDINATION OF IMPLEMENTATION 12.1
12.2 TIMETABLE AND PROCESS FOR REPORTING AND REVISION 12.3
12.3 TIMETABLE CLARIFYING NON-SPECIFIC LONG-TERM GOALS 12.4
12.4 ADAPTIVE MANAGEMENT 12.4

13 References Cited 13.1

List of Tables

TABLE 2-1	California streams for which coho salmon genetic tissue samples have been collected, analyzed, and reported, 1982 to the present	2.12
TABLE 2-2	Freshwater habitats of the different life stages of coho salmon	2.21
TABLE 2-3	Fundamental habitat elements and suitable ranges for coho salmon life stages	2.22
TABLE 3-1	Identified concerns about maintenance of existing genetic diversity and possible causes of reduction of genetic diversity in California coho salmon	3.6
TABLE 3-2	Guidelines for number of breeders per generation and number of breeders per year needed to maintain genetic diversity in populations of California coho salmon	3.7
TABLE 3-3	Forestry activities and potential effects to stream environment, salmonid habitat, and salmonid biology	3.9
TABLE 3-4	Comparison of watercourse protection standards	3.10
TABLE 3-5	Major dams within the California portion of the SONCC Coho ESU that block coho salmon from accessing historical spawning and rearing habitat	3.14
TABLE 3-6	Major dams within the CCC Coho ESU that block coho salmon from accessing historical spawning and rearing habitat	3.14
TABLE 3-7	Clean Water Act §303(d) list of impaired water bodies within the range of coho salmon in California	3.16
TABLE 4-1	Delisting targets for the SONCC Coho ESU	4.7
TABLE 4-2	Downlisting targets for the CCC Coho ESU	4.8
TABLE 4-3	Delisting targets for the CCC Coho ESU	4.8
TABLE 4-4	Recovery units within the SONCC and CCC Coho ESUs	4.9
TABLE 5-1	Partial outline of potential ecological and land management variables for coho salmon recovery strategy assessment, monitoring, and research	5.18
TABLE 5-2	Existing laws, regulations, and permits that contribute to coho salmon recovery	5.23
TABLE 6-1	Recovery units and CALWATER watersheds in the SONCC Coho ESU	6.2
TABLE 6-2	Recovery units and CALWATER watersheds in the CCC Coho ESU	6.32
TABLE 9.1	Implementation schedule for range-wide recommendations	9.4
TABLE 9.2	Implementation schedule for SONCC Coho ESU	9.23
TABLE 9.3	Implementation schedule for CCC Coho ESU	9.65
TABLE 10.1	Recovery recommendations and implementation schedule for the Shasta-Scott Pilot Program	10.4
TABLE 11.1	Recovery strategy costs by Hydrologic Unit	11.8
TABLE 11.2	Range-wide costs	11.9
TABLE 11.3	Total estimated costs of coho salmon recovery	11.10
TABLE 11.4	Socioeconomic impacts of restoration	11.10
TABLE 11.5	Range-wide measured socioeconomic impacts	11.11

List of Figures

FIGURE 2-1 Historic and present ranges of coho salmon in California 2.3
FIGURE 2-2 Coho Evolutionarily Significant Units in California 2.4
FIGURE 2-3 Present distribution of coho salmon in the SONCC Coho ESU 2.7
FIGURE 2-4 Present distribution of coho salmon in the CCC Coho ESU 2.8
FIGURE 2-5 Calendar indicating the seasonal presence of coho salmon in California coastal watersheds 2.9
FIGURE 2-6 Dendrogram based on pairwise genetic distances (Cavalli-Sforza and Edwards 1967) between 26 samples of coho salmon from southern Oregon and California 2.14
FIGURE 2-7 Unrooted UPGMA phylogram showing chord distances (Cavalli-Sforza and Edwards 1967) among 33 California coho salmon populations after adjustments for admixture and family structure and pooling of homogeneous samples within drainages and sites 2.15
FIGURE 2-8 Unrooted UPGMA phylogram showing chord distances (Cavalli-Sforza and Edwards 1967) among 27 California coho salmon populations after adjustments for admixture and family structure, pooling of homogeneous samples within drainages and sites, and removal of Green Valley and Redwood Creek outliers shown in Figure 2-7 . . . . . 2.16
FIGURE 3-1 Monthly values for the Pacific interdecadal oscillation index: January 1900 to April 2003 . . . . 3.3
FIGURE 4-1 The process of coho salmon recovery and fishery restoration 4.1
FIGURE 5-1 Land ownership in the SONCC Coho ESU 5.3
FIGURE 5-2 Land ownership in the CCC Coho ESU 5.4
FIGURE 6-1 Recovery units in the California portion of the SONCC Coho ESU 6.5
FIGURE 6-2 Hydrologic Subareas in the California portion of the SONCC Coho ESU . . 6.6
FIGURE 6-3 Rogue River and Klamath River Hydrologic Units 6.7
FIGURE 6-4 Winchuck River and Smith River Hydrologic Units 6.8
FIGURE 6-5 Salmon River Hydrologic Area 6.13
FIGURE 6-6 Shasta Valley Hydrologic Area 6.14
FIGURE 6-7 Scott River Hydrologic Area 6.17
FIGURE 6-8 Trinity River Hydrologic Unit 6.18
FIGURE 6-9 Mad River Hydrologic Unit 6.21
FIGURE 6-10 Redwood Creek and Trinidad Hydrologic Units 6.22
FIGURE 6-11 Eureka Plain Hydrologic Unit 6.25
FIGURE 6-12 Eel River Hydrologic Unit 6.26
FIGURE 6-13 Cape Mendocino Hydrologic Unit 6.29
FIGURE 6-14 Recovery Units in the CCC Coho ESU 6.30
FIGURE 6-15 Hydrologic Subareas in the CCC Coho ESU 6.35
FIGURE 6-16 Mendocino Coast Hydrologic Unit (North) 6.36
FIGURE 6-17 Mendocino Coast Hydrologic Unit (South) 6.39
FIGURE 6-18 Russian River Hydrologic Unit 6.40
FIGURE 6-19 Bodega and Marin Coastal Hydrologic Units 6.47
FIGURE 6-20 San Francisco Bay Hydrologic Units 6.48
FIGURE 6-21 San Mateo Hydrologic Unit 6.51
FIGURE 6-22 Big Basin Hydrologic Unit 6.52
FIGURE 6-23 Consistent presence of coho salmon in the SONCC Coho ESU 6.57
FIGURE 6-24 Consistent presence of coho salmon in the CCC Coho ESU 6.58

FIGURE 6-25 Risk of extinction in watersheds in the SONCC Coho ESU 6.59
FIGURE 6-26 Risk of extinction in watersheds in the CCC Coho ESU 6.60
FIGURE 6-27 Restoration and management potential in the SONCC Coho ESU 6.61
FIGURE 6-28 Restoration and management potential in the CCC Coho ESU 6.62
FIGURE 6-29 Disconnected habitat in the SONCC Coho ESU 6.63
FIGURE 6-30 Disconnected habitat in the CCC Coho ESU 6.64
FIGURE 12-1 Adaptive management cycle 12.5

List of Appendices

APPENDIX A: Abbreviations and Acronyms
APPENDIX B: Glossary
APPENDIX C: Other Species at Risk
APPENDIX D: Key Streams and Rivers
APPENDIX E: Watershed Groups and Gap Analysis
APPENDIX F: Watershed Prioritization
APPENDIX G: Role of Existing Hatcheries
APPENDIX H: Recommended Guidelines for Recovery Hatcheries
APPENDIX I: Cost and Socioeconomic Impacts

1 Introduction

Coho salmon *(Oncorhynchus kisutch)* have experienced a significant decline in the past 40 to 50 years. Coho salmon abundance, including hatchery stocks, has declined at least 70% since the 1960s, and is currently 6 to 15% of its abundance during the 1940s. Coho salmon harvest decreased considerably in the late 1970s, despite a fairly stable rate of hatchery production. Recent abundance-trend information for several stream systems along the central and north coasts indicates an overall declining trend throughout California.

As a result, the California Fish and Game Commission (Commission) received a petition to list coho salmon north of San Francisco to the Oregon border as an endangered species under California Endangered Species Act (CESA). The California Department of Fish and Game (Department) prepared a comprehensive status review of the species, which recommended that the species be listed as endangered south of Punta Gorda to San Francisco Bay and threatened north of Punta Gorda to the California-Oregon border. The Commission found the recommendation to be warranted, but deferred regulatory action to add the species to the threatened and endangered species lists, and directed the Department to prepare a recovery strategy for coho salmon. This report fulfills that mandate, and the Commission formally adopted the Recovery Strategy on February 4, 2004.

1.1 STATE OF CALIFORNIA COHO SALMON LISTING ACTIONS

On December 16, 1993, the Santa Cruz County Fish and Game Advisory Commission submitted a petition to the California Fish and Game Commission (Commission) to list coho salmon south of San Francisco Bay under CESA. On April 7, 1994, the Commission designated the coho salmon south of San Francisco Bay a candidate species, starting the one-year review process by the Department. Based on this review, the Department recommended that coho salmon south of San Francisco Bay be listed as endangered. The Commission accepted the recommendation and listed those coho salmon as endangered, effective December 31, 1995.

On July 28, 2000, the Commission received a petition to list coho salmon north of San Francisco as an endangered species under CESA. The Commission referred the petition to the Department on August 7, 2000, for evaluation. The Department found that the information in the petition was sufficient to indicate the action may be warranted and recommended that the Commission accept the petition. The petition was accepted by the Commission on April 5, 2001. On April 27, 2001, the Commission published a Notice of Findings in the California Regulatory Notice Register declaring coho salmon a candidate species, thereby starting the candidacy period. Pursuant to Fish and Game Code (FGC) §2074.6, the Department prepared a status review evaluating the status separately for the two coho salmon Evolutionary Significant Units (ESUs) that occur in California. (See section 1.2 below regarding ESUs.) The Department recommended that coho salmon be listed as endangered from Punta Gorda south to San Francisco Bay and threatened north of Punta Gorda to the California-Oregon border.

On August 30, 2002, the Commission found that coho salmon warranted listing as an endangered species under CESA from San Francisco Bay north to Punta Gorda and as a threatened species from Punta Gorda north to the California-Oregon border. However, the Commission deferred regulatory action to add the species to the State threatened and endangered species lists while a recovery strategy was prepared, keeping in place regulations, which were adopted by the Commission pursuant to FGC §2084 in April 2001, that allow for incidental take of coho salmon. Both hatchery and naturally produced coho salmon are included in the CESA listing and are addressed by the Recovery Strategy.

1.2 FEDERAL COHO SALMON LISTING ACTIONS

In 1993, Oregon Trout, Pacific Rivers Council, and others petitioned for listing of coho salmon in California, Oregon, Washington, and Idaho under the Federal Endangered Species Act (ESA). National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries)[1] identified six ESUs of coho salmon in California, Oregon, and Washington. The ESUs in California are the California Central Coast (CCC) Coho ESU and the Southern Oregon-Northern California Coasts (SONCC) Coho ESU. The CCC Coho ESU extends from the San Lorenzo River in Santa Cruz County north to Punta Gorda in Humboldt County (Federal Register 1996). The SONCC Coho ESU begins at Punta Gorda and extends north into Oregon to Cape Blanco (Federal Register 1997). The CCC Coho ESU and SONCC Coho ESU were listed as threatened on December 2, 1996 and June 5, 1997, respectively (Federal Register 1996, 1997).

The status of California coho salmon populations was recently reviewed and updated by NOAA Fisheries Southwest Fisheries Science Center (NMFS 2001a). This status review update confirms previous conclusions of the NOAA Fisheries Biological Review Team: 1) the CCC Coho ESU is presently in danger of extinction and the condition of coho salmon is worse than indicated by previous reviews, and 2) the California portion of the SONCC Coho ESU warrants threatened status and is likely to become endangered in the foreseeable future. NOAA Fisheries is presently updating status reviews and revisiting listing determinations for all salmon and steelhead ESUs that have one or more hatchery populations included in the ESU. This includes both the CCC and SONCC Coho ESUs.

1.3 STRATEGIC PLANNING FOR RECOVERY

Planning for coho salmon recovery is a complex process that involves both State and Federal actions because of the species' status under both the ESA and CESA. This section describes actions of the Commission, the recovery teams that were assembled to aid the Department in its development of a coho salmon recovery strategy (Recovery Strategy), and the Federal government's preliminary steps toward a Federal recovery plan.

1.3.1 FISH AND GAME COMMISSION ACTION

Following the determination that coho salmon warranted CESA listing, rather than proceeding immediately with regulatory action, the Commission, pursuant to FGC §2114, directed the Department to prepare a Recovery Strategy for coho salmon within 12 months under FGC §2105 *et seq*. The Commission subsequently extended this deadline a total of 18 months, to February 2004.

[1] National Marine Fisheries Service now uses the acronym NOAA Fisheries. NMFS was used until mid-2003. In this document, NMFS is used in direct quotations from and citations to documents that were published when NMFS was used; otherwise, NOAA Fisheries is used.

During this time extension, the Department released a public review draft of the Recovery Strategy (dated November 2003). The Department voluntarily provided a 21-day comment period on the public review draft and held three public meetings. Approximately 173 people attended the public meetings and a total of 79 people submitted written and/or verbal comments during this period. The Department prepared a formal Response to Comments (available on the Department's website) that detailed changes made, in response to public comments received, in the November 2003 draft of the Recovery Strategy. During the Commission meeting on February 4, 2004, the Commission approved the Recovery Strategy, as modified by the Response to Comments, and inclusive of the Department's recommendations for specific provisions of the timber management alternatives.

1.3.2 DEPARTMENT OF FISH AND GAME ACTION

In accordance with the Commission's direction as well as statutory requirements, the Department immediately embarked on establishing two recovery teams: a Range-wide Coho Salmon Recovery Team (CRT), and a local Shasta-Scott Recovery Team (SSRT) for a special focus on agricultural water and land use in the Shasta and Scott River valleys in Siskiyou County. The Department sought innovative ideas and creativity in the development of a strategy that balances coho salmon recovery with other interests. Both teams brought together people with a variety of concerns and perspectives. The efforts of the two teams, over a short time frame, aided the Department in the development of a single Recovery Strategy to recover coho salmon throughout its range in California.

1.3.3 RANGE-WIDE COHO SALMON RECOVERY TEAM

The CRT is made up of 21 members from a wide range of interests, professions, and perspectives. The team represents county, State, and Federal governments, tribes, commercial and recreational fishing, forestry, agriculture, ranching, water management, and environmental interests. The CRT first met and commenced its work in December 2002. The team addressed many significant issues affecting coho salmon range-wide: coho salmon habitat; coho salmon population numbers; water quality, quantity and use; county and other agencies public works; agriculture, forestry, and ranching; legacy effects of activities that took place decades ago; monitoring of habitat improvement efforts and coho salmon population numbers; respecting private property rights; incentives to promote voluntary efforts to improve habitat; prioritizing recovery actions across the range of both ESUs; and restoration of Tribal, recreational, and commercial fisheries.

The CRT recognizes that recovery of the coho salmon requires a cooperative effort across entire watersheds, considerable financial investment, and many years of effort. The CRT developed a mission statement to guide their effort to aid the Department:

> *Within our vision of restoring populations of coho salmon, including healthy, wild, naturally reproducing populations throughout its range, and restoring Tribal, commercial, and recreational fisheries in California, it is our mission to aid the Department in the development of a recovery strategy for coho salmon, with the goal that the species will no longer warrant listing.*

On August 4, 2003, the CRT sent an independent report to the Director detailing their findings and recommendations. The report also included a partial list of existing voluntary and cooperating groups and activities focused on recovery of coho salmon by watershed. The CRT report to the Director can be viewed on the Department website. CRT recommendations are presented in Chapter 7 (Range-wide Recommendations) and Chapter 8 (Watershed Recommendations).

1.3.4 SHASTA-SCOTT RECOVERY TEAM

The SSRT is made up of 13 members representing a variety of interests in the Shasta and Scott valleys in Siskiyou County. Members include landowners, local governments, State and Federal agencies, environmental groups, and recreational anglers. The SSRT held its first meeting in January 2003 and was tasked with assisting the Department in development of recommendations that will help recover coho salmon relative to agricultural water and land uses in the Shasta and Scott valleys. The focal points of the SSRT are to restore coho salmon populations, maintain a healthy agricultural industry, and water management in each valley. A mission statement was agreed to as follows:

> *Within our vision of restoring healthy, wild and naturally reproducing populations of coho salmon in the Shasta and Scott Rivers, it is our mission to provide the Department of Fish and Game with recovery recommendations focusing on agriculture and agricultural water use, based on local knowledge and scientific information regarding the biological and physical environment, local customs and preferences, as well as local experiences with habitat restoration efforts and strategies. It is our goal to aid the Department in development of a recovery strategy for coho salmon, with the eventual goal that environmental conditions in the Shasta and Scott Rivers will no longer be found to be contributing to the need for listing of coho salmon as a threatened or endangered species in California. Further, it is our intent that the Recovery Strategy developed by the "Scott and Shasta Rivers Pilot Program" will become a demonstration project for future recovery strategies for other threatened or endangered species in California and the nation.*

On July 28, 2003, the SSRT sent an independent report to the Director entitled *Shasta and Scott River Pilot Program for Coho Salmon Recovery: with recommendations relating to Agriculture and Agricultural Water Use,* which can be viewed on the Department's website. SSRT recommendations, presented as the Shasta-Scott Pilot Program (SSPP), are in Chapter 10.

1.3.5 FEDERAL TECHNICAL RECOVERY TEAMS

NOAA Fisheries is in the process of developing scientifically based criteria for delisting ESUs of anadromous salmonids, including the CCC and SONCC Coho ESUs of coho salmon. Federal recovery efforts are focused on geographically defined Recovery Domains. There are two phases in the Federal recovery planning process for anadromous salmonids. Phase I is the development of recovery goals. These goals will be developed by Technical Recovery Teams (TRTs), which will also be responsible for developing criteria that, when met, will allow listed species to be removed from the Federal Endangered Species List.

Four Recovery Domains exist in California, and TRTs have been created for both California Recovery Domains that include coho salmon. The TRTs are responsible for developing recovery criteria for all the listed salmonids in the recovery domain. The TRTs are composed of scientists from NOAA Fisheries, other Federal and State agencies, academia, and other local experts on salmon biology. Department biologists are part of both coho salmon TRTs, which are chaired by NOAA Fisheries staff.

TRT activity will be the primary focus of all teams for the next several years. Both the Southern Oregon/Northern California and North-Central California Coast TRTs had their first meetings in October 2001.

1.4 RECOVERY STRATEGY FOR COHO SALMON IN CALIFORNIA

This Recovery Strategy is based on general goals identified in this section, which also describes the approach to recovery and implementation considerations. For reference, the abbreviations and acronyms used in this document are listed in Appendix A and technical terms are defined in Appendix B.

1.4.1 GENERAL GOALS

The primary purpose the Recovery Strategy is to recover coho salmon to the point where the regulations or other protections for coho salmon listed under CESA are not necessary. In addition, the Recovery Strategy seeks to restore Tribal, recreational, and commercial coho salmon fisheries in California.

On February 4, 2004, the Commission found that the Recovery Strategy met specific conditions contained in statute [FGC §2111(a)-(e)][2] and approved its adoption. These conditions are:

a. The Recovery Strategy would conserve, protect, restore, and enhance the species;

b. The Recovery Strategy and the implementation schedule are capable of being carried out in a scientifically, technologically, and economically reasonable manner;

c. The Recovery Strategy is supported by the best available scientific data;

d. The Recovery Strategy represents an equitable apportionment of both public and private and regulatory and nonregulatory obligations; and

e. The Recovery Strategy would recover a formerly commercially valuable species to a level of abundance that would permit commercial use of that species.

The approach to achieving the primary goal of recovery is to improve coho salmon populations and habitat so the species is neither threatened nor endangered with extinction throughout or in a significant portion of its range and the regulations or other protections for coho salmon under CESA are not necessary. In order for an ESU to be down or delisted, recovery goals should be attained in each recovery unit within the ESU (see Chapter 6). Significance is not defined by CESA but is a scientific judgment based on the entire record of the species.

Achieving recovery will require meeting five delisting goals and corresponding criteria that address coho salmon populations and habitat:

GOAL I	Maintain and improve the number of key populations and increase the number of populations and brood years of coho salmon.
GOAL II	Maintain and increase the number of spawning adults.
GOAL III	Maintain the range and maintain and increase the distribution of coho salmon.
GOAL IV	Maintain existing habitat essential for coho salmon.
GOAL V	Enhance and restore habitat within the range of coho salmon.

A sixth goal meets the criterion set forth in CESA, which requires that in order to approve the Recovery Strategy, the Commission must find, among other things, that the Recovery

[2] FGC § 2111(e) was added by SB 216 (Statutes 2003 Chap. 854). The author of SB 216 notes in a letter, dated September 12, 2003 (published in the Senate Journal on September 13, 2003) that it "does not change the primary goal of the Recovery Strategy program as set forth in Section 2105 of the Fish and Game Code… Therefore, if a species has recovered to the point that the regulatory requirements or other protections for species listed pursuant to CESA are no longer necessary, then no permit pursuant to CESA would be required for incidental take of the species, even if the species has not achieved a level of abundance that would permit resumption of commercial use."

Strategy would recover a formerly commercially valuable species to a level of abundance that would permit commercial use of that species [FGC § 2111(e)].

GOAL VI Reach and maintain coho salmon population levels to allow for the resumption of Tribal, recreational, and commercial fisheries for coho salmon in California.

Once delisting is achieved and protections under CESA are not necessary, it is the intention of the Department to collaborate with the CRT and the SSRT to determine how to continue implementation of appropriate elements of the Recovery Strategy.

1.4.2 ELEMENTS NECESSARY TO ACHIEVE RECOVERY GOALS

The Recovery Strategy is centered on several elements necessary to achieve the goals of recovery. The foundation of recovery will be based on these elements and implementation of recovery actions at various biological and geographic levels. The Department's recovery elements are education and public outreach, emphasizing the cooperation and coordination of the public and private sectors, implementing and enforcing existing laws, maximizing use of public lands for protection and recovery, and conducting research and monitoring to track and understand the progress of recovery and make needed changes over time to advance coho salmon recovery.

The Recovery Strategy takes the approach of dividing California coho salmon into geographic and biological units. The primary biological division is the ESU. With the CCC Coho ESU designated as endangered and the SONCC Coho ESU designated as threatened, the Recovery Strategy treats each ESU separately. Additionally, as unique populations are identified within either ESU, specific directed actions may occur to promote the potential of recovery.

Prioritization is of paramount importance to the Recovery Strategy. By establishing priorities, the Recovery Strategy will ensure efficient use of resources on the most effective recovery activities. These priorities, which were derived with involvement of the recovery teams, land owners and watershed councils, are set both geographically (by HSA) and by task. Entire watersheds and subunits of watersheds are the primary geographic divisions and are discussed individually.

1.4.3 IMPLEMENTATION

The Recovery Strategy includes hundreds of potential actions to recover coho salmon. FGC §2114 states: "The Recovery Strategy itself shall have no regulatory significance, shall not be considered to be a regulation for any purpose ... and is not a regulatory action or document." Therefore, the recommendations will be implemented through existing statutory and/or regulatory authorities, voluntary actions, and/or new statutory and/or regulatory authority.

Responsibility for implementation of the Recovery Strategy lies primarily with the Department, which intends to work closely with other entities to ensure that the tasks are undertaken. Implementation of these actions will require many years, long-term commitments and involvement of many parties and organizations, considerable financial support, and careful planning and management.

The Recovery Strategy describes issues facing coho salmon and the many recommendations to address the issues, the vast majority of which were discussed and recommended by the recovery teams to the Department. The implementation schedules in Chapters 9 and 10 list actions by task-level priority, potential party or parties capable of (and in some cases responsible for) carrying out the actions, and the estimated commencement time and duration. The task level priorities identified in the implementation schedule are to be considered in conjunction with watershed priorities developed by the CRT and the Department, which are identified in the implementation schedules and described in section 6.3.

Implementation of recovery tasks has the potential to affect other species listed under ESA and under CESA. Potential effects on the conservation of these species could range from beneficial to detrimental. Other species at risk within the range of coho salmon, and any constraints on the implementation of recovery actions, are described in Appendix C.

1.4.3.1 Interim Actions

Some recommendations for recovery of coho salmon can be implemented immediately, both because it is economically and technical feasible and because no regulatory or statutory change is required to start the recovery activity or decision. For the purposes of this Recovery Strategy, interim actions are defined as those actions that can be initiated immediately or within the first five years of the strategy and require no regulatory or statutory changes.

1.4.3.2 Long-term Actions

Long-term recommendations require more time and planning before they can be implemented, a long duration to complete, additional funding, or require changes to law or regulation to be successful or even allowable.

1.4.4 ADAPTIVE MANAGEMENT

The Department believes adaptive management[3] is essential for successful planning and implementation of coho salmon recovery. Adaptive management is the process of involving scientific method and the experience of stakeholders and resource managers in an iterative process that allows for plan flexibility and responsiveness in revising the Recovery Strategy based on the best available scientific and other data. The Recovery Strategy is based on the current best available scientific and other information, but comprehensive and predictive knowledge is not available regarding ecological processes, synergistic effects of human activities, stochastic natural events, the most effective management practices, and the means of addressing stakeholder issues or conflicts. As we learn more about these things, adaptive management allows the Recovery Strategy to benefit accordingly.

The adaptive management process used in the Recovery Strategy is a six-step cycle, the success of which depends on the completion of all six steps:

1. Assess the problem by identifying the issues facing coho salmon and habitat and evaluate the scientific, management, and economic options and feasibility of potential solutions;
2. Design and select the policies, programs, and activities to be applied to recovery and additional assessment;
3. Implement programs and activities for recovery of coho salmon and continuing assessment designed to reveal the critical knowledge that is currently lacking;
4. Monitor the key response indicators that inform the Department on the progress and effectiveness of recovery programs and activities, and status and trend of coho salmon and habitat;
5. Evaluate recovery activities, programs, and assessment and monitoring information; and
6. Adjust and incorporate the results of implementation and monitoring into future decisions and revisions of the Recovery Strategy.

[3] Adapted from Taylor et al., 1997.

Biology 2

Coho salmon are one of seven species of Pacific Salmon belonging to the genus *Oncorhynchus,* and one of two native salmon species regularly occurring in California. This chapter, which describes coho salmon biology, is summarized from the Department's *Status Review of California Coho Salmon North of San Francisco* (CDFG 2002). The Status Review compiled the best available data on coho salmon. To the extent that new studies are provided, they must be evaluated in context of the entire body of literature as the recovery effort proceeds.

2.1 RANGE

Coho salmon occur naturally in the northern Pacific Ocean and tributary drainages. It ranges in freshwater drainages from Hokkaido, Japan, and eastern Russia, around the Bering Sea and Aleutian Islands to mainland Alaska, and south along the North American coast to Monterey Bay, California.

Within California, coho salmon historically ranged from the Oregon-California border (including the Winchuck and Illinois River drainages) south to the streams of northern Monterey Bay (Snyder 1931; Fry 1973), including small tributaries to San Francisco Bay (Brown and Moyle 1991; Leidy and Becker 2001). However, there is some evidence that they historically ranged as far south as the Pajaro River (Anderson 1995), the Big Sur River (Hassler et al. 1991), or even the Santa Ynez River (Lucoff 1980, as cited in National Council on Gene Resources 1982), although evidence of spawning populations south of the Pajaro River is anecdotal (Anderson 1995). Currently, the southernmost stream that contains coho salmon is Aptos Creek in Santa Cruz County (NMFS 2001). Historic and present ranges of coho salmon are shown in Figure 2-1.

Information on the possible existence of coho salmon in the San Joaquin and Sacramento rivers is sparse. Fry (1973) states that coho salmon did not occur in the Sacramento-San Joaquin river system prior to attempts to introduce them beginning in 1956. Hatchery fish returned in large numbers and spawned naturally, but were unable to sustain a natural run. Moyle (1976) noted that coho salmon in the Sacramento River are rare. It is likely that coho salmon historically observed in these streams were occasional strays (Hallock and Fry 1967; Hopkirk 1973). Intensive sampling efforts using trawling and beach seining by the United States Fish and Wildlife Service (USFWS) in the Sacramento and San Joaquin rivers and estuary have recorded no coho salmon since the project began in 1976 (USFWS 2001 unpublished data). For these reasons, the Department does not consider the Sacramento-San Joaquin river system to be within the historical range of coho salmon.

2.2 EVOLUTIONARILY SIGNIFICANT UNITS

The Federal Endangered Species Act (ESA) includes in the definition of species "any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature.” In order to improve consistency, NOAA Fisheries developed the ESU concept. In the document describing this concept, Waples (1991a) states, “A population (or group of populations) will be considered distinct (and hence a ‘species’) for purposes of the ESA if it represents an ESU of the biological species.” A population must meet two criteria in order to be considered an ESU: 1) it must be reproductively isolated from other conspecific population units; and 2) it must represent an important component of the evolutionary legacy of the species (Waples 1991a).

ESUs reflect the best and most current understanding of the likely geographic boundaries of reproductively isolated salmon populations. Understanding these boundaries is especially important for NOAA Fisheries, which is charged with evaluating and protecting salmon species with broad ranges extending across State borders. Similar populations are thus grouped for efficient protection of biological and genetic diversity. The Department, in contrast, has responsibility for evaluation and protection of California stocks only and typically evaluates and manages salmon on a watershed basis, regardless of the biological affinities of California stocks to stocks across our borders. The Department recognizes the importance of genetic structure and biodiversity among California stocks in evaluating and protecting coho salmon.

Two coho salmon ESUs are found in California: the SONCC Coho ESU (from Punta Gorda, California, north across the State border to Cape Blanco, Oregon) and the CCC Coho ESU (from Punta Gorda, California, south to the San Lorenzo River) (Figure 2-2).

Only naturally spawning populations within these ESUs were included in the Federal listings. Mad River Hatchery stocks in northern California were not included in the SONCC Coho ESU. The relationship of the Iron Gate Hatchery stock with the rest of the SONCC Coho ESU was judged uncertain and it was, therefore, not included in the ESU. Four other hatchery populations in the Mattole, Eel, and Trinity rivers, and Rowdy Creek were specifically included as part of the ESU, but these populations were not deemed essential to recovery and they were, therefore, not included in the listing. Any hatchery population that is included as part of an ESU may have a role in its recovery under certain conditions.

2.2.1 SOUTHERN OREGON/NORTHERN CALIFORNIA COASTS COHO ESU

Coho salmon are now found in less than 60% of the SONCC Coho ESU streams that were historical coho salmon streams. However, these declines appear to have occurred prior to the late 1980s and the data do not support a significant decline in distribution between the late 1980s and the present. Some streams in this ESU have lost one or more brood-year lineages.

Although streams supporting coho salmon in the California portion of the SONCC Coho ESU are fewer now in comparison to the period 1985 to 1991, the available data suggest that population fragmentation within the larger river systems is not as severe as in the CCC Coho ESU. The major stream systems within the California portion of the SONCC Coho ESU still contain coho salmon populations, although many tributaries may have missing runs. Department analysis of the SONCC data when grouped (1986 to 1991 vs. 1995 to 2000) indicates that the decline is not statistically significant, whereas the NOAA Fisheries analysis of the ungrouped data (1989 to 2000) indicates that the decline in the northern ESU is significant.

Because of the decline in distribution prior to the 1980s, together with the possibility of a severe reduction in distribution as indicated by the field surveys and the downward trend of most abundance indicators, the Department believes that coho salmon populations in the California portion of this ESU will likely become endangered in the foreseeable future in the absence of the protection and management required by CESA.

FIGURE 2-1: Historic and present ranges of coho salmon in California

FIGURE 2-2: Coho Evolutionarily Significant Units in California

2.2.2 CENTRAL CALIFORNIA COAST COHO ESU

Coho salmon populations in streams in the northern portion of this ESU seem to be relatively stable or are not declining as rapidly as those to the south. However, the southern portion, where widespread extirpation has occurred, is a significant portion of the range of coho salmon in this ESU. Widespread extirpation or local extinctions have already occurred within some larger stream systems (e.g., Gualala and Russian rivers), or over broad geographical areas (e.g., Sonoma County coast, San Francisco Bay tributaries, streams south of San Francisco).

Most abundance trend indicators for streams in the CCC Coho ESU suggest a decline since the late 1980s. However, some streams of the Mendocino County coast showed an upward trend in 2000 and 2001. Time-series analyses for these streams show a declining trend and predict that this trend will continue, despite the recent increases.

Small population size, along with large-scale fragmentation and collapse of range, indicate that metapopulation structure may be severely compromised and remaining populations may face greatly increased threats of extinction. For this reason, the Department concluded that coho salmon in the CCC Coho ESU are in serious danger of extinction throughout all or a significant portion of their range.

2.3 PRESENT DISTRIBUTION

Coho salmon distribution is described as the streams within the range where the species can be, or has been, detected. The Department has mapped the present distribution of coho salmon in the SONCC Coho ESU (Figure 2-3) and the CCC Coho ESU (Figure 2-4). Present distribution is based on the most recently available information and includes streams where coho salmon are still believed to exist.

The Department used a conservative approach when determining the upper extent of coho salmon distribution. Where data were present, the upper mapped extent was defined as that point furthest upstream where coho were last observed. This uppermost point on the map does not preclude coho usage further upstream, only that they have not been documented as yet in those areas.

The full extent of a stream was mapped when the data available indicated coho existed there, but had no location information. An exception to this was when there was a known limit to anadromy. Known limits to anadromy include natural (e.g., waterfalls) as well as man-made barriers (e.g., dams). Some of these known man-made barriers may be removed or modified to allow access to more of the stream, increasing the limit of anadromy.

Waterways that are not indicated as coho streams may still support populations or provide seasonal refugia, but as yet have no usage documented. Therefore the known present distribution for coho salmon will change with new information.

2.4 LIFE HISTORY

Adult coho salmon enter fresh water from September through January in order to spawn. In the short coastal streams of California, migration usually begins between mid-November and mid-January (Baker and Reynolds 1986). Coho salmon move upstream after heavy rains have opened the sand bars that form at the mouths of many California coastal streams, but may enter larger rivers earlier. On the Klamath River, coho salmon begin entering in early to mid-September and reach a peak in late September to early October. On the Eel River, adult coho salmon return four to six weeks later than on the Klamath River (Baker and Reynolds 1986). Arrival in the upper reaches of these streams generally peaks in November and December. Timing varies by stream and/or flow (Neave 1943; Brett and MacKinnon 1954; Ellis 1962) (Figure 2-5).

Generally, coho salmon spawn in smaller streams than do Chinook salmon. In California, spawning occurs mainly from November to January, although it can extend into February or March if drought conditions are present (Shapovalov and Taft 1954). In the Klamath and Eel rivers, spawning occurs in November and December (USFWS 1979). Shapovalov and Taft (1954) note that females usually choose spawning sites near the head of a riffle, just below a pool, where the water changes from a laminar to a turbulent flow and there is a medium to small gravel substrate. The female digs a redd (nest) by turning partly on her side and using powerful, rapid movements of the tail to dislodge the gravels, which are transported a short distance downstream by the current. Repeating this action creates an oval-to-round depression at least as deep and as long as the fish. Eggs and milt (sperm) are released into the redd, where, because of the hydrodynamics of the redd, they tend to remain until they are buried. Approximately one-hundred or more eggs are deposited in each redd. The fertilized eggs are buried by the female digging another redd just upstream. The flow characteristics of the redd location usually ensure good aeration of eggs and embryos, and the flushing of waste.

Larger coho salmon produce more eggs and there is a definite tendency for fecundity to increase from California to Alaska (Sandercock 1991). Average coho salmon fecundities, as determined by various researchers working on streams in British Columbia, Washington, and Oregon, range from 1,983 to 2,699 and average 2,394 eggs per female (Sandercock 1991). The fecundity of coho salmon in Washington streams ranged from 1,440 to 5,700 eggs for females that were 44 cm to 72 cm in length (Scott and Crossman 1973).

In California, eggs incubate in the gravels from November through April. The incubation period is inversely related to water temperature. California coho salmon eggs hatch in about forty-eight days at 48°F, and thirty-eight days at 51.3°F (Shapovalov and Taft 1954). After hatching, the alevins (hatchlings) are translucent in color (Shapovalov and Taft 1954; Laufle et al. 1986; Sandercock 1991). This is the coho salmon's most vulnerable life stage, during which they are susceptible to siltation, freezing, gravel scouring and shifting, desiccation, and predation (Sandercock 1991; Knutson and Naef 1997; Pacific Fisheries Management Council [PFMC] 1999). Alevins remain in the interstices of the gravel for two to ten weeks until their yolk sacs have been absorbed, at which time their color changes to that more characteristic of fry (Shapovalov and Taft 1954, Laufle et al. 1986, Sandercock 1991). The fry are silver to golden with large, vertical, oval, dark parr marks along the lateral line that are narrower than the spaces between them.

Fry emerge from the gravel between March and July, with peak emergence occurring from March to May, depending on when the eggs were fertilized and the water temperature during development (Shapovalov and Taft 1954). They seek out shallow water, usually moving to the stream margins, where they form schools. As the fish feed heavily and grow, the schools generally break up and individual fish set up territories. At this stage, the fish are termed parr (juveniles). As the parr continue to grow and expand their territories, they move progressively into deeper water until July and August, when they inhabit the deepest pools (CDFG 1994a). This is the period when water temperatures are highest, and growth slows (Shapovalov and Taft 1954). Food consumption and growth rate decrease during the winter months of highest flows and coldest temperatures (usually December to February). By March, parr again begin to feed heavily and grow rapidly.

Rearing areas used by juvenile coho salmon are low-gradient coastal streams, lakes, sloughs, side channels, estuaries, low-gradient tributaries to large rivers, beaver ponds, and large slackwaters (PFMC 1999). The most productive juvenile habitats are found in smaller streams with low-gradient alluvial channels containing abundant pools formed by large woody

FIGURE 2-3: Present distribution of coho salmon in the SONCC Coho ESU

2 BIOLOGY

FIGURE 2-4: Present distribution of coho salmon in the CCC Coho ESU

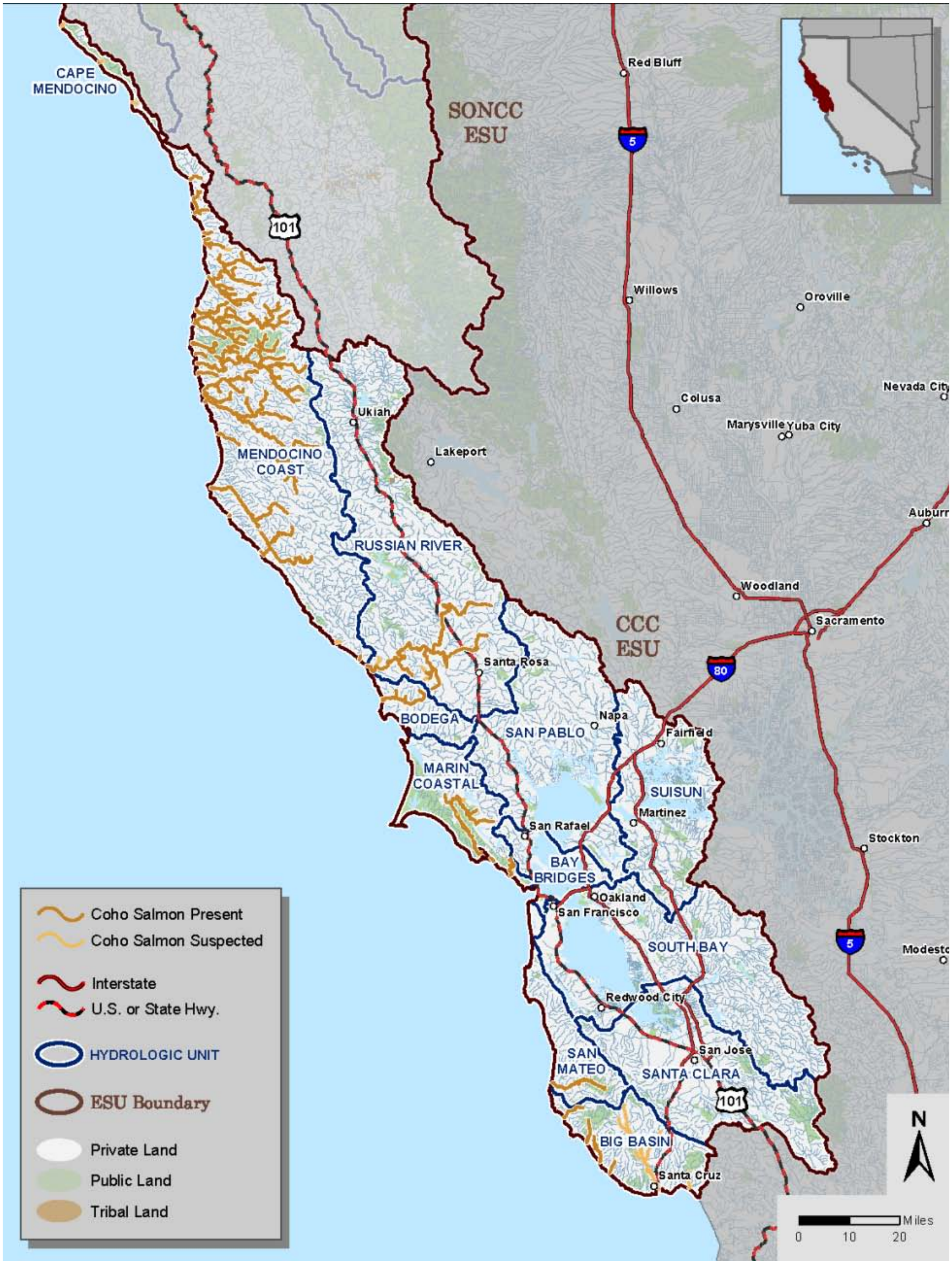
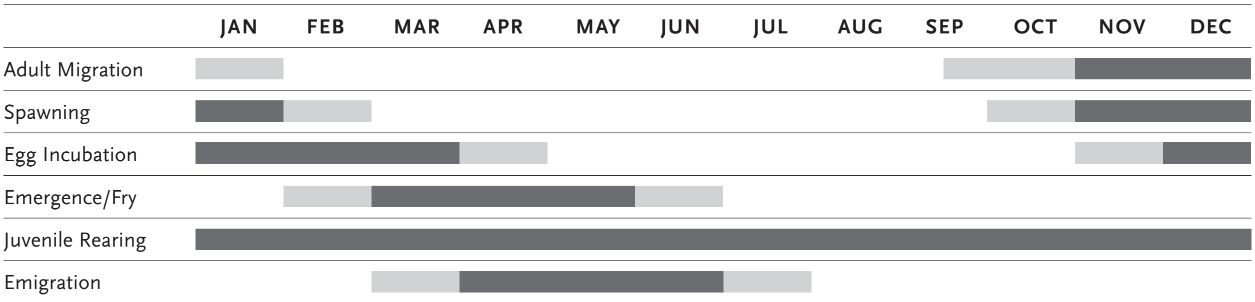


FIGURE 2-5: Calendar indicating the seasonal presence of coho salmon in California coastal watersheds



NOTE: Dark shading indicates months of peak activity for a particular life stage; the lighter shading indicates months of lesser activity.

debris (LWD). Adequate winter rearing habitat is important to successful completion of coho salmon life history.

After one year in fresh water, smolts begin migrating downstream to the ocean in late March or early April. In some years emigration can begin prior to March (CDFG unpublished data) and can persist into July (Shapovalov and Taft 1954; Sandercock 1991). Weitkamp et al. (1995) indicate that peak downstream migration in California generally occurs from April to early June. Factors that affect the onset of emigration include the size of the fish, flow conditions, water temperature, dissolved oxygen (DO) levels, day length, and the availability of food. In Prairie Creek, Bell (2001) found that a small percentage of coho salmon remain more than one year before emigrating to the ocean. Low stream productivity, due to low nutrient levels or cold water temperatures, can contribute to slow growth, potentially causing coho salmon to postpone emigration (PFMC 1999). There may be other factors that contribute to a freshwater residency of longer than one year, such as late spawning, which can produce fish that are too small at the time of smolting to migrate to sea (Bell 2001).

The amount of time coho salmon spend in estuarine environments is variable, and the time spent there is less in the southern portion of their range (PFMC 1999). Upon entry into the ocean, the immature salmon remain in inshore waters, congregating in schools as they move north along the continental shelf (Shapovalov and Taft 1954; Anderson 1995). Most remain in the ocean for two years; however, some return to spawn after the first year, and these are referred to as grilse or jacks (Laufle et al. 1986). Data on ocean distribution of California coho salmon are sparse, but it is believed that the coho salmon scatter and join schools from Oregon and possibly Washington (Anderson 1995).

2.5 POPULATION STRUCTURE AND VIABILITY

McElhany et al. (2000) define an independent fish population as a group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place at a different season. This definition of a population is the one used for purposes of this document and is much the same as Ricker's definition of stock (1972, as cited in McElhany et al. 2000). The term "coho salmon population" typically refers here to spawning adults.

The Department defines and manages runs of anadromous salmonids based on genetic distinctiveness, run-timing differences, juvenile emigration timing, and watershed distinction (CDFG 1998). In many cases, California coho salmon populations roughly correspond to distinct spawning runs within watersheds. However, there is not enough information to assess the degree of gene flow between groups of spawners in different reaches of large streams. The relationship of tributary spawners to one another and to mainstem spawners is similarly unknown. Therefore, coho salmon spawning runs may actually be composed of more than one population.

2.5.1 POPULATION STRUCTURE

Salmon have strong fidelity to breeding in the stream of their origin. This provides the potential for substantial reproductive isolation of local breeding populations, and may result in significant local adaptation. Isolated populations are subject to different levels of genetic drift and unique natural selection pressures that tend over time to result in differences between them. In addition, populations arising through colonization or artificial production, and populations that have experienced recent drastic reductions in size, are often genetically different from the population from which they were derived. Salmon also naturally exhibit a small and variable amount of exchange among populations, connecting them genetically, and tending to make them more similar to one another. Even small amounts of gene flow between stocks (e.g., due to straying) can prevent their complete separation unless there is strong differential selection to maintain separation (Nei 1987). The amount of exchange may be influenced by factors like stream blockages (e.g., road crossings or sandbars at the mouths of rivers) and straying. Because of these factors, salmon populations are largely, but often not completely, isolated.

Levins (1969) proposes the idea of the metapopulation to describe a "population of populations." A metapopulation is comprised of subpopulations that are local breeding populations, with limited exchange among the subpopulations so that they are reasonably isolated but connected. Similarly, larger assemblages (e.g., all of the breeding populations in a watershed) can themselves form a metapopulation due to the connection between them afforded by natural straying. Fragmentation of this structure can affect the ability of populations to respond to natural environmental variation and catastrophic events.

Differential productivity among habitat patches can lead to a source-sink relationship in which some highly productive habitats support self-sustaining subpopulations (source subpopulations) that continually supply individuals to other non-self-sustaining subpopulations (sink subpopulations) in less productive habitats (Pulliam 1988). Data for at least one coho salmon population in Washington (McElhaney et al. 2000) are consistent with this model. Because of the fact that sink subpopulations are not self-sustaining and rely on source subpopulations for their existence, Schlosser and Angermeier (1995) and Cooper and Mangel (1999) stress the importance of protecting natural source subpopulations. However, over longer periods, the relationship between source and sink subpopulations may change (i.e., sources may become sinks and vice versa). Thus protecting only current source subpopulations may be inadequate to ensure long-term persistence. In some salmonid systems, hatchery and wild populations may represent sources and sinks, respectively (McElhaney et al. 2000).

Structure within a salmon species can be seen as hierarchical and there can be more than one hierarchical system. For example, the National Research Council (NRC 1996) describe the structure of genetic variation in salmon populations as beginning with substantially reproductively isolated local breeding populations that together constitute metapopulations typically connected by some small amount of gene flow, followed by larger biological races, then by subspecies (or ecotypes), and culminating with the species as a whole. McElhaney et al. (2000) suggest a hierarchy containing individual, subpopulation, population, ESU, and species levels. An ESU can also function as a metapopulation (McElhaney et al. 2000). For purposes of this document, coho salmon populations are assumed to be organized in a hierarchical structure that includes connections among subpopulations as well as connections over a larger geographic scale.

Coho salmon have an almost fixed three-year life cycle throughout most of their range, including California (Sandercock 1991; Waples et al. 2001). Therefore, a complete generation of coho salmon in a stream consists of three consecutive, almost completely non-overlapping, brood years. Because of this, the number of locally produced adults returning to a stream in a given spawning season is almost entirely dependent upon the number of juveniles produced there three years earlier. Loss of one of the three coho salmon brood years in a stream (called brood-year extinction or cohort failure), therefore, represents loss of a significant component of the total coho salmon resource in that stream. Brood-year extinction in a stream may be the result of the inability of adults to return to their place of origin, productivity failure, or high mortality. Recovery of an extinct coho salmon brood year in a stream is made more difficult by its almost complete dependence on strays from other, usually nearby, sources (including hatcheries). Stray rates among natural populations are variable, unpredictable, and are probably low in healthy natural populations (McElhaney et al. 2000). This dependence on sources that may also be depressed and fragmented adds considerable uncertainty to the potential for natural recovery of missing coho salmon brood years.

2.5.2 POPULATION VIABILITY

McElhaney et al. (2000) define a viable salmonid population for purposes of the ESA as "an independent population of any Pacific salmonid (genus *Oncorhynchus*) that has a negligible risk of extinction due to threats from demographic variation (random or directional), local environmental variation, and genetic diversity changes (random or directional) over a one-hundred year time frame." One hundred years was chosen to represent the time frame over which to evaluate risk of extinction. This long time frame is important because typical recovery actions can affect populations over many years. Many genetic processes (e.g., loss of diversity) can occur over decades or centuries, and at least some environmental cycles occur over decadal or longer time frames. By considering extinction risk far into the future, large-scale environmental oscillations and long-term trends can be accounted for. Short-term viability (i.e., one-hundred or fewer years) is also considered. Evaluations of both long-term viability (i.e., 100 years) and short-term viability use the same criteria over different time scales.

The number of individuals that would ensure population viability to a negligible probability of extinction over one-hundred years is difficult to calculate (e.g., McElhaney et al. 2000; Morris et al. 1999; Dennis et al. 1991). For California coho salmon, evaluation of viability is based on assessments of abundance, population growth rate, population structure, and diversity, for which reliable estimates are not available. Therefore, it is not possible to determine viability targets, in terms of numbers of fish, for coho salmon at this time.

2.6 GENETICS

California coho salmon population genetics have been studied using allozymes (Bartley et al. 1982; Hjort and Schreck 1982; Olin 1984, Sollazi 1986; Weitkamp et al. 1995), transferrin (Hjort and Schreck 1982), and microsatellite deoxyribonucleic acid (DNA) (Banks et al. 1999; Hedgecock 2001; Hedgecock et al. 2002). CDFG (2002) and Weitkamp et al. (1995) contain reviews of the recent population genetic analyses. Table 2-1 lists locations in California from which genetic samples have been analyzed and reported, along with the loci used in each analysis.

Recent work (Weitkamp et al. 1995; Banks et al. 1999; Hedgecock et al. 2001; Hedgecock et al. 2002) has added considerably to the understanding of coho population genetics in California. While the distribution of genetic sampling within California (Table 2-1) is likely not sufficient to resolve coho population genetics at a scale useful to recovery in many watersheds (e.g., identification of local populations), it may prove useful in some of them. Large-scale relationships (e.g., at the ESU scale) are fairly consistent, although some of the existing studies may not have adequately captured the true range of genetic variation in coho salmon. This could be the result of one or more of the following factors: limited geographic context, availability of variable loci, small sample size coupled with low levels of variation in a large number of loci examined, and complications due to the effects of selection in transferrin studies (Weitkamp et al. 1995; Ford et al. 1999). The Department is working with geneticists at NOAA Fisheries Southwest Fisheries Science Center (Santa Cruz Laboratory) to further characterize California coho population structure. Data from these analyses will be incorporated into the Department's recovery strategy as they become available.

Waples et al. (2001), in a review of Pacific salmon diversity, report that coho salmon (along with pink and chum salmon), show relatively low levels of heterozygosity and only modest levels of genetic differentiation among populations across their species range, but that a strong

TABLE 2-1: California streams for which coho salmon genetic tissue samples have been collected, analyzed, and reported, 1982 to the present

LITERATURE SOURCE	CALIFORNIA SAMPLE LOCATIONS	TYPE OF GENETIC DATA	LOCI/ALLOZYMES USED IN ANALYSIS
Hjort and Schreck 1982	Iron Gate Hatchery/Klamath River, Trinity River Hatchery, Mad River Hatchery	Transferrin locus Allozyme	Transferrin, PGI
Olin 1984[a]	Iron Gate Hatchery/Klamath River	Allozymes	AAT-1, 2, 3; ACON; CK-2; EST-2, 3, 4, 5; GL-1, 2; IDH-1, 2, 3, 4; LDH-1, 2, 4; LGG; MDH-2, 3; 6-PGD; PGI-2, 3; PGM-1, 2; PHAP; PMI; SDH-1, 2; TFN.
Bartley et al. 1992[a]	Scott Creek, Waddell Creek, Lagunitas Creek, Tanner Creek/Salmon Creek, Willow Creek/Russian River, Flynn Creek/Navarro River, John Smith Creek/Navarro River, Albion River, Little River, Twolog Creek/Big River, Russian Gulch, Caspar Creek, Hare Creek, Little North Fork Noyo River, Kass Creek/Noyo River, Pudding Creek, Little North Fork Ten Mile River, Cotteneva Creek, Huckleberry Creek/South Fork Eel River, Butler Creek/South Fork Eel River, Redwood Creek/South Fork Eel River, Elk River, Prairie Creek, Rush Creek/Trinity River, Trinity River Hatchery, Deadwood Creek/Trinity River, West Branch Mill Creek/Smith River	Allozymes	AAD, AH, ADH, AK, FBA, CK, GALA, GPDH, GPI, IDDH, IDH, LDH, MDH, MPI, PGDH, PGK, PGM, SOD, TFN, PEPA, PEPC, PEPB, PEPD
Weitkamp et al. 1995[b]	Trinity River Hatchery	Allozymes	sAAT-1, 2*; sAH; GPI-A*; IDDH-1*; LDH-B1*; LDHB2*; sMDH-B1, 2*; MPI*; PEPA*; PEPC*; PEPD-2*; PGDH*; PGM-1*.
Banks et al. 1999	Warm Springs Hatchery/Russian River, Green Valley Creek/Russian River, Olema Creek, Noyo Egg Taking Station/Noyo River, Hare Creek	Microsatellite DNA	Ots-1, Ots-2, Ots-3, Ots-4, Omy-77
Hedgecock et al. 2001	Eel River, Noyo River, Russian River, Lagunitas Creek, Olema Creek, Scott Creek	Microsatellite DNA	Ots-2; iso-Ots-2; Ots-3; Ots-103; Oki-1; One-13; P-53
Hedgecock et al. 2002[c]	Klamath River, Trinity River, Little River, S.F. Eel River, Mattole River, Pudding Creek, S.F. Noyo River, Albion River, Russian River, Lagunitas Creek, Olema Creek, Redwood Creek, Waddell Creek, Scott Creek	Microsatellite DNA	Ots-2, iso-Ots-2, Ots-3, Ots-103, Oki-1, One-13, P-53

NOTES: Literature sources marked with bold contain a majority of data from sampling locations outside California, and those locations are not listed here. See CDFG (2002) for a complete review.

[a] Reanalysis of these data appear in Sollazi (1986).

[b] Contains a reanalysis of 20 samples from Bartley et al. (1982) and the Iron Gate Hatchery sample from Olin (1984) along with four newly collected samples from Oregon and one from California.

[c] Samples in this analysis overlap with those in Banks (1999) and Hedgecock et al. (2001).

geographic component exists nevertheless. Although some earlier studies found low levels of diversity (Bartley et al. 1982; Olin 1984), Weitkamp et al. (1995), Banks et al. (1999), Hedgecock (2001), and Hedgecock et al. (2002) found substantial genetic diversity in the California samples that they analyzed. All of the studies that have attempted to do so discriminate groups of coho salmon with some geographic component to the pattern. These relatively consistent patterns are summarized in the NOAA Fisheries ESU delineations.

Data summarized in the NOAA Fisheries status review of coho salmon (Weitkamp et al. 1995) were used to document areas of "genetic discontinuity/transition" for delineation of ESU boundaries (Figure 2-2). These discontinuities represent areas of restricted gene flow that likely result in some level of reproductive isolation. In California, this area of discontinuity occurs around Punta Gorda. Populations north of Punta Gorda (i.e., SONCC Coho ESU) and those south (i.e., CCC Coho ESU) are likely to experience some level of gene-flow restriction that is greater than that experienced within each geographic region. Populations in the transition region around Punta Gorda are not easily placed in either of the two geographic regions. NOAA Fisheries identified four other more northerly coho salmon ESUs that extend from Oregon to Canada.

Identification of populations and determination of local population genetic structure are essential to recovery. Figures 2-6, 2-7, and 2-8 show recently constructed genetic distance dendrograms using microsatellite DNA (Hedgecock et al. 2002) and allozyme (Weitkamp et al. 1995) data that depict the scale and relationships among the analyzed California coho salmon samples. Figures 2-7 and 2-8 present phylograms developed using the unweighted pair group method with arithmetic averages (UPGMA). These relationships can be used as a starting point in identifying populations of coho salmon for recovery purposes. These analyses are supportive of California ESU delineations drawn by Weitkamp et al. (1995) and adopted by the Department (CDFG 2002). The available analyses suggest that two to three somewhat reproductively isolated ESU-level groups exist across the range of coho salmon in California. These correspond to the SONCC Coho ESU, the CCC Coho ESU, and, arguably, populations of coho salmon south of San Francisco. Whether these ESU-level groups are equivalent to populations of coho salmon is not known. There may be more than one population in each ESU. However, at this time we accept that the ESU structure depicted here is a good guide to broad patterns of reproductive isolation of California coho.

2.7 HABITAT REQUIREMENTS

Each life stage of the coho salmon requires specific stream and habitat conditions in order to survive and to develop sufficiently to reach the next life stage at the time when naturally occurring favorable conditions prevail. Any natural or man-made changes in the stream environment jeopardize the success of a generation of fish that are adapted to the specific conditions of a watershed.

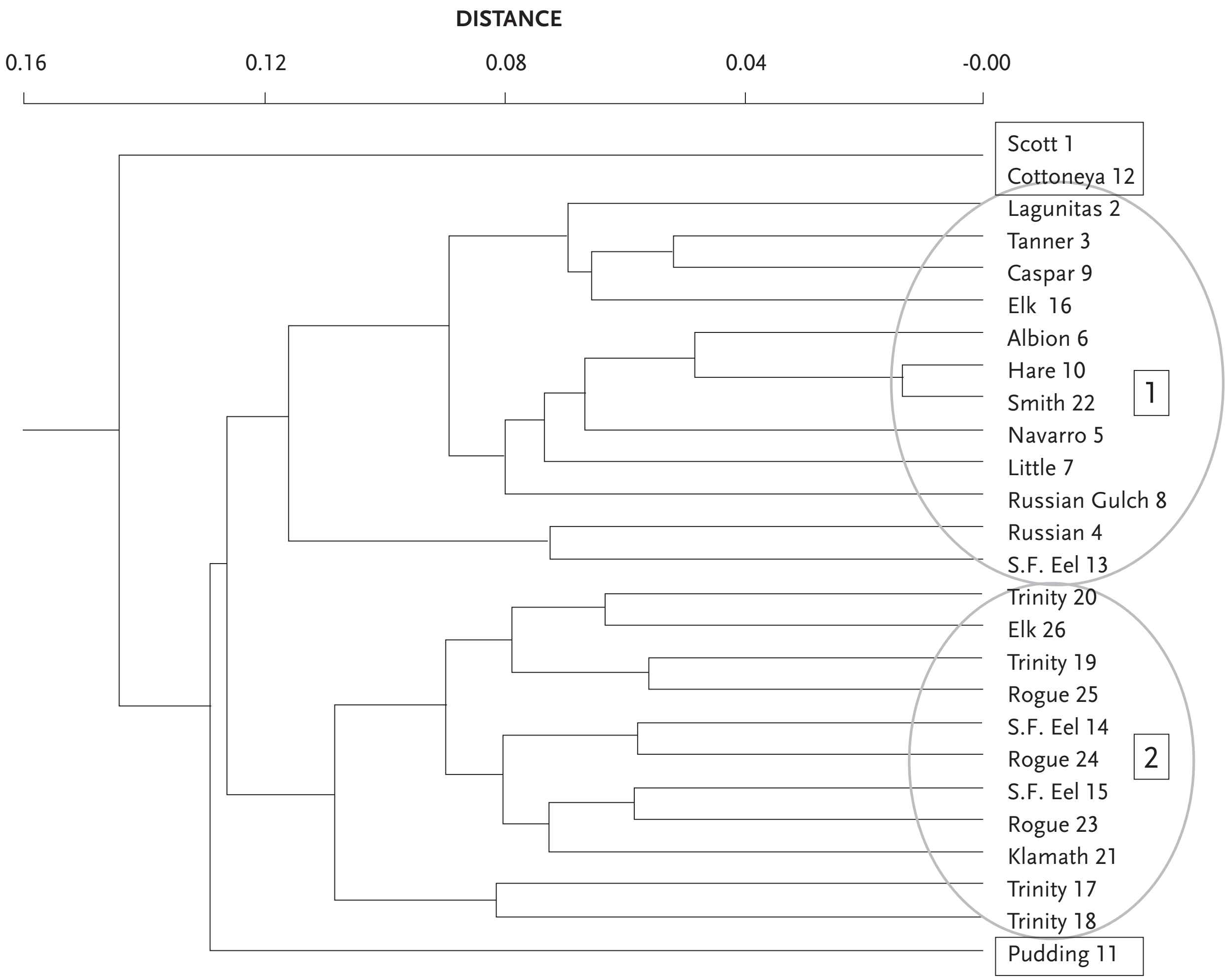
2.7.1 HABITAT REQUIREMENTS FOR ADULTS

Most coho salmon spend approximately half of their three-year life cycle in the ocean environment before returning to fresh water. They then migrate upstream and spawn mainly in small streams that flow directly into the ocean or in tributaries of large rivers.

2.7.1.1 Migration

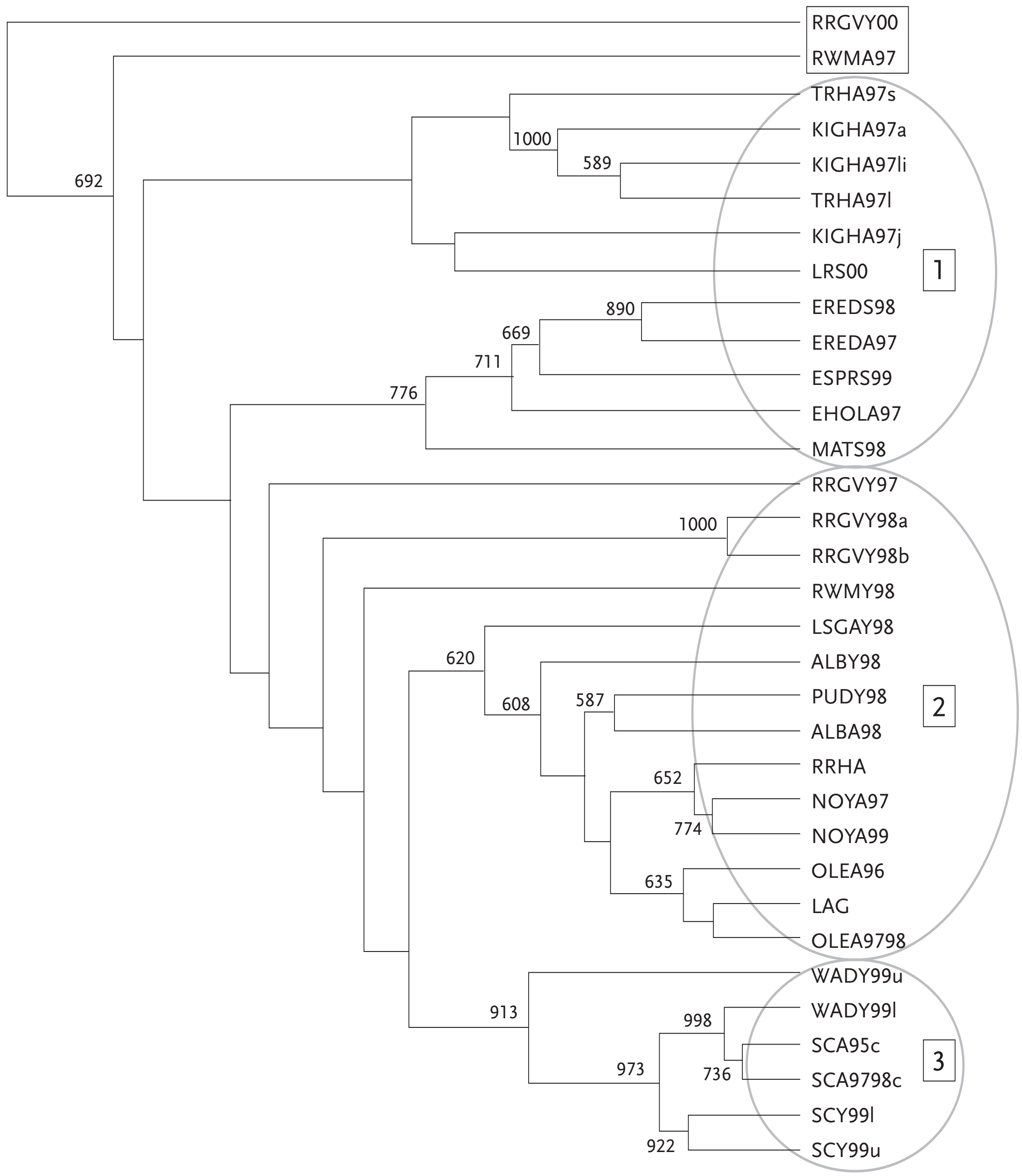
Coho salmon usually migrate during late summer and fall and their specific timing may have evolved in response to particular flow conditions. For example, obstructions that may be passable in high waters may be insurmountable during low flows. Conversely, early-running stocks are

FIGURE 2-6: Dendrogram based on pairwise genetic distances (Cavalli-Sforza and Edwards 1967) between 26 samples of coho salmon from southern Oregon and California



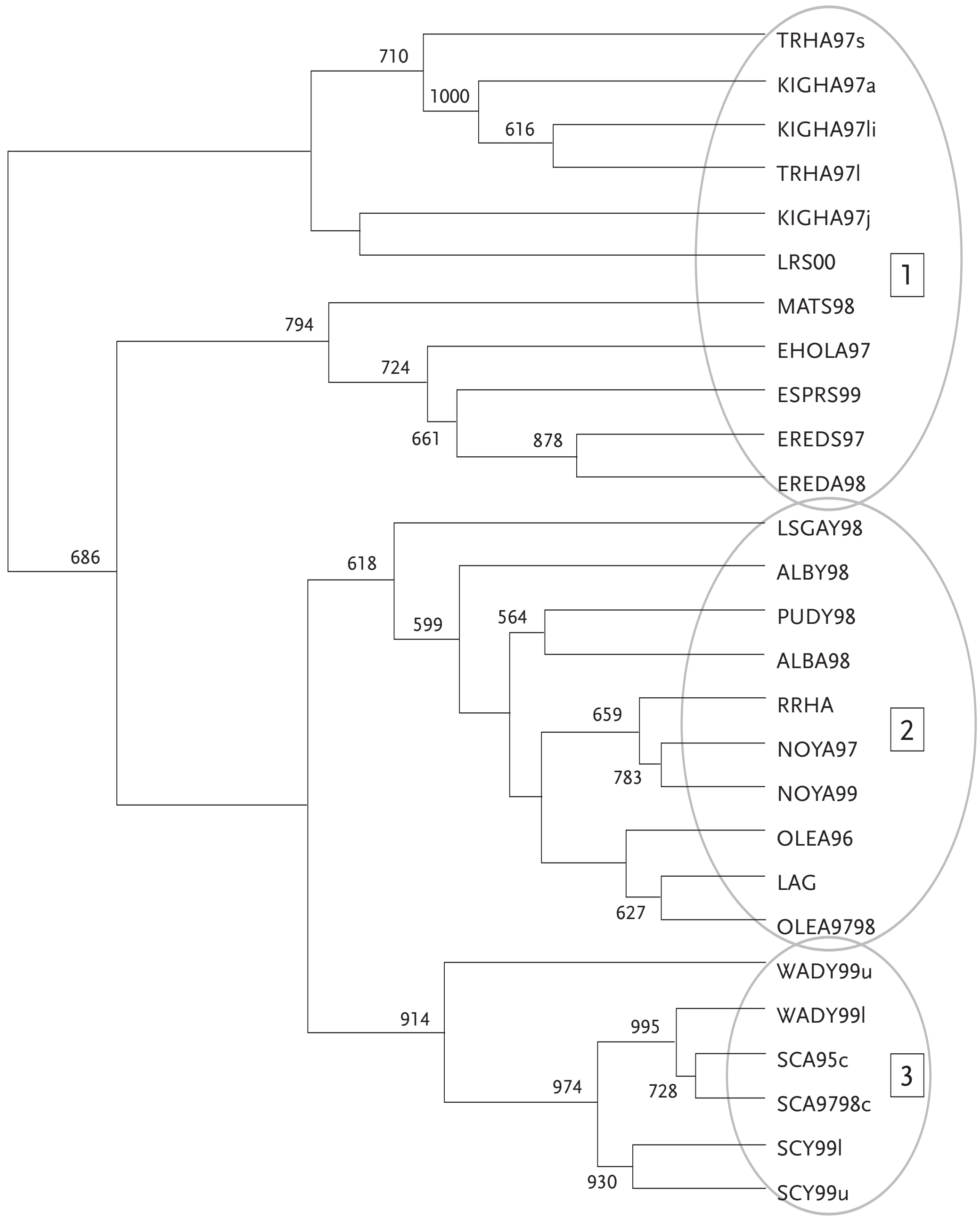
NOTES: Distances were calculated using data for 13 polymorphic allozyme loci from Bartley et al. (1982), Olin (1984), and new NOAA Fisheries samples. Ellipses encompass two major clusters: 1) mostly central California samples generally corresponding to the CCC Coho ESU, and 2) samples corresponding to the SONCC Coho ESU. Boxed samples are outliers to the two major groups from Scott Creek, and Pudding and Cotteneva creeks. From Weitkamp et al. (1995) with modification.

FIGURE 2-7: Unrooted UPGMA phylogram showing chord distances (Cavalli-Sforza and Edwards 1967) among 33 California coho salmon populations after adjustments for admixture and family structure and pooling of homogeneous samples within drainages and sites



NOTES: Genetic analysis is of microsatellite DNA. Nodes with significant bootstrap values (greater than 500 out of 1,000) are shown. Ellipses encompass groups of samples from 1) SONCC Coho ESU, 2) CCC Coho ESU, and 3) locations south of San Francisco. Boxed samples are outliers from Green Valley Cr. and Redwood Cr. Abbreviations: K*, Klamath; T*, Trinity ; LR*, Little R.; ERHO*, Eel-Hollow Tree Cr.; ERED*, Eel-Redwood Cr., ESPR, Eel-Sprowl Cr.; M*, Mattole; PUD*, Pudding Cr.; NOY*, Noyo; ALBA*, Albion; ALBY, Albion-Marsh Cr.; RRH*, Warm Springs Hatchery; RRGV, Green Valley Cr.; RRDS, Russian River Delta; RRM, Mirabel; LAG, Lagunitas Cr.; LSGA*, San Geronimo; OLE*, Olema Cr.; RWM*, Redwood Cr.; WAD*, Waddell Cr.; SC*, Scott Cr. Modified from Hedgecock et al. (2002).

FIGURE 2-8: Unrooted UPGMA phylogram showing chord distances (Cavalli-Sforza and Edwards 1967) among 27 California coho salmon populations after adjustments for admixture and family structure, pooling of homogeneous samples within drainages and sites, and removal of Green Valley and Redwood Creek outliers shown in Figure 2-7



NOTES: Genetic analysis is of microsatellite DNA. Nodes with significant bootstrap values (greater than 500 out of 1,000) are shown. Ellipses encompass groups of samples from 1) SONCC Coho ESU, 2) CCC Coho ESU, and 3) locations south of San Francisco. Abbreviations: K*, Klamath; T*, Trinity; LR*, Little R.; ERHO*, Eel-Hollow Tree Creek; ERED*, Eel-Redwood Cr., ESPR, Eel-Sprowl Cr.; M*, Mattole; PUD*, Pudding Cr.; NOY*, Noyo; ALBA*, Albion; ALBY, Albion-Marsh Creek; RRH*, Warm Springs Hatchery; RRGV, Green Valley Cr.; RRDS, Russian River Delta; RRM, Mirabel; LAG, Lagunitas Creek; LSGA*, San Geronimo; OLE*, Olema Cr.; RWM*, Redwood Creek; WAD*, Waddell Cr.; SC*, Scott Creek. Modified from Hedgecock et al. (2002).

thought to have developed because those fish could surmount obstacles during low or moderate flows but not during high flows. If flow conditions in a stream are unsuitable, the fish will often mill about in the vicinity of the stream mouth, sometimes waiting weeks, or even (in the case of early-run fish) months for conditions to change (Sandercock 1991). Although substantially greater depth may be needed to negotiate some barriers, minimum depth to allow passage of coho salmon is approximately 7.1 inches (Bjornn and Reiser 1991).

Reiser and Bjornn (1979) indicate that adult migration normally occurs when water temperature is in the 45 to 61°F range. Excessively high temperature may result in delays in migration (Monan et al. 1975). Additionally, excessively high temperature during migration may lead to disease outbreaks (Spence et al. 1996) and may reduce the egg viability (Leitritz and Lewis 1980).

The high-energy expenditure during sustained upstream swimming requires adequate concentrations of DO (Davis et al. 1963). Supersaturation of dissolved gases (especially nitrogen), however, has been found to cause gas-bubble disease in migrating salmonids (Ebel and Raymond 1976).

Reid (1998) found that high turbidity affects all life stages of coho salmon. In the case of adults, high concentrations of suspended sediment may delay or divert spawning runs (Mortensen et al. 1976). As an example of a response to a catastrophic event (the eruption of Mount St. Helens, Washington) coho salmon strayed from the highly impacted Toutle River to nearby streams for the two following years (Quinn and Fresh 1984). Salmonids have been found to wait rather than travel up a stream where the suspended sediment load reached 4,000 mg/l (Bell 1986).

Migrating coho salmon require deep and frequent pools for resting and to escape from shallow riffles where they are susceptible to predation. Deep pools are also necessary for fish to attain swimming speeds necessary to leap over obstacles. Pools need to be 25% deeper than the height of the jump for adult fish to attain the necessary velocity for leaping (Flosi et al. 1998).

LWD and other natural structures such as large boulders provide hydraulic complexity and pools. They also facilitate temperature stratification and the development of thermal refugia by isolating pockets of cold water (Bilby 1984; Nielsen et al. 1994). Riparian vegetation and undercut banks provide cover from terrestrial predators in shallow reaches.

2.7.1.2 Spawning

Coho salmon typically spawn in small streams where the flow is 2.9 to 3.4 cubic feet per second (cfs) and the stream depth ranges between 3.94 and 13.78 inches, depending on the velocity (Gribanov 1948; Briggs 1953; Thompson 1972; Bovee 1978; Li et al. 1979). On the spawning grounds, they seek out sites of groundwater seepage and favor areas where the stream velocity is 0.98 to 1.8 ft/s. They also prefer areas where water upwells through the redds, eliminating wastes, and preventing sediments from filling the interstices of the spawning gravel. The female generally selects a redd site at the outlet of a pool or at the head of a riffle, where there is good circulation of oxygenated water through the gravel. A pair of spawning coho salmon requires about 126 square feet for redd and inter-redd space.

About 85% of redds are located in areas where the substrate is comprised of gravel of 15cm diameter or smaller. There must be sufficient appropriately sized gravel and minimal fine sediments to ensure adequate interstitial space for egg survival. In situations where there is mud or fine sand in the nest site, it is removed during the digging process. LWD and other structures such as large boulders provide stream-bank support, which over time helps to reduce sediment input resulting from bank erosion.

Eggs deposited within a zone of scour and fill can wash downstream. LWD, riparian vegetation, and upslope stability enhance bank stability, which in turn promotes gravel stability and minimizes the risk to redds from the scouring effects of high flows. In addition to promoting bank stability, LWD also diversifies flows, reducing stream energy directed towards redds (Naiman et al. 1992).

2.7.2 HABITAT REQUIREMENTS FOR JUVENILES

The coho salmon typically spends the first half of its life in the freshwater or estuarine environment. The following sections describe habitat requirements for the early life stages.

2.7.2.1 Eggs and Alevin Incubation

Low winter flows can result in the desiccation of redds or may expose eggs to freezing temperatures. High water flows can disturb redd gravel, resulting in eggs being dislodged and swept downstream. Winter storms often cause excessive siltation that can smother eggs and inhibit intragravel movement of alevins. Siltation from these storms can reduce water circulation in the gravel to the point where low oxygen levels become critical or lethal.

According to Bjornn and Reiser (1991), the optimum temperature for coho salmon egg incubation is between 40 and 55°F. In one study, coho salmon embryos suffered 50% mortality at temperatures above 56.3°F (Beacham and Murray 1990). Because of the close connection between temperature and developmental processes, changes in thermal regime, even when well within the physiologically tolerable range for the species, can have significant effects on development time (and hence emergence timing), as well as on the size of emerging fry.

A high proportion of fine sediments in the gravel effectively reduces DO levels and also results in smaller emergent fry. Embryos and alevins need high levels of oxygen to survive (Shirazi and Seim 1981), and Phillips and Campbell (1961) suggest that DO levels must average greater than 8.0 mg/l for embryos and alevins to thrive. Excessive sediment deposition may also act as a barrier to fry emergence (Cooper 1959). McHenry et al. (1994) found that when sediment particles smaller than 0.85 mm[1] made up more than 13% of the total sediment, it resulted in intragravel mortality for coho salmon embryos because of oxygen deficiency. Cederholm et al. (1981) found that in the Clearwater River in Washington, the survival of salmonid eggs to emergence from gravel was inversely correlated with the percent of fine sediment when the proportion of fines exceeded the natural level of 10%. Tagart (1984) found that if sediment composition included a high concentration (up to 50%) of fine sediment (<0.85 mm), survival rate was lowered.

Shade provided by tall and/or mature vegetation is an important temperature regulator. LWD and large boulders provide stream-bank support that helps to meter out sediment deposition resulting from bank erosion and runoff, thus decreasing sediment input to spawning gravel.

2.7.2.2 Fry Emergence

Recently emerged coho salmon fry prefer shallow water, which leaves them vulnerable to floods that can displace them downstream into unsuitable habitat. This problem is greatly exacerbated in streams having little complexity due to lack of in-channel LWD. Displacement downstream may lead to early migration toward the estuary, and fry are poorly equipped to survive in brackish or salt water.

After emergence, fry continue to hide in gravel and under large stones, and within a few days they progress to swimming close to the banks, taking advantage of available cover. They congregate in quiet backwaters, side channels, and small creeks, especially in shady areas with overhanging branches. Fry are found in both pools and riffles, but they are best adapted to holding in pools. Cold, deep, dark, complex pools surrounded by streamside vegetation are optimal for coho salmon rearing. LWD and associated pool habitats provide cover from predators and refugia during high flow events (Everest et al. 1985).

[1] This size category includes clay, silt, and some sand. It excludes larger sand particles.

2.7.2.3 Juvenile Rearing

The area of a particular stream available to juveniles for rearing is directly related to the turbidity of stream discharges (Everest et al. 1985). Lloyd et al. (1987) found that juveniles avoided chronically turbid streams, although they appear to be little affected by short transitory occurrences (Sorenson et al. 1977). Published data suggest that the feeding efficiency of juvenile coho salmon drops by 45% at a turbidity of one hundred Nephelometric Turbidity Units (NTUs) (Reid 1998). Coho salmon rarely eat stationary food or from the bottom, preferring food in suspension or on the surface of the water. At the yearling stage, they may supplement their insect diet with the fry of their own or of other species.

By late summer or early fall, juvenile feeding activity decreases and the fish move into deeper pools, especially those with overhanging logs, submerged woody debris and dense riparian vegetation. Juveniles spend time hiding under the cover of logs, exposed tree roots, and undercut banks. Lack of adequate pools and side channels makes them more susceptible to predation and to being swept out of the stream during winter high flows. At this stage they are especially vulnerable as their swimming ability is reduced because of lowered metabolic rate.

Salmonid behavior for coping with high turbidity includes the use of off-channel and clean-water refugia and holding temporarily at clean-water tributary mouths. These coping strategies are partially defeated by sediment inputs from roads, for example, when road runoff discharges into small tributaries that formerly provided clean inflows. In addition, roads adjacent to streams can reduce availability of flood-plain and off-channel pools to juvenile coho salmon (Reid 1998). Coho salmon streams with the best over-wintering habitat are those with LWD accumulations, spring-fed ponds adjacent to the main channel, or protected and slow-flowing side channels that may only be filled in winter. Backwaters and side channels that develop along unconstrained reaches in alluvial flood plains were historically important rearing habitats for juveniles (Sedell and Luchessa 1982).

In unstable coastal systems, coho salmon production may be limited by the lack of side channels and small tributaries to provide additional habitat for protection from winter floods. Beaver ponds can create additional habitat for coho salmon, both in winter to avoid high flows, and in summer to avoid stranding as a result of low flows. Habitat complexity contributes to the creation of microhabitats within reaches, thus providing more opportunities for inter- and intra-species stratification (Bjornn and Reiser 1991). Terrestrial insects and leaves falling into streams from riparian vegetation constitute much of the food base for stream macroinvertebrates, which in turn are a major food source for juvenile coho salmon.

2.7.2.4 Emigration

Stream flow is important in facilitating the downstream migration of coho salmon smolts. Dorn (1989) found that increases in stream flow triggered downstream movement of coho salmon. Spence (1995) also found short-term increases in stream flow to be an important stimulus for smolt emigration. Thus, the normal range of stream flow may be required to maintain normal temporal patterns of migration. In years with low flows, emigration is earlier. Artificial obstructions such as dams and diversions of water may impede emigration where they create unnatural flow patterns.

Water temperature affects timing of emigration of smolts by influencing their rate of growth and physiological development, and their responsiveness to other environmental stimuli (Groot 1982). Alteration of thermal regimes through land-use practices and dam operations can influence the timing of emigration. The probability that coho salmon smolts will migrate downstream increases with rapid increases in temperature (Spence 1995). Holtby (1988) found that coho salmon smolts in British Columbia emigrated approximately eight days earlier in response to logging-induced increases in stream temperatures. In addition, the age-class distribution was shifted from populations evenly split between one- and two-year-old smolts to populations dominated by one-year-old fish. If most smolts emigrate at the same age, poor ocean conditions would have a greater effect on that particular year class than if the risk were spread over two years. Coho salmon have been observed throughout their range to emigrate at temperatures ranging from 36.6°F up to as high as 55.9°F (Sandercock 1991). Coho salmon have been observed emigrating through the Klamath River estuary in mid- to late-May when water temperature ranged from 53.6 to 68°F (CDFG unpublished data).

Supersaturation of dissolved gases (especially nitrogen) has been found to cause gas-bubble disease in downstream-migrating salmonids (Ebel and Raymond 1976). Smolts are particularly vulnerable to predation (Larsson 1985). Physical structures in the form of undercut banks and LWD provide refugia during resting periods and cover from predators.

2.7.3 ESTUARINE HABITAT

Estuaries are essential habitat of Pacific salmon, including coho salmon (Sedell et al. 1991). Adults use estuaries as a holding area as they prepare for their migration upstream. Juveniles use estuaries for rearing, and completion of smoltification. Juveniles may occupy estuaries for several weeks before migrating out to sea. In fact, the phenomenon of smolts migrating out is not a single, unidirectional event; smolts may move in and out of an estuary a few times before finally remaining in the marine environment.

Returning adults enter the freshwater environment through estuaries. Access to the estuaries, sufficient cover, and adequate flow and water quality, including suitable temperature, are all important factors for these fish. Once in the estuaries, upstream migration is generally associated with high outflow combined with high tides (Sandercock 1991).

Young fish are very susceptible to predation once they reach the lower river system and estuary, where water quality and habitat complexity is a crucial factor in their ability to survive. Substrate habitat complexity and adequate woody debris are imperative for shelter and hiding, while a sufficient invertebrate food source is imperative for continued growth and physiological development prior to leaving the estuary. These physical and biological requirements are related to: 1) the type, diversity, distribution, and quality of substrate; 2) the amount, timing and quality of freshwater discharge; and 3) the tidal pattern and quality of marine waters. Estuaries provide important rearing habitat, especially in smaller coastal streams where freshwater rearing habitat is limited.

2.7.4 SUMMARY OF ESSENTIAL HABITAT

Coho salmon inhabit three aquatic environments during the course of their life cycle: freshwater streams, coastal estuaries, and the ocean. In each of these environments, particular ecological conditions are necessary for each coho salmon life stage, as described below. Each condition has a broader range that allows for survival and a narrower range that represents the optimum for coho salmon health, as measured by activity, growth, resistance to disease, and other factors.

It should be noted that most studies define optimal conditions as those producing defined physiological responses or efficiencies under laboratory conditions. Assuming that coho salmon populations are locally adapted to the particular suite of environmental conditions in their natal stream, ecologically optimal conditions in fact may produce physiological responses in fish that lie outside of the narrow range deemed physiologically optimal in laboratory conditions. Most important of these potential influences is the alteration in timing of events relating to the species' life history.

The major freshwater habitats used by each life stage of coho salmon are identified in Table 2-2. Table 2-3 summarizes essential habitat elements by life stage and for each element shows the range of suitability necessary for the viability and survival of coho salmon.

TABLE 2-2: Freshwater habitats of the different life stages of coho salmon

FRESHWATER HABITAT	COHO SALMON LIFE STAGE
Flat water riffle	fry, juveniles, spawning adults
Flat water	juveniles, spawning adults
Gravel streambed	eggs, alevins, young fry, spawning adults
Pool	fry, juveniles, migrating adults
Side-channel	fry, juveniles
Stream bank	fry, juveniles
Submerged vegetation and LWD	juveniles

2.7.4.1 Stream Vegetation

Vegetation in the riparian corridor provides many essential benefits to stream conditions and habitat. It serves as a buffer from sediment and pollution, influences the geomorphology and stream flow, and provides stream-bank stability. Vegetation adjacent to the water stabilizes the stream bank. The riparian buffer is vital to moderating water temperatures that influence spawning and rearing by providing the canopy, which protects the water from direct insolation, and the buffer, which provides a cooler microclimate and lower ambient temperatures near the stream. The riparian canopy also serves as cover from predators, and supplies both insect prey and organic nutrients to streams.

2.7.4.2 Large Woody Debris

LWD is an essential component with several ecological functions. Within the estuarine environment, it stabilizes substrate, provides cover from predators, and provides shelter. In the freshwater environment, it serves these same functions as well as providing for pool establishment and maintenance, spawning bed integrity, habitat for aquatic invertebrate prey, and instream productivity.

2.7.4.3 Sediment and Substrate

The channel substrate type and size, and the quantity and distribution of sediment have essential direct and indirect functions at several life stages of coho salmon. Adults require gravel of appropriate size and shape for spawning, building redds, and laying eggs. Eggs develop and hatch within the substrate, and alevins remain there for some time for protection and shelter. The substrate also functions as habitat for rearing juveniles by providing shelter from faster flowing water and protection from predators. Also, some invertebrate prey inhabit the benthic and epibenthic environment of the stream substrate. An excess of fine sediment is a significant threat to eggs and fry because it can: 1) reduce the interstitial flow necessary to regulate water temperature and DO, remove excreted waste, and provide food for fry; 2) reduce available habitat; and 3) envelop, and then suffocate, eggs and fry. The flushing and cycling of fine sediments is paramount to coho salmon survival.

2.7.4.4 Hydrological Regime

The characteristics of the water and the geomorphology of the stream channel are fundamentally essential to all coho salmon life stages that inhabit coastal watersheds. Important charac-

TABLE 2-3: Fundamental habitat elements and suitable ranges for coho salmon life stages[a]

ELEMENT	LIFE STAGE	SUITABLE RANGE	REFERENCE OR CITATION
Large woody debris	rearing juvenile	>400 ft^3/100 ft reach[b]	Murphy 1995
Riparian cover	rearing juvenile	>80%	Flosi et al. 1998
Sediment and substrate	spawning adult	20% fine sediment; 0.51-4.02 inches (size)[c]	Reiser and Bjornn 1979; Bjornn and Reiser 1991
	egg and fry	depth: 7.01-15.41 in; ~9.85 in; diameter: 1.54-5.40, ~3.70; <20% fine; <12% fine, <5% fine (optimum)	Briggs 1953; Cederholm and Reid 1987; PFMC 1999
Stream flow (peak flow, freshets, minimum summer flow)	migrating adult	discharge is specific to stream	
	spawning adult	discharge is specific to stream	
	rearing juvenile	discharge is specific to stream	
Territory (square feet)	spawning pair	126	Bjornn and Reiser 1991
	rearing juvenile	26-59/fish; 0.001-1.0 fish per 3.281 [0.5-1 year old]	Reiser and Bjornn 1979; Bjornn and Reiser 1991
Turbidity (NTU[d])	migrating adult	<30 ounces/gal	Bjornn and Reiser 1991
	spawning adult	clear to heavily silted	Sandercock 1991
	juvenile	>60 (disrupted behavior); >70 (avoidance)	Bjornn and Reiser 1991
Water depth (inches)	migrating and spawning adult	4.02-7.88; ~6.19; 7 (minimum)	Briggs 1953; Bjornn and Reiser 1991
	rearing juvenile[e]	9.46-48.07	Bjornn and Reiser 1991
Dissolved oxygen (oz/gal)	migrating adult	‡80% saturation and >0.037	Bjornn and Reiser 1991
	rearing juvenile	100% saturation (preferred); 0.037-0.044 (stressed); >.059 (optimum)	Reiser and Bjornn 1979; Bjornn and Reiser 1991, PFMC 1999
	egg and fry	near saturation (preferred); >0.059 (optimum)	Reiser and Bjornn 1979; Bjornn and Reiser 1991; PFMC 1999
Water temperature (°F)	migrating adult	44.6-59	Reiser and Bjornn 1979
	spawning adult	39.2-48.2	Bjornn and Reiser 1991
	rearing juvenile	35 (lower lethal); 78.8-83.8 (upper lethal); 53.6-57.2 (optimum); 48-59.9 (optimum); 63.7-64.9 (MWAT[f]); 62.1 (MWAT) and 64.4 (MWMT[g])	Bjornn and Reiser 1991; Flosi et al. 1998; Ambrose et al. 1996; Ambrose and Hines 1997, 1998; Hines and Ambrose ND; Welsh et al. 2001
	egg and fry	39.2-51.8; 39.2-55.4 (optimum); 32-62.6	Davidson and Hutchinson 1938; Bjornn and Reiser 1991, PFMC 1999
Water velocity (ft/s)	migrating adult	<8	Reiser and Bjornn 1979
	spawning adult	0.98-2.46; 1.02; 1.9, 0.98-2.99	Briggs 1953; Reiser and Bjornn 1979; Bjornn and Reiser 1991
	rearing juvenile	0.30-0.98 (preferred for age 0), 1.02-1.51 (riffle), 0.30-0.79 (pool); 0.16-1.283; 0.16-0.98	Reiser and Bjornn 1979; PFMC 1999
	egg and fry	0.82-2.95	PFMC 1999

NOTES:

[a] Values presented in this table are based on general conditions found within suitable coho salmon habitat in California and elsewhere. Individual determinations of habitat suitability and restoration potential should be based on site-specific conditions in consultation with the Department.

[b] Coho salmon research conducted in southeast Alaska.

[c] Estimated from other species or general for anadromous salmonids.

[d] NTU = Nephelometric Turbidity Units

[e] Various sizes and ages. Fish either aged (0 or 1) or measured (15.8-24.4 cm).

[f] MWAT = Maximum weekly average temperature

[g] MWMT = Maximum weekly maximum temperature

teristics include water temperature, water velocity, flow volume, and the seasonal changes and dynamics of each of these (e.g., summer maximum and mean temperature, summer flow, peak flow, winter freshets).

2.7.4.5 Water Temperature

Appropriate water temperature regines are essential throughout the freshwater phases of the coho salmon life cycle. Water temperature affects the rate and success of egg development; fry maturation; juvenile growth, distribution, and survival; smoltification; initiation of adult migration; and survival and success of spawning adults. Water temperature is influenced by many factors including stream flow, riparian vegetation, channel morphology, hydrology, soil-geomorphology interaction, climate, and impacts of human activities. The heat energy contained within the water and the ecological paths through which heat enters and leaves the water are dynamic and complex. There is also small- and large-scale heterogeneity of temperatures based on stream depth, width, and flow (Essig 1998).

Water temperature requirements must be considered in relation to the unique physiological phenomena associated with each life stage. Additionally, environmental conditions in specific watersheds may affect the normal range and extreme end-points for any of these temperature conditions for coho salmon within these watersheds. Water temperature requirements are dependent on fish metabolism and health, and on available food. Individual coho salmon populations are genetically adapted to habitat conditions within specific watersheds; therefore some populations may differ slightly in their temperature requirements and tolerances. These factors need to be considered together when trying to understand the habitat needs of coho salmon in a particular watershed or river system.

2.7.4.6 Dissolved Oxygen

An adequate level of dissolved oxygen is necessary for each life stage of coho salmon and is affected by water temperature, instream primary productivity, and stream flow. Fine sediment concentrations in gravel beds can also affect DO levels, impacting eggs and fry.

Threats 3

This chapter summarizes threats to coho salmon. The severity of the decline in the numbers of coho salmon and the number of extirpated populations increases as one moves closer to the historical southern limit of the species' range, suggesting that these environments are less able to support coho salmon populations than in the past. Freshwater habitat loss and degradation have been identified as leading factors in the decline of anadromous salmonids in California, including the coho salmon. Past timber harvest activities, especially road construction, have had deleterious effects on coho salmon habitat. Urbanization and increased diversion of water for agricultural, domestic, and other purposes, and dams that block access to former habitat, have resulted in further reduction of habitat. Water quality in streams historically inhabited by coho salmon has degraded, as evidenced by the number of north- and central-coast streams that have been placed on the list of impaired water bodies, pursuant to §303 of the Clean Water Act (CWA).

3.1 CLIMATIC VARIATION

California experiences wide variation in climatic and hydrologic conditions. Various climatic phenomena including severe storms, drought, seasonal cycles, El Niño and La Niña events, decadal events, and regime shifts can alter the physical, chemical, and biological aquatic environment (Parrish and Tegner 2001). These changes can, in turn, play a major role in the life history, productivity, and persistence of coho salmon populations. Coho salmon evolved with, and have persisted in the face of, extreme variability in habitat conditions caused by these natural phenomena. However, catastrophic conditions combined with low population numbers, habitat fragmentation, impacts of human activities, and habitat degradation or loss can cause an unrecoverable decline of a given population or species (Moyle et al. 1995).

3.1.1 DROUGHT

In California, coho salmon populations exist in many coastal streams where stream closures occur at their mouths when coastal wave action and low summer flows lead to sandbar formation. Coho salmon are able to identify their natal stream by the seepage of fresh water entering the ocean through the bars, but they are unable to enter the streams until fall or winter rains increase flows sufficiently to breach the sand bars. Shapovalov and Taft (1954) found that streams south of San Francisco may not be passable until as late as March. When this happens, a large portion of the run may enter the stream over a short period. Up to 70% of the total returning spawning population may enter the stream from the ocean within a few days (Sandercock 1991). During prolonged droughts, sandbars may never open in a given season. When that happens, spawners are unable to enter those streams (Anderson 1995). Reduced flows can reduce habitat quantity and result in increased water temperature, causing increased heat stress to fish and thermal barriers to migration.

3.1.2 FLOODING

High flows associated with floods can result in complete loss of eggs and alevins as they are scoured from the gravel or buried in sediment (Sandercock 1991; NMFS 1998). Juveniles and smolts can be stranded on the flood plain, washed downstream to poor habitat such as isolated side channels and off-channel pools, or washed out to sea prematurely. Peak flows can induce adults to move into isolated channels and pools or prevent their migration through excessive water velocities.

Streams can be drastically modified by erosion and sedimentation in large flood flows almost to the extent of causing uniformity in the stream bed (Spence et al. 1996). After major floods, streams can take years to recover pre-flood equilibrium conditions. Flooding is generally not as devastating to salmon in morphologically complex streams, because protection is afforded to the fish by the natural in-stream structures such as LWD and boulders, stream channel features such as pools, riffles, and side channels and an established riparian area (Spence et al. 1996).

Flooding does, however, have beneficial effects such as cleaning and scouring of gravels, transporting sediment to the flood plain, moving and rearranging LWD, recharging flood plain aquifers (Spence et al. 1996), allowing salmonids greater access to a wider range of food sources (Pert 1993), and maintaining the active channel.

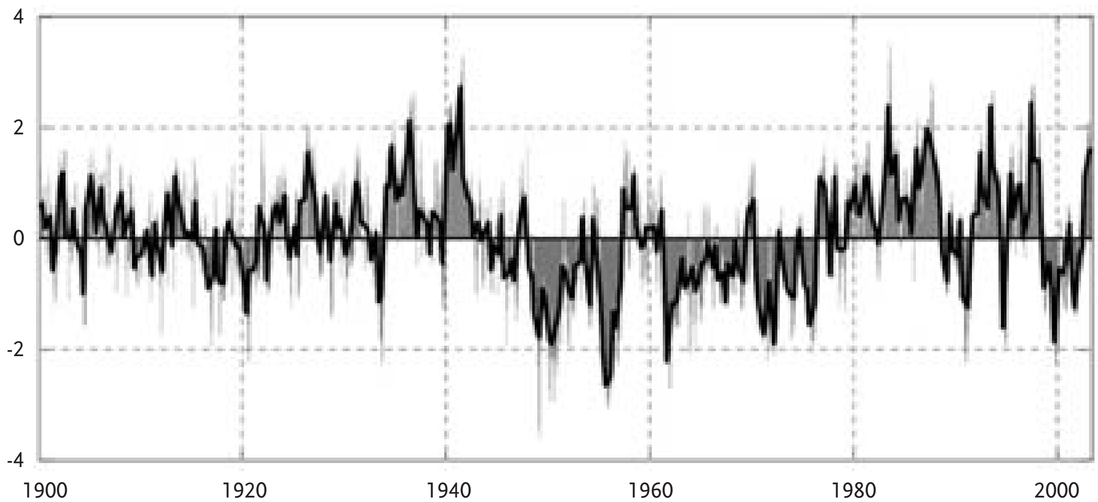
3.1.3 OCEAN CONDITIONS

Changing ocean conditions, extreme climatic conditions, and natural variation in ocean conditions can strongly impact Pacific salmon populations. However, salmon populations have not, until the past century, experienced these conditions in conjunction with the widespread degradation of their spawning, rearing, and overwintering habitat caused by human related activities (Brown et al. 1994; Anderson 1995).

Periodic changes in Pacific currents, winds, and upwelling regimes have had major impacts on the primary and secondary productivity of the northeast Pacific Ocean (Brown et al. 1994; Mantua et al. 1997). These oceanic events, described as El Niño/Southern Oscillation (ENSO) and Pacific interdecadal oscillation (PDO) are associated with declines and increases in ocean survival and decreases and increases in size of coho and Chinook salmon (Johnson 1988; Spence et al. 1996; Tschaplinski 1999; Cole 2000; Ryding and Skalski 1999; Koslow et al. 2002). ENSO events are of relatively short duration (6-18 months) with their primary influence in the tropics and secondary expression in the North Pacific/North American sector. In contrast, PDO events are most visible in the North Pacific and typically cycle over periods of about 50 years; within a PDO cycle there may be short-lived reversals of conditions (Mantua 2003). Figure 3-1 summarizes monthly PDO indices developed by the University of Washington; negative values indicate cool PDO periods that are generally favorable for coho salmon populations in California.

Marine conditions have several ramifications that must be considered in planning for coho salmon recovery and the interpretation of monitoring results. The cyclic nature of marine productivity, as outlined by Lawson (1993), can mask the reproductive decline of a salmonid population. The conceptual model he presents combines the effects of oceanic cycles and freshwater habitat degradation. As the freshwater habitat degrades, the salmon populations do not decline in an immediate and linear fashion. Instead, due to the long-term cycles of productivity in the marine environment, the downward trend in freshwater productivity can be masked by higher escapement due to more favorable oceanic conditions. These trends must be considered when assessing the success of coho salmon recovery efforts.

FIGURE 3-1: Monthly values for the Pacific interdecadal oscillation index: January 1900 to April 2003



SOURCE: http://tao.atmos.washington.edu/pdo/

3.2 DISEASE

Coho salmon are susceptible to an array of bacterial, viral, parasitic, and fungal diseases found in many salmonids of the Pacific Northwest. Symptomatic conditions appear when fish are stressed by high water temperatures, crowding, environmental contaminants, or decreased oxygen supply (Warren 1991). Diseases affect various life stages differently. Diseases and disease agents in California that can cause significant losses in adult salmonids include: bacterial kidney disease *(Renibacterium salmoninarum),* furunculosis *(Aeromonas salmonicida),* columnaris *(Flexibacter columnaris),* pseudomonas infection, aeromonas infection, and ichthyopthirius or "ich" *(Ichthyophthirius multifiliis)* (W. Cox pers. comm.). The diseases that are known to cause significant losses in juvenile salmonids are furunculosis, columnaris, coldwater disease *(Flexibacter psychrophilis),* pseudomonas, aeromonas, ichthyopthirius, nanophyetes, and ceratomyxosis *(Ceratomyxa shasta)* (William Cox pers. comm.).

The introduction of disease by hatchery fish into wild stocks is an increasing concern, but the degree of risk and seriousness of the problem are little known (Brown et al. 1994).

3.3 PREDATION

Predation occurs during all life stages of the coho salmon and it is accommodated by a healthy population; however it can be detrimental to those populations with low numbers or poor habitat conditions (Anderson 1995).

3.3.1 FRESHWATER PREDATION

Predators in the freshwater environment, such as invertebrates, fish, and birds, reduce the survival rate of eggs and alevins (Sandercock 1991). Some native fishes known to consume coho salmon are: sculpin *(Cottus spp.),* Sacramento pikeminnow *(Ptychocheilus grandis),* steelhead rainbow trout *(Oncorhynchus mykiss),* coastal cutthroat trout *(O. clarki clarki),* and other coho salmon (Shapovalov and Taft 1954; Sandercock 1991; Anderson 1995). Non-native fishes such as Sacramento pikeminnow *(Ptychocheilus grandis)* introduced to the Eel River, smallmouth bass *(Micropterus dolomieu)*, and channel catfish (*Ictalurus punctatus*) can consume significant numbers of juvenile salmon if the conditions are favorable for them (NMFS 1998). Striped bass *(Morone saxatilis)* can also be a significant predator of juvenile salmonids, and has been observed in the Russian River system. However, current information does not indicate that they have had a significant impact on coho salmon populations. Avian predators of juvenile salmonids include dipper *(Cinclus mexicanis)*, gulls *(Larus spp.)*, double-crested cormorant *(Phalacrocorax auritus)*, belted kingfisher *(Megaceryle alcyon)*, herons *(Ardea spp.)*, common merganser *(Mergus merganser)*, and osprey *(Pandion haliaetus)* (Fresh 1997; Sandercock 1991; Spence et al. 1996). Among mammalian predators that can impact salmonid populations, mink *(Mustela vison)* and otter *(Lutra canadensis)* can take significant numbers of the overwintering coho salmon juveniles and migrating smolts, although this is dependent upon conditions favorable to predators and the availability of other prey (Sandercock 1991).

3.3.2 MARINE PREDATION

The relative impacts of marine predation on anadromous salmonids are not well understood, though documentation of predation from certain species is available. NMFS (1998) noted that several studies have indicated that piscivorous predators may control salmonid abundance and survival. Beamish et al. (1992) documented predation of hatchery-reared Chinook and coho salmon by spiny dogfish *(Squalus acanthias)*. Pacific hake *(Merluccius productus)* and pollock *(Theragra chalcogramma)* are known to consume salmon smolts (Holtby et al. 1990). Marine sculpins also consume juvenile salmonids, although salmonids are not a major part of their diet.

There are many known avian predators of juvenile salmonids in the estuarine and marine environments. Some of these include belted kingfisher, gulls, grebes *(Podicipedidae)*; and loons *(Gavia spp.)*, herons, egrets, bitterns *(Ardeidae)*; cormorants *(Phalacrocorax spp.)*, terns (*Sterna* spp.), mergansers *(Mergus spp.)*, pelicans *(Pelecanus spp.)*, auklets, murres, murrelets, guillemots, and puffins *(Alcidae)*; and sooty shearwater *(Puffinus grisens)* (Emmett and Schiewe 1997; NMFS 1998). Bald eagles *(Haliaeetus leucocephalus)* and osprey are predators of adult salmonids (Emmett and Schiewe 1997). It is important to note that these predators are opportunistic feeders, preying upon the most abundant and easiest to catch.

In most cases, salmonids appear to be a minor component of the diet of marine mammals (Scheffer and Sperry 1931; Jameson and Kenyon 1977; Graybill 1981; Brown and Mate 1983; Roffe and Mate 1984; Hanson 1993; Botkin et al. 1995; Goley and Gemmer 2000; Williamson and Hillemeier 2001a, 2001b). The principal food sources of marine mammals include lampreys (Jameson and Kenyon 1977; Roffe and Mate 1984; Hanson 1993), benthic and epibenthic species (Brown and Mate 1983; Hanson 1993), and flatfish (Scheffer and Sperry 1931; Graybill 1981; Hanson 1993; Goley and Gemmer 2000; Williamson and Hillemeier 2001a, 2001b). Although salmonids appear to make up a relatively minor component of the diet of seals and sea lions, this does not indicate conclusively that pinniped predation is not significant. Predation may significantly influence salmonid abundance in populations when other prey are absent and physical habitat conditions lead to the concentration of adult and juvenile salmonids in small areas (Cooper and Johnson 1992).

3.4 HATCHERIES

A large body of evidence supports the conclusion that artificial propagation can be detrimental to natural and hatchery salmonid populations (Steward and Bjornn 1990; Hindar et al. 1991; Waples 1991b; Campton 1995; Flagg et al. 2000). Several published studies have found that hatchery stocks are generally less productive in the wild than locally adapted natural stocks, and that transplanted stocks are also less productive than locally adapted natural ones (Leider et al. 1990; Waples 1991b; Meffe 1992; Fleming and Gross 1993; Reisenbichler and Rubin 1999).

Although no direct connection can be made because specific data are lacking, stock transfers from various sources from within and from outside California have been implicated by several authors as a factor that might have contributed to the low diversity and weak population genetic divergence observed in California coho salmon stocks (Brown and Moyle 1991; Bartley et al. 1992; Weitkamp et al. 1995; NMFS 2001). Prolonged hatchery stocking in a particular stream should not be used by itself as documentation of extinction of a distinct wild population. Wild coho salmon stocks can persist in the presence of extensive hatchery stocking.

Hatcheries may have contributed to declines of coho salmon in California, although to what degree is unknown. Currently, their potential to do harm is limited by decreased hatchery production and modern management policy. Hatcheries in California have dramatically reduced their production of coho salmon, limited outplanting, and stopped virtually all stock transfers in recent years. Therefore, current impacts of hatchery fish on remaining natural stocks are significantly less than in the past.

3.5 GENETIC DIVERSITY

An understanding of the existing range and pattern of genetic diversity is essential to effective recovery planning. Section 2.6 reviews the available population genetics information for coho salmon, including patterns of genetic variation that will be useful first approximations for delimiting populations.

Maintenance of genetic diversity is crucially important to the recovery of depleted stocks because genetically diverse taxa:

a. Have a potential for greater overall abundance because different populations can exploit different habitats and resources;

b. Exhibit enhanced long-term stability due to spread risk and redundancy in the face of unpredictable catastrophes (e.g., dramatic rapid fluctuation of climatic or ocean conditions); and

c. Contain a broad range of raw material that allows adaptation and increases the probability of persistence in the face of long-term environmental change (McElhany et al. 2000; Levin and Shiewe 2001).

Numerous literature sources have expressed concerns about loss of genetic diversity in California coho salmon populations (CDFG 2002; Hedgecock et al. 2002; NMFS 2001; Weitkamp et al. 1995; Brown et al. 1994; Brown and Moyle 1991). Coho salmon status reviews (CDFG 2002; NMFS 2001; Weitkamp et al. 1995; Brown et al. 1994; Brown and Moyle 1991) have consistently characterized many California coho salmon populations as small and fragmented, with missing brood years in some places. Some of the threats to genetic diversity that were identified in these reviews are shown in Table 3-1. These threats include small population size effects, inappropriate levels of migration or straying, negative hatchery-natural interactions, and missing brood years. Any recovery actions should take these possible factors into account.

TABLE 3-1: Identified concerns about maintenance of existing genetic diversity and possible causes of reduction of genetic diversity in California coho salmon

FACTOR	RESULTS	EFFECT ON RECOVERY POTENTIAL
Few breeding individuals in each population	• Reduced N_e • Inbreeding depression • Increased rate of genetic drift • Allee Effect	• Loss of within-population genetic diversity • Reduced fitness • Reduced adaptive potential • Reduced evolutionary potential • Inability to find mates • Reduced productivity • High vulnerability to catastrophic events and rapid environmental change
Migration and straying (both more and less than natural rates)	• Impaired metapopulation structure • Inappropriately high migration rate among populations • Outbreeding depression	• Reduced connectivity among populations • Loss of between-population genetic diversity (Homogenization of stocks) • Loss of adaptive complexes • Reduced fitness • Reduced productivity
Hatcheries	Domestication of broodstock Negative natural/hatchery interactions	• Loss of adaptive complexes • Genetic swamping • Reduced fitness of all run components (HO, NO, and HO+NO) • Replacement of well adapted natural runs with poorly adapted hatchery runs • Inappropriate levels of straying • Masking of declines in natural run size
Missing brood years and local extinction	• Reduced N_b, N_e • Loss of potential migrants • Change in population age structure • Incomplete brood-year cycles • Impaired metapopulation structure	• Loss of genetic diversity components • Reduction of potential for gene flow among brood years • Loss of adaptive potential

SOURCES: CDFG 2002; Hedgecock et al. 2002; NMFS 2001; Weitkamp et al. 1995; Brown et al. 1994; Brown and Moyle 1994.

Loss of genetic variation can mean loss of alleles, loss of heterozygosity, or changes in allele frequencies. All of these have the potential to reduce fitness, and can be detrimental to the character and persistence of breeding populations. The risks associated with loss of genetic diversity have been explored in a number of published works including Waples (1991b), Currens and Busack (1995), Busack and Currens (1995), Campton (1995), Grant (1997), and Utter (1998). Loss of variation has been implicated as a factor limiting evolutionary potential (Frankham et al. 1999), and can affect the potential range of response to pathogens (O'Brien and Everman 1989).

Small populations can experience genetic diversity losses through inbreeding and genetic drift. Loss of variation due to inbreeding depression has been reported as a factor that may increase the probability of local extinction (Saccheri et al. 1998). When new populations arise from small numbers of individuals, founder effects can also cause geographically close populations to be different from one another. These effects are countered by migration among populations (straying), mutation, and selection.

Introgressive hybridization can reduce genetic diversity and fitness of genetically different stocks. Straying, artificially high levels of gene flow, and/or inappropriate choice of broodstock for hatchery supplementation may cause locally adapted populations to be more similar to one another with concomitant loss of adaptive complexes, reduced fitness, lowered productivity, and reduction of recovery potential. Even if hybridization effects only become evident in the second generation, long-term recovery may be impeded. It is important to draw a distinction between total genetic diversity and adaptive genetic diversity. The ability of a population to respond to change can be negatively affected by unique but maladaptive genes that nonetheless add to total genetic diversity.

Much of the discussion in the literature regarding loss of diversity has been in the context of impacts associated with hatchery management and practice, and interactions of hatchery fish with natural fish. These impacts include loss of fitness due to domestication and artificial selection that can occur in hatcheries and a variety of other possible negative effects (see CDFG 2002 for a review). In the course of recovery planning, it is important to avoid hatchery impacts on recovering stocks, even as we consider the valid use of hatcheries as a recovery tool.

Many of the causes of genetic diversity loss are related to decreases in population size and associated decreases in effective population size and number of breeders. Because per generation loss of genetic diversity is related to the effective population size of the spawner population, several authors have proposed N_e thresholds that can be used as guidelines in evaluating the severity of potential genetic diversity reductions. The upper portion of Table 3-2 shows some effective population size guidelines from the literature. The lower portion of Table 3-2 shows estimates of the number of breeders per generation and the number of breeders per year that would theoretically be needed to maintain genetic diversity in populations of California coho salmon.

Because salmon populations are usually connected by some small amount of gene flow, and gene flow between populations is a contributor to overall genetic variation, smaller than predicted effective sizes might be sufficient to maintain diversity. Because of this, these guidelines may be more appropriate for evaluating the potential for genetic diversity loss in isolated runs that do not experience immigration from other places. Estimates from two of the studies shown in Table 3-2 (Franklin 1980 and Lande 1995) were based on study of a single species, the fruit fly *Drosophila melanogaster*, and might not be generally applicable to salmon (McElhaney et al. 2000). Therefore, these guidelines should not be used as hard targets for recovery unless they are supported on a case-by-case basis. They can be useful for roughly estimating the potential for diversity loss due to small population size in the absence of specific data. For example, a population with consistent returns of 50 spawners per year might be judged large enough to avoid inbreeding depression, but we would be less confident that a population of this size could maintain adaptive potential over the long term.

TABLE 3-2: Guidelines for number of breeders per generation and number of breeders per year needed to maintain genetic diversity in populations of California coho salmon

Values of N_e or N_b needed to maintain genetic variation:

- Franklin (1980): avoidance of inbreeding depression: $N_e = 50$
- Waples (1990): maintain short term genetic variation [based on p(loss of rare alleles)]: N_b/year = 100
- Franklin (1980) and Lande and Barrowclaw (1987): avoidance of long-term loss of genetic variation: $N_e = 500$
- Lynch (1990), maintain genetic variation in a population: $N_e = 1{,}000$
- Lande (1995), maintain potentially adaptive genetic variation: $N_e = 5{,}000$

$N_e/N_t = N_e$ MIN	0.1 N_b PER GENERATION	0.1 N_b PER YEAR	0.33 N_b PER GENERATION	0.33 N_b PER YEAR
50	500	167	152	51
100	1,000	333	303	101
500	5,000	**1,667**	1,515	505
1,000	10,000	3,333	3,030	1,010
5,000	50,000	**16,667**	15,152	5,051

NOTES: N_e is effective population size, N_b is number of breeders, and N_t is the total census population size. Estimates of N_e/N_t for pacific salmon range from 0.1 to 0.33. An average generation length of three years is used in the calculations.

Values in bold were identified in CDFG (2002) as precautionary targets for maintenance of genetic variation in coho salmon populations.

3.6 LAND USES

A variety of problems and land uses have degraded freshwater and estuarine habitat, created barriers to salmon passage, or degraded coho salmon habitat in other ways. This section describes some of these actions.

3.6.1 FORESTRY ACTIVITIES

Historical forestry practices and some current forestry practices have been shown to impact several freshwater habitat components important to anadromous salmonids in general, and coho salmon specifically. These impacts include increased maximum and average summer water temperatures, decreased winter water temperature, and increased daily temperature fluctuations; increased sedimentation; loss of LWD; decreased DO concentrations; increased instream organic matter; and decreased stream-bank stability (Salo and Cundy 1987; Meehan 1991; Moring et al. 1994; Murphy 1995; Monschke 1996). Table 3-3 lists forestry practices, and describes changes to the landscape and the potential effects on salmonid habitat conditions.

Even when some habitat conditions return to pre-timber-harvest levels, fish populations do not always recover, which may be due to other habitat conditions remaining sub-standard or having been permanently altered (Moring et al. 1994). Logged areas are further affected and aggravated by natural incidents (e.g., blow-downs, landslides) and by human activity subsequent to logging, all of which may result in negative cumulative impacts.

Identifying the relationships between forestry practices and habitat impacts is complicated for several reasons. First, there is a long history of timber harvesting, and some effects, such as sedimentation and slope instability, continue long after harvesting has occurred. These alterations are referred to as “legacy” effects, and recovery may take many decades (Murphy 1995). Legacy effects are a factor along the north coast of California (Monschke 1996). Second, there have been many technological and management changes in timber harvest, and it is difficult to differentiate legacy effects from recent or current effects. Third, the salmonid habitat elements affected by timber harvest are themselves intimately inter-related. The amount and size frequency distribution of LWD, water temperature, near-stream vegetation, sediment transport and deposition, landsliding, stream flow and supply, and turbidity are all linked to one another.

During the approximate 150-year history of timber harvest in coastal northern California, harvest practices have changed dramatically, primarily due to changes in technology and decreasing availability of larger or higher quality logs. Historical harvest and milling were often close to waterways; whereas modern trucks and tractors have enabled more recent harvesting to occur in a wider variety of areas within a watershed. Logs were once primarily transported by river and are now transported by trucks along specially constructed roads. Logs used to be removed from the forest by mules and railroad, and these mechanisms have been replaced by tractors and cabling networks.

Current forestry activities, including forest nonpoint source control programs, have made strides in improving pollution and sediment discharge into streams over historical forestry practices. Forest Practice Rules (FPRs) adopted, in part, for the benefit of anadromous fishes (e.g., FPR 916.9, 936.9, 956.9. Watershed Protection Extension, a.k.a. Threatened and Impaired Watersheds) have been in effect since 2000. Table 3-4 compares the different watercourse protection standards, under pre-2000 FPRs, current California FPRs, and Federal protection (Forest Ecosystem Management Assessment; FEMAT). Although the new rules reduce some site-specific impacts, there has not been sufficient time to determine if there have been benefits to coho salmon.

The Department’s conclusion is that historical forestry practices impacted and continue to impact watersheds inhabited by northern California coho salmon, and that current activities

TABLE 3-3: Forestry activities and potential effects to stream environment, salmonid habitat, and salmonid biology

FORESTRY PRACTICE	POTENTIAL EFFECTS TO:		
	STREAM ENVIRONMENT	SALMONID HABITAT	SALMONID BIOLOGY
Timber harvest in the riparian zone	increased incident solar radiation	increased stream temperature, light levels, and primary production	decreased growth efficiency; increased susceptibility to disease; increased food productivity; changes in growth rate and age at smolting
	decreased supply of LWD	decreased cover, storage of gravel and organic debris, and protection from high flows; loss of pool habitat and hydraulic and overall habitat complexity	decreased carrying capacity, spawning gravel, food production, and winter survival; increased susceptibility to predation; loss of species diversity
	increased, short-term input of LWD	increase in number of pools and habitat complexity; creation of debris jams	increased carrying capacity for juveniles and winter survival; barrier to migration and spawning and rearing habitat
	increased influx of slash	increased oxygen demand, organic matter, food, and cover	decreased spawning success; short-term increase in growth
	stream-bank erosion	reduced cover and stream depth	increased carrying capacity for fry; decreased carrying capacity for older juveniles; increased predation
		increased instream fine sediment; reduced food supply	reduced spawning success; slower growth rates for juveniles
Timber harvest on upslope areas	altered stream flow	temporary increase in summer stream flow	temporary increase in survival of juveniles
		increased severity of peak flows during storm season; bedload shifting	increased egg mortality
Timber harvest on upslope areas and road construction and use	increased erosion and mass wasting	increased instream fine sediment; reduced food supply	reduced spawning success, growth and carrying capacity; increased mortality of eggs and alevins; decreased winter hiding space and side-stream habitat
		increased instream coarse sediment	increased or decreased carrying capacity
		increased debris torrents; decreased cover in torrent tracks; increased debris jams	blockage to migration of juveniles and spawning adults; decreased survival in torrent tracks
	increased nutrient runoff	increased primary and secondary production	increased growth rate and summer carrying capacity
	stream crossings	barrier in stream channel; increased sediment input	blockage or restriction to migration; reduced spawning success, carrying capacity and growth; increased winter mortality
Scarification and slash burning	increased nutrient runoff	increased primary and secondary production	increased growth rate and summer carrying capacity
	increased input of fine organic and inorganic sediment	increased sedimentation in spawning gravels and production areas; temporary increase in oxygen demand	decreased spawning success; increased mortality of eggs and alevins

SOURCE: Adapted from Hicks et al. 1991

TABLE 3-4: Comparison of watercourse protection standards

Management Application	California Forest Practice Rules (FPR) Prior To July 1, 2000	FPRS; Protection In Watersheds With Threatened Or Impaired Values	Forest Ecosystem Management Assessment Team (FEMAT) July 1993[a]
CLASS I WATERCOURSE			
Watercourse and Lake Protection Zone (from the hillslope edge of channel zone)	1. to 75' for <30% slopes 2. to 100' for 30-50% 3. to 150' for >50% Widths may be reduced if cable or helicopter system is used	1. 150' minimum 2. No Emergency Notice or Exemption operations allowed within the WLPZ	To top of inner gorge, outer edges of 100-year flood plain, outer edge of riparian vegetation, or to distance equal to height of two site potential trees, or 300 feet, whichever is greatest
WLPZ retention	1. 50% overstory canopy 2. 50% understory canopy 3. Retained overstory canopy must be at least 25% existing overstory conifer 4. Retention of at least 75% surface cover	1. Inner band (0-75'): 85% overstory canopy 2. Outer band (75-150'): 65% overstory canopy 3. Retained overstory canopy must be at least 25% overstory conifer 4. Retention of at least 75% surface cover	Removed from timber base; no timber harvest
Large wood debris retention	Two living conifers/acre, and 50' tall, within 50' of Class I and II watercourses.	The 10 largest trees (dead or alive) per 330' of stream, within 50' of the water-course transition line.	No harvest zones in Riparian Reserves; salvage allowed only if required to attain Aquatic Conservation Strategy (ACS) objectives
Inner gorge special treatment (special zone established where the slope >55%)	None	1. Extends to the first major break-in-slope a distance of 100' or 300' from the water-course transition line, whichever is less 2. Requires use of selection harvesting 3. Even-age management above zone on slope >65% to be reviewed by geologist 4. All slopes exceeding 65% in the zone reviewed by Certified Engineering Geologist	Included in Riparian Reserve; no harvest
CLASS II WATERCOURSE			
WLPZ	1. to 50' for <30% slopes 2. to 75' for slopes 30-50% 3. to 100' for >50% slopes	1. to 50' for <30% slopes 2. to 75' for slopes 30-50% 3. to 100' for >50% slopes 4. No Emergency Notice or Exemption operations allowed within the WLPZ	Permanently flowing non-fish bearing streams – measure from edge of active stream channel; use distance from top of inner gorge, outer edge of 100-year flood plain, outer edges of riparian vegetation, distance of one site potential tree, or 150 feet, whichever is greatest
WLPZ retention	1. 50% total canopy 2. Overstory canopy must be at least 25% existing overstory conifer 3. At least 75% surface cover	1. 50% total canopy 2. Overstory canopy must be at least 25% existing overstory conifer 3. At least 75% surface cover	Removed from timber base, no timber harvest
Large woody debris retention	None	None	No harvest zones in Riparian Reserves; salvage allowed only if required to attain ACS objectives
Inner gorge special treatment	None	None	Included in Riparian Reserve; no harvest
CLASS III WATERCOURSE			
WLPZ	Established at the discretion of the Registered Professional Forester or California Department of Forestry and Fire Protection (CDF)	Established at the discretion of the Registered Professional Forester or CDF	Definable channel and evidence of annual scour or deposition; includes extent of unstable, potentially unstable areas, top of inner gorge, distance equal to site potential tree height or 50', whichever is greatest
WLPZ retention	1. No canopy retention required. 2. 0-30% slope: 25' equipment limitation zone (ELZ) 3. >30% slope: 50' ELZ 4. 50% understory vegetation 5. Trees in channel zone	1. No canopy retention required 2. 0-30% slope: 25' ELZ 3. >30% slope: 50' ELZ 4. 50% understory vegetation 5. Trees in channel zone	No harvest
LWD retention	None	None	No harvest zones in Riparian Reserves; salvage allowed only if required to attain ACS objectives
Inner gorge special treatment	None	None	Included in Riparian Reserve; no harvest

[a] Title 14 of the California Code of Regulations (14 CCR):
§ 895.1 Definitions
§ 898(a) Feasibility Alternatives
§§ 914.8 [934.8, 954.8](g) Tractor Road Watercourse Crossing
§§ 916 [936, 956](e) Intent of Watercourse and Lake Protection
§§ 916.2 [936.2, 956.2](d) Protection of Beneficial Uses of Water and Riparian Functions
§§ 916.9 [936.9, 956.9](y) Protection and Restoration in Watersheds with Threatened or Impaired Values
§§ 916.11 [936.11, 956.11](b) Effectiveness and Implementation Monitoring
§§ 916.12 [936.12, 956.12](f) Section 303(d) Listed Watersheds
§§ 923.3 [943.3, 963.3](h) Watercourse Crossings
§§ 923.9 [943.9, 963.9](g) Roads and Landings in Watersheds with Threatened and Impaired Values

(e.g., road construction, use, and maintenance; activity near streams and on unstable slopes; removal of sources of future LWD), depending on how they are managed, can still affect important habitat elements essential to coho salmon.

3.6.2 WATER DIVERSIONS AND FISH SCREENS

A substantial amount of coho salmon habitat has been lost or degraded as a result of water diversions and groundwater extraction (CDFG 1997, KRBFTF 1991). The nature of diversions varies from major water developments which can alter the entire hydrologic regime in a river, to small domestic diversions which may only have a localized impact during the summer low flow period. In some streams the cumulative effect of multiple small legal diversions may be severe. Illegal diversions are also believed to be a problem in some streams within the range of coho salmon.

Diversions are subject to regulation by the State Water Resources Control Board (SWRCB) through the appropriative water rights process, and by the Department under FGC §1600 *et seq.* (which requires an agreement with the Department for any substantial flow diversion), FGC §2080 *et seq.* (CESA take authorization), and FGC §5937 (which requires sufficient water below a dam to maintain fish in good condition). NOAA Fisheries has authority under ESA to regulate the take of coho salmon at diversions. Hydroelectric diversions, such as those on the Klamath and the Eel rivers are also subject to regulation by the Federal Energy Regulatory Commission (FERC).

In some watersheds, the demand for water has already exceeded the available supply and some water rights have been allocated though court adjudication. These adjudications usually did not consider coho salmon habitat needs at a level that could be considered protective under CESA. The use of wells adjacent to streams is also a significant and growing issue in some parts of the coho salmon range. Extraction of flow from such wells may directly affect the adjacent stream, but is often not subject to the same level of regulatory control as diversion of surface flow. Site specific groundwater studies are required to determine a direct connection between surface flow and groundwater, and these are often very costly and take a significant amount of time to complete.

Losses of coho salmon result from a wide range of conditions related to unscreened water diversions and substandard fish screens. Primary concerns and considerations for fish at diversions that are unscreened or equipped with poorly functioning screens are:

a. Delay of downstream migration and reduced overall survival of downstream migrants;

b. Entrainment of juvenile coho salmon into the diversion;

c. Impingement of juvenile coho salmon on the screen because of high approach velocities or low sweeping velocities;

d. Predator holding areas created by localized hydraulic effects of the fish screen and related facilities;

e. Entrapment of juvenile coho salmon in eddies or other hydraulic anomalies where predation can occur;

f. Elevated predation levels due to concentrating juveniles at diversion structures; and

g. Disruption of normal fish schooling behavior caused by diversion operations, fish screen facilities, or channel modifications.

3.6.3 INSTREAM FLOWS

Land-use practices such as urbanization, agricultural activities, and timber harvest can alter natural hydrologic cycles and impact stream flows, peak flows, flow timing, and flood frequencies. Alteration of the natural hydrological cycle can in turn create significant impacts to coho salmon and their habitat. Impacts to coho salmon can include increasing juvenile and adult mortality by delaying migration because of insufficient flows, stranding fish during rapid flow fluctuations; decreased food supply because of reduced invertebrate drift, and increasing mortality due to higher water temperatures (California Advisory Committee on Salmon and Steelhead Trout [CACSST] 1988; CDFG 1991; Berggren and Filardo 1993; Reynolds et al. 1993; Chapman et al. 1994; Cramer et al. 1995; NMFS 1996). In addition to these factors, alteration of the natural hydrograph can increase deposition of fine sediments in spawning gravels, decrease recruitment of LWD and spawning gravels; it may also lead to encroachment of riparian and non-endemic vegetation into spawning and rearing areas (e.g., on the Trinity River) (CACSST 1988; Forest Ecosystem Management Assessment Team 1993; Botkin et al. 1995; NMFS 1996).

Many of the watersheds where coho salmon are present have been developed and flows have been regulated and significantly reduced compared to natural flows. Base flow necessary for coho salmon rearing during the typical May to November low flow period may be severely limited due to interactions between watershed area, climate, geology, and land use. For example, an Instream Flow Incremental Methodology study of lower Scott Creek, Santa Cruz County (Snider et al. 1995) found that optimum habitat conditions for juvenile steelhead and coho salmon in Scott Creek are provided at 20 cfs, and only half of the maximum habitat remains at 5 to 6 cfs. However, median flows in Scott Creek in August, September and October are 2 cfs or less (roughly 16% of maximum habitat).

A common problem in minimizing the direct and cumulative effects of diversions on instream flow is the lack of detailed data regarding minimum instream flow needs for coho salmon in a given stream. Some of the major water developments in the range of coho salmon are, or have been, the subject of extensive studies and programs aimed at evaluating and reducing the impact of those projects on coho salmon and other species. However, studies on the effects of smaller diversions are generally lacking, as are studies of overall instream flow needs in watersheds in the range of coho salmon. The owners of smaller diversions frequently lack the resources to conduct the appropriate studies to evaluate instream issues.

For small diversions (≤ 3 cfs and ≤ 200 acre-feet) in Mendocino, Sonoma, Marin and Napa counties, the Department and NOAA Fisheries have proposed draft guidelines that may serve as conditions for protection of salmonid habitat in lieu of results from site-specific studies (CDFG/NOAA Fisheries 2002), and in some cases these conditions may require substantial alteration of existing diversion and storage patterns. Current resource agency staffing and funding is generally inadequate to conduct watershed-level instream flow studies and to take the effective regulatory actions to restore flow for coho salmon habitat where it is an issue. The lack of adequate enforcement staff and problems coordinating efforts by regulatory agencies also makes consistent control of illegal diversions difficult.

3.6.4 ARTIFICIAL BARRIERS

Artificial structures on streams fragment aquatic ecosystems by blocking or impeding migration and altering nutrient cycling patterns, streamflows, sediment transport, channel morphology, and stream-corridor species composition. This reduces available habitat, changes habitat conditions for anadromous salmonids, and reduces native biodiversity. Instream structures have the potential to, depending on conditions, either entirely or partially block fish from accessing upstream reaches and block critical habitat necessary for survival. Barriers can be formed by:

a. Road crossings (e.g., bridges, culverts, and low-water fords);
b. Dams;
c. Flood-control structures (e.g., concrete channels);
d. Erosion control structures (riprap and energy dissipaters);
e. Canal and pipeline crossings;
f. Pits from gravel mining; and
g. Conditions that sever surface or subsurface hydrologic connections between the stream channel and adjacent wetlands.

Even if stream barriers are eventually negotiated by fish, the extra energy expended may result in their death prior to spawning or in reductions in viability of eggs and offspring. Barriers that increase the time required for migration can limit the distance adult fish are able to travel upstream before spawning, resulting in the crowding of redds in lower stream reaches and under-utilization of upstream habitat. Migrating adults and juveniles concentrated below barriers with impassable crossings are also more vulnerable to predation and illegal harvest.

Hydropower and water storage projects alter the hydrograph of downstream river reaches and can affect migration cues and physical passage conditions. Dams often block access to areas used historically by coho salmon. Weitkamp et al. (1995) identified nine dams in California that currently have no fish passage facilities to allow coho salmon access to former spawning and rearing habitats. Blocked habitat constitutes approximately 9 to 11% of the historical range of each coho salmon ESU. Five major dams within the California portion of the SONCC Coho ESU (Table 3-5) and four major dams within the CCC Coho ESU (Table 3-6) block access to historical spawning and rearing areas of coho salmon. In addition to these, there are five smaller impoundments on the mainstem Russian River, and approximately five hundred licensed or permitted dams on its tributaries (SEC 1996).

3.6.5 GRAVEL EXTRACTION

Gravel extraction (the removal of sediment from the active channel) has various impacts on salmonid habitat by interrupting sediment transport and often causing channel incision and degradation (Kondolf 1993). The impacts that can result from gravel extraction include: direct mortality; loss of spawning habitat; noise disturbance; disruption of adult and juvenile migration and holding patterns; stranding of adults and juveniles; increases in water temperature and turbidity; degradation of juvenile rearing habitat; destruction or sedimentation of redds; increased channel instability and loss of natural channel geometry; bed coarsening; lowering of local groundwater level; and loss of LWD and riparian vegetation (Humboldt County Public Works 1992; Kondolf 1993; Jager 1994; Halligan 1997). Terrace mining (the removal of aggregate from pits isolated from the active channel) may have similar impacts on salmonids if a flood causes the channel to move into the gravel pits.

Instream gravel extraction has had direct, indirect, and cumulative impacts on salmonids in the recent past. Current (post-1995) mining, monitoring, and reporting standards developed by the Department and the mining industry, which were incorporated into County Conditional Use Permits, reclamation plans required by the Surface Mining and Reclamation Act, and U.S. Army Corps of Engineer (USACE) Letters of Permission, seek to avoid and minimize current impacts. Many rivers continue to suffer the effects of years of channel degradation from the millions of tons of aggregate removed from the systems over time (Collins and Dune 1990).

TABLE 3-5: Major dams within the California portion of the SONCC Coho ESU that block coho salmon from accessing historical spawning and rearing habitat

NAME OF DAM	LOCATION	UPSTREAM HABITAT BLOCKED	PERCENT OF ENTIRE BASIN
Scott Dam	Eel River, approximately 169 miles upstream from the Pacific Ocean, forming Lake Pillsbury in Lake County	36 miles	8% (Eel River Basin)
Matthews Dam	Mad River, approximately 79 miles upstream from the Pacific Ocean, forming Ruth Lake in Trinity County	2 miles	13% (Mad River Basin)
Lewiston Dam	Trinity River (tributary to the lower Klamath River), approximately 112 miles upstream from the Pacific Ocean, forming Lewiston Reservoir in Trinity County	109 miles	24%(Trinity Basin) 9% (Klamath Basin
Dwinnell Dam	Shasta River (tributary to the upper Klamath River), approximately 214 miles upstream from the Pacific Ocean, forming Dwinnell Reservoir in Siskiyou County	17 miles	17% (Shasta Basin) 2% (Klamath basin)
Iron Gate Dam	Klamath River, approximately 190 miles upstream from the Pacific Ocean, forming Iron Gate Reservoir in Siskiyou County	30 miles	8% (Klamath basin)

TABLE 3-6: Major dams within the CCC Coho ESU that block coho salmon from accessing historical spawning and rearing habitat

NAME OF DAM	LOCATION	UPSTREAM HABITAT BLOCKED	PERCENT OF ENTIRE BASIN
Peters Dam	Lagunitas Creek, approximately 14 miles upstream from the Pacific Ocean, forming Kent Lake in Marin County	8 miles	6%
Nicasio Dam	Nicasio Creek, (tributary to Lagunitas Creek), approximately 8 miles upstream from the Pacific Ocean, forming Nicasio Reservoir in Marin County	5 miles	10%
Warm Springs Dam	Dry Creek (tributary to the Russian River), approximately 45 miles upstream from the Pacific Ocean, forming Sonoma Lake in Sonoma County	50 miles	9%
Coyote Dam	Russian River, approximately 95 miles upstream from the Pacific Ocean, forming Lake Mendocino in Mendocino County	36 miles	7%
Newell Creek Dam	San Lorenzo River, approximately 14 miles upstream from the Pacific Ocean, forming Loch Lomond Reservoir in Santa Cruz County	6 miles	10%

3.6.6 SUCTION DREDGING

Suction-dredge placer miners extract gold from the river gravels by sucking the gold- bearing gravels through a nozzle (typically 6 to 8 inches in diameter) into floating dredges, pumping the gravel and water mixture across a settling table where the gold concentrates by gravity, and then discharging the gravel and water back into the river. Both the pump and the sluice box are usually mounted on a floating platform, often positioned over the work area by ropes or cables secured to trees or rocks. The portion of stream bottom dredged ranges from a few small excavations to the entire wetted area in a section of the stream. Larger suction dredges have the capacity to process as much as several cubic yards of gravel from the river bottom at one time. An annual permit from the Department (Title 14 California Code of Regulations [CCR], §228) and, in some circumstances, a Lake and Streambed Alteration Agreement (FGC §1600) is required to engage in this activity.

Dredging activities in freshwater environments can have a variety of direct impacts on the environment, including impacts on aquatic and riparian organisms (Griffith and Andrews 1981;

Thomas 1985; Harvey 1986) and channel stability. Impacts can also result from the potential release of hazardous materials such as mercury into aquatic and terrestrial environments. However, there are no studies that document such dredging-related impacts on coho salmon or their habitat within the range of coho salmon. The restrictions currently imposed by regulations on this activity are designed to eliminate the potential for impacts to coho salmon by restricting suction dredging actions to locations and times when such activities should not impact the species.

3.6.7 STREAMBED ALTERATION

Streambed alteration activities such as construction of roads, navigational improvements, dams, bank stabilization structures, and channels can result in a loss of habitat complexity (Bisson et al. 1987). Effects include decreases in the range and variability of stream flow velocities and depths, and reductions in the amount of large wood, boulders, and other stream structures. Construction activities in the stream channel can cause excess sediment to fill pools. Channelization that includes paving the channel bottom, or changing the length or sinuosity of the channel, permanently alters the substrate, eliminating macroinvertebrate habitat, instream vegetation, and the gravel substrate necessary for spawning.

3.6.8 WATER QUALITY

Water pollution originates from point sources and non-point sources as listed in Table 3-7, and includes sediment, nutrients, biocides, metals, and metalloids. It is difficult to correlate specific pollutants with specific and direct effects on coho salmon. Mixed compounds may have different effects on the biological community of a stream than would an accumulation of the same compounds considered separately. In addition, effects vary with habitat alteration, temperature, and the concentration of dissolved materials in the surface waters (Brown and Sadler 1989). Water quality within coho salmon range is known to be affected by industrial discharges, agricultural discharges, silvicultural discharges, mineral mining wastes, municipal wastewater discharge, road surface discharge, and urban stormwater discharge.

Under CWA § 303(d), states, territories and authorized tribes are required to develop lists of impaired waters that do not meet water quality standards, even after those responsible for point sources of pollution have installed the minimum required levels of pollution control technology. In addition, the law requires that they establish priority rankings for waters on the lists and develop action plans, including total maximum daily load (TMDL) plans to improve water quality. Within the California range of coho salmon, there are 74 water bodies that are on the § 303(d) list of impaired water bodies (Table 3-7).

TMDLs in California are developed either by Regional Water Quality Control Boards (RWQCB) or by the U.S. Environmental Protection Agency (EPA). TMDLs developed by RWQCBs are designed as Basin Plan amendments and must include implementation provisions. TMDLs developed by EPA typically contain the total load and load allocations required by § 303(d), but do not contain comprehensive implementation provisions. It is the responsibility of the RWQCBs to develop implementation programs for TMDLs established by the EPA and during that process, it has often been necessary for the RWQCBs to reevaluate, and sometimes change, the EPA requirements.

3.6.9 AGRICULTURAL IMPACTS

Historic, and some current, agricultural practices impact freshwater habitat components important to coho salmon. While current agricultural activities and programs have made strides in improving pollution and sediment discharge into streams and in habitat restoration,

TABLE 3-7: Clean Water Act §303(d) list of impaired water bodies within the range of coho salmon in California (as approved by USEPA, July 2003)

NAME	EST. SIZE/LENGTH OF AFFECTED AREA	POLLUTANT/STRESSOR	SOURCE OF POLLUTION[a]
SAN FRANCISCO BAY			
Carquinez Strait	5,657 acres	Chlordane; DDT; PCBs; PCBs (dioxin-like); Diazinon; Dieldrin; Dioxin compounds; Exotic species; Mercury; Furan compounds; Selenium	5, 6, 20, 26, 27, 28, 36, 48
Richardson Bay	2,439 acres	Chlordane; DDT; PCBs; PCBs (dioxin-like); Dieldrin; Dioxin compounds; Exotic species; Mercury; Furan compounds; High coliform counts	5, 6, 7, 26, 27, 28, 36, 38, 45, 48
San Francisco Bay[b]	171,954 acres	Agriculture; Chlordane; DDT; Diazinon; Dieldrin; Dioxin compounds; Exotic species; Furan compounds; Mercury; Nickel; PCBs; PCBs (dioxin-like); Selenium	1, 5, 6, 20, 26, 27, 28, 36, 48
San Pablo Bay	68,349 acres	Agriculture; Chlordane; DDT; Diazinon; Dieldrin; Dioxin compounds; Exotic species; Furan compounds; Mercury; Nickel; PCBs; PCBs (dioxin-like); Selenium	1, 5, 6, 20, 26, 27, 28, 36, 48
Suisun Bay	27,498 acres	Chlordane; DDT; Diazinon; Dieldrin; Dioxin compounds; Exotic species; Furan compounds; Mercury; Nickel; PCBs; PCBs (dioxin-like); Selenium	5, 6, 20, 27, 28, 36, 48
Suisun Marsh Wetlands	66,339 acres	Metals; Nutrients; Organic enrichment/low dissolved oxygen; Salinity/TDS/chlorides	1, 45, 15
Suisun Slough	1,124 acres	Diazinon	45
Tomales Bay	8,545 acres	Mercury; Nutrients; Pathogens; Sedimentation/siltation	1, 4b, 25, 38, 44
Alameda Creek	51 miles	Diazinon	45
Arroyo Corte Madera Del Presidio (Mill Creek)	4 miles	Diazinon	45
Corte Madera Creek	4.1 miles	Diazinon	45
San Antonio Creek	18 miles	Diazinon	45
San Pablo Creek	9.9 miles	Diazinon	45
Walker Creek	16 miles	Mercury; Nutrients; Sedimentation/siltation	1, 25, 42
Walnut Creek	9 miles	Diazinon	45
NORTH COAST			
Albion River	77 miles	Sediment/siltation	23, 28, 39
Big River	225 miles	Sediment/siltation; Temperature	12, 13, 17, 22, 23, 28, 32, 37, 39, 41
Eel River[b]	4,637 miles	Sediment/siltation; Temperature	4b, 9, 10, 12, 13, 15, 16, 17, 19, 22, 23, 28, 32, 33, 34, 35, 36, 39, 41, 43, 44
Elk River	88 miles	Sediment/siltation; Temperature	13, 16, 23, 27, 28, 32, 33, 34, 39, 41

continued

TABLE 3-7: Clean Water Act §303(d) list of impaired water bodies within the range of coho salmon in California (as approved by USEPA, July 2003) (continued)

NAME	EST. SIZE/LENGTH OF AFFECTED AREA	POLLUTANT/STRESSOR	SOURCE OF POLLUTION[a]
Estero Americano	199 acres	Nutrients; Sediment/siltation	13, 19, 24, 28, 32, 35, 41, 43
Freshwater Creek	84 miles	Sediment/siltation	13, 16, 23, 27, 28, 32, 33, 34, 39, 41
Garcia River	154 miles	Temperature	17, 28, 32, 41
Gualala River	455 miles	Sediment/siltation; Temperature	16, 33, 34, 39,
Humboldt Bay	16,075 acres	PCBs	49
Klamath River[b]	4,759 miles	Nutrients; Temperature; Organic enrichment/low dissolved oxygen	1, 2, 3, 4a, 4b, 9, 11, 12, 15, 17, 19, 20, 21, 26, 27, 28, 32, 35, 40, 43, 44, 46, 49, 50, 51
Mad River	654 miles	Sediment/siltation; Temperature; Turbidity	15, 17, 28, 32, 36, 39, 44, 49
Mattole River	503 miles	Sediment/siltation; Temperature	13, 17, 19, 27, 28, 32, 35, 37, 39, 40, 41, 43
Navarro River Delta	48 acres	Sediment/siltation	13
Navarro River	415 miles	Sediment/siltation; Temperature	1, 3, 8, 9, 10, 12, 13, 15, 16, 17, 18, 21, 22, 23, 28, 32, 33, 34, 35, 36, 39, 40, 41, 46
Noyo River	144 miles	Sediment/siltation	28, 39
Redwood Creek	332 miles	Sediment/siltation; Temperature	10, 13, 16, 23, 27, 28, 32, 33, 34, 35, 39, 41
Russian River[b]	1,711 miles	Sediment/siltation; Temperature; Pathogens	1, 4a, 4b, 8, 9, 10, 11, 12, 13, 15, 17, 19, 21, 22, 27, 28, 32, 35, 39, 41, 43, 44, 52, 53
Scott River	902 miles	Sediment/siltation; Temperature	3, 12, 15, 17, 21, 27, 28, 32, 35, 36, 39, 43, 46, 54
Shasta River	630 miles	Organic enrichment/low dissolved oxygen; Temperature	2, 4a, 11, 12, 15, 17, 19, 32, 55
Ten Mile River	162 miles	Sediment/siltation; Temperature	17, 23, 28, 32, 33, 34, 39, 41
Trinity River[b]	3,410 miles	Sediment/siltation; Temperature	9, 11, 12, 13, 15, 16, 17, 19, 23, 25, 27, 28, 32, 33, 34, 35, 36, 39, 41, 42, 44, 46
Van Duzen River	585 miles	Sediment/siltation	9, 10, 13, 16, 17, 23, 27, 32, 33, 34, 35, 39, 41, 43,
CENTRAL COAST			
Aptos Creek	8.4 miles	Sediment/siltation; Pathogens	9, 22, 45
San Lorenzo River	27 miles	Nutrients; Pathogens; Sedimentation/siltation	10, 28, 38, 39, 45
San Lorenzo River Lagoon	66 acres	Pathogens	27, 45
Soquel Lagoon	1.2 acres	Nutrients; Pathogens; Sedimentation/siltation	10, 27, 28, 28, 45
Waddell Creek, East Branch	3.5 miles	Nutrients	26

[a]
1 Agriculture
2 Agriculture-irrigation tailwater
3 Agricultural return flows
4a Agriculture-storm runoff
4b Animal operations
5 Atmospheric deposition
6 Ballast water
7 Boat discharges/vessel wastes
8 Bridge construction
9 Channel modification, channelization
10 Construction/land development
11 Dam construction and operation
12 Drainage/filling of wetlands
13 Erosion/siltation
14 Filling of wetlands
15 Flow regulation/modification
16 Harvesting
17 Habitat modification
18 Highway/road construction
19 Hydromodification
20 Industrial point source
21 Irrigated crop production
22 Land development
23 Logging road construction/maintenance
24 Manure lagoons
25 Mine tailings
26 Municipal point source
27 Natural sources
28 Nonpoint source
29 Other urban runoff
30 Pasture land
31 Range land
32 Removal of riparian vegetation
33 Residue management
34 Restoration
35 Riparian grazing
36 Resource extraction
37 Road construction
38 Septage disposal
39 Silviculture
40 Specialty crop production
41 Stream-bank modification/destabilization
42 Surface mining
43 Upland grazing
44 Upstream impoundment
45 Urban runoff/storm sewers
46 Water diversions
47 Water (groundwater), domestic use
48 Source unknown
49 Out-of-state source
50 Wastewater land disposal
51 Combined sewer overflow
52 Geothermal development
53 Surface runoff
54 Mill tailings
55 Dairies

[b] Contains combined information for two or more separate river forks or subsystems.

some activities can affect coho salmon habitat. Agricultural practices affect aquatic and riparian areas through non-point source pollution, since these areas eventually receive sediments, fertilizers, pesticides, and wastes from associated agricultural lands.

While it has been reported that sediment delivery to streams in the form of non-point source pollution is caused mainly by roads (Lewis et al. 2001), sediment is the most common type of non-point source pollution from agricultural lands (Knutson and Naef 1997). According to Terrell and Perfetti (1989), erosion of crop lands accounts for 40 to 50% of the sediment in United States waterways. Storm runoff erodes the topsoil from open agricultural areas, and irrigation water from standard agricultural practices also carries significant amounts of sediment to the stream environment. According to Terrell and Perfetti (1989), two types of irrigation systems, sheet flow and rill, cause the greatest amount of surface erosion, while drip irrigation and piped laterals produce the least. Irrigation often uses water that is drawn from a stream, lake, pond, or the ground. Pumping from the water table reduces its level, decreasing flow to and in the river. The ability of a stream to diminish the effects of irrigation waste discharged decreases proportionally with reductions in stream flow.

Small coastal streams often rely on springs to maintain flows through the summer months, but the flow of these springs is often diminished by pumping from the aquifers that supply them. Many streams that once flowed year-round no longer do so, because of recent increases in hillside agricultural land conversion and reduction in local groundwater levels. The conversion of uplands from forest or grasslands to agriculture increases erosion and ground water use (CDFG 2001). In February 2000, Sonoma County adopted a vineyard ordinance to control sedimentation caused by vineyard erosion (Merenlender et al. 2000). The ordinance identifies three levels of vineyards and seven types of highly erosive soils, imposing corresponding requirements (CDFG 2001).

Animal wastes carried by runoff can contaminate water sources through the addition of oxygen-depleting organic matter (Knutson and Naef 1997). Runoff from concentrated fecal sources can change water quality, causing lethal conditions for fish. As the biochemical oxygen demand increases, dissolved oxygen decreases, and ammonia is released, causing additional changes that are stressful to fish.

Grazing can affect riparian characteristics and associated aquatic systems, such as vegetative cover, soil stability, bank and channel structure, instream structure, and water quality and quantity. Behnke and Zarn (1976) and Armour et al. (1991) indicate that overgrazing is one of the major contributing factors in the decline of Pacific Northwest salmon. Trampling may compact soils, decreasing water infiltration and increasing runoff. However, light trampling can break up surface soils that have become impervious, and allow for greater water absorption; but this also makes the soil more susceptible to erosion (Spence et al. 1996). George et.al. (2002) found that cattle trails in California produced 40 times more sediment than adjacent vegetated soil surfaces. Possible grazing impacts also include increased nutrient inputs from deposition or release of animal waste in watercourses. According to Knutson and Naef (1997), some of the ways that poor grazing practices can impact fish and wildlife include:

a. Destruction of riparian vegetation;

b. Reduction or elimination of regeneration of woody vegetation;

c. Changes to plant species composition in favor of non-riparian species;

d. Loss of protective vegetation and associated bank stability and structure;

e. Soil compaction;

f. Increase of stream-bank erosion, causing stream channel widening, shallowing, trenching, or braiding;

g. Reduction in the ability of riparian areas to trap and filter sediments and pollutants;

h. Increase in stream temperatures due to loss of cover;

i. Increase in the magnitudes of high and low flows;

j. Lowering of the water table, and associated loss of riparian vegetation; and

k. Loss of nutrient inputs, especially invertebrate food sources, to stream.

To address potential environmental impacts of agricultural operations, several programs have been developed. These programs assist landowners in developing best management practices for their respective crops and land use. Some of the programs developed include the Code of Sustainable Winegrowing Practices, the Rangeland Water Quality Shortcourse, and the Dairy Quality Assurance Program.

3.6.10 URBANIZATION AND URBAN IMPACTS

Within the California range of coho salmon, urban and suburban development occupy 924 square miles or 9.3% of the land base (CDFG unpublished data). Cities and towns with large developed areas within the range of California coho salmon include, from north to south, Crescent City, Arcata, Eureka, Fortuna, Willits, Ukiah, Healdsburg, Sebastopol, Santa Rosa, Petaluma, Sonoma, Napa, Novato, San Francisco Bay Area, and Santa Cruz.

Urbanization not only affects habitat in obvious ways – for example, direct loss of habitat, channelization of streams, degradation of water quality, and dewatering of streams – but it can also affect habitat in less obvious ways by altering and disrupting ecosystem processes that can have unintended impacts to aquatic ecosystems through increased flooding, channel erosion, landslides, and aquatic habitat destruction (Booth 1991).

It is impossible to separate the overlapping and interrelated impacts of urbanization; however, the following broad categories are used to frame the following discussion.

3.6.10.1 Alteration of Natural Vegetation

Urbanization can cause severe and permanent alteration of the natural vegetation by its removal or conversion to lawns and ornamental plants. In upland areas this can contribute to erosion and altered drainage, often reducing infiltration and increasing surface runoff. However, impacts are particularly severe in riparian corridors where vegetation is commonly removed to increase the visibility of and access to streams and to allow the installation of landscaping and structures very near the tops of stream banks. Loss of riparian vegetation reduces inputs of nutrients, recruitment of LWD, and stream-bank stability (Booth 1991; Spence et al.1996). It also leads to an increase in stream temperature by removing much of the overhead canopy (Booth 1991).

3.6.10.2 Disrupted Hydrological Processes and Reduced Stream Complexity

Construction and landscaping near streams is often followed by the installation of retaining walls and other hard structures intended to protect or enlarge developed areas. This results in severely constricted streams with disabled or altered hydrological and riparian processes. Furthermore, in developed areas, much of the surface soil is covered by impervious surfaces (buildings, parking lots, roads) which increase peak flows and change channel characteristics. These changes produce measurable effects in the hydrologic response of a drainage basin, particularly an increase in maximum discharge associated with floods and an increase in frequency of flooding (Klein 1979; Booth 1991).

To facilitate the movement of storm runoff, stream channels are often straightened and the banks denuded of vegetation and covered with revetment. In areas where revetments are not installed, channels become less stable because of the increase in bedload transport that accompanies increased water volumes and velocities (Bryan 1972). Both situations lead to loss of bank and instream habitat complexity and an increased uniformity of the channel and bed. The lack of LWD inputs exacerbates channel simplification, causing increased bed scour and fill. Many degraded urban streams have uniform beds with few pools or riffles, exposed near-vertical banks downcut by several feet, chronic high sediment loads due to increased bank erosion, deficient woody debris, and severely reduced aquatic organisms compared to nearby undeveloped streams (Booth 1991). Urbanized streams take on a clean, washed-out look as channel complexity is lost (Lucchetti and Fuerstenberg 1993, as cited in Spence et al. 1996). These highly modified channels generally provide poor habitat for fish (Spence et al. 1996).

Not only do impervious areas increase peak flow, they also block infiltration into the soil (Klein 1979; Booth 1991), thus decreasing the ability of the basin to store precipitation and reducing summer base flows (Spence et al. 1996). These changes occur primarily because of increases in the impervious surface area and the replacement of complex, natural drainage channels with a network of storm pipes and drainage ditches (Lucchetti and Fuerstenberg 1993, as cited in Spence et al. 1996). Clearing of vegetation, compaction of soil, installation of roads and other impervious surfaces, grading of depressions, and direct interception of subsurface flows by drains can lead to irreversible effects to drainage basin hydrology (Booth 1991).

3.6.10.3 Degradation of Soil Function

Significant soil disturbance occurs during the construction phase of urban development, which leads to increased sediment loads (Klein 1979). After construction, buildings, concrete, and asphalt cover much of the surface soil and areas that remain exposed are often altered by irrigation and fertilization necessary to support domestic vegetation. This likely diminishes the ecological functions of the soil (Spence et. al., 1996).

3.6.10.4 Impaired Water Quality

Wanielista (1978, as cited in Spence et al. 1996) identifies numerous types of urban non-point source pollution, including heavy metals, pesticides, bacteria, organics (oil and grease), dirt, and nutrients. In urbanized streams, the type and quantity of nutrients can change significantly: such as LWD and leafy detritus are replaced in importance by nutrient loading from sewage and other sources (Spence et al. 1996). Novitzki (1973, as cited in Spence et al. 1996) reports that high nutrient levels from a small Wisconsin sewage treatment plant effluent significantly degraded brook trout *(Salvelinus fontinalis)* habitat.

The principal effect of nutrients upon a stream is the stimulation of algae and other aquatic plant growth (Klein 1979). As plant growth increases, night-time dissolved oxygen levels can be become critically low due to continuing plant respiration coupled with the cessation of photosynthesis. Novitzki (1973, as cited in Spence et al. 1996) notes that the nutrients greatly stimulated primary and secondary production, which resulted in a high oxygen demand that created critically low dissolved oxygen levels that ultimately resulted in fish kills. Omernik (1977, as cited in Klein 1979) found that total nitrogen exports from urban areas were second only to intensively farmed watersheds.

Water quality impacts from stormwater runoff are well documented. Bryan (1972) found that pesticide concentration in runoff was three times as high as that from a rural area. In industrial areas, runoff may include heavy metals, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), high pH concrete dust, and other toxic chemicals (Birch et al. 1992, as cited in Spence et al. 1996). Non-point source pollution from agricultural and urban land uses has caused long-term, cumulative harm to stream ecosystems (Jones and Clark 1987;

McDonnell and Pickett 1990; Richards et al. 1996, all cited in Wang et al. 1997). Contaminants associated with sediments can have significant impacts on water quality (Spence et al. 1996).

Several habitat changes caused by urbanization can affect the natural stream temperature regimen (Klein 1979). The effect of reduced shade on maximum temperatures has been well documented. Reduction in shading results from alteration of banks and loss of riparian vegetation. Increase in channel width increases the area of unshaded stream surface area, reduces water depths, and further contributes to heat loss or gain, increasing diurnal temperature fluctuations (Klein 1979). Stream temperatures in urban areas may also be indirectly affected by changes in hydrology, channel morphology, and microclimate (Spence et al. 1996). Lower summer base flows resulting from reduced infiltration can also contribute to higher water temperatures.

3.6.10.5 Barriers to Passage

Urban development is characterized by high road densities and the resulting bridges, culverts, and other structures that constrain channels and impede fish migration (Spence et al. 1996). Areas of high temperature and poor water quality can also present barriers to passage.

3.6.10.6 Degraded Biological Diversity and Habitat Suitability

The structure of the biological community and abundance and diversity of aquatic organisms are greatly altered by urban impacts on channel characteristics and water quality. Wang et al. (1997) found that high urban land use was strongly associated with poor biotic integrity and was associated with poor habitat quality.

Fish populations are also adversely affected by urbanization. Limburg and Schmidt (1990, as cited in Spence et al. 1996) found a measurable decrease in spawning success of anadromous species in Hudson River tributaries that had 15% or more of the watershed in urban development. Wang et al. (2003) found a strong negative relation between urban land cover in the watershed and the quality of fish assemblages in coldwater streams in Wisconsin and Minnesota. In a study of urbanized Puget Sound streams, Lucchetti and Fuerstenberg (1993, as cited in Spence et al. 1996) found that coho salmon appeared to be more sensitive than cutthroat trout *(O. clarki)* to habitat alteration, increased nutrient loading, and degradation of the intergravel environment. They found that as impervious surfaces increased, coho salmon abundance declined, and concluded that coho salmon are of particular concern in urbanized areas because of their specific habitat needs (smaller streams, relatively low velocity microhabitats, and large pools). Other recent studies have documented that pollution associated with urban areas is causing impacts to juvenile Chinook salmon, including suppressed immune response due to bioaccumulation of PCBs and PAHs, increased mortality associated with disease, and suppressed growth (Spence et al. 1996).

The key to protecting and restoring urban streams appears to be reducing imperviousness and protecting channel integrity and riparian vegetation. Klein (1979) found that stream quality impairment is first observed when watershed imperviousness reaches 15% of the total watershed, and becomes severe at 30%. He recommends that for more sensitive stream ecosystems, such as those containing self-sustaining trout populations, watershed imperviousness should not exceed 10%. Wang et al. (2003) found that even low levels of urban development can damage cold-water stream systems, and State that strategies that protect the riparian area and minimize imperviousness may reduce the damage. Booth (1991) states that the strategy for minimizing or avoiding impacts associated with urban development is to reduce the amount of runoff and minimize landscape disturbance.

3.6.11 FISHING

Retention of coho salmon has been prohibited in ocean commercial fisheries south of Cape Falcon, Oregon since the beginning of the 1993 season. From Cape Falcon to Horse Mountain, California, coho salmon retention has been prohibited in ocean recreational fisheries since the 1994 season, and starting May 1995, the prohibition was extended to include sport fisheries south of Horse Mountain. California's inland waters have been explicitly closed by regulation to coho salmon retention since 1998. Coho salmon are taken incidentally in commercial and recreational fisheries directed toward other salmon species. If large enough numbers are hooked, substantial mortality can be incurred.

The Klamath Basin's Native American tribes (Yurok, Hoopa Valley, and Karuk) currently operate the only existing sanctioned coho salmon fishery. Both the Yurok and Hoopa Valley tribes have Federally recognized fishery rights in the basin, and Tribal subsistence, ceremonial, and minor commercial fisheries operate under the regulatory authority of each tribe. Each tribe determines the extent of fishing opportunities that will be provided its Tribal members based on estimates of preseason abundance. Data for this review are only available for the Yurok Tribe's harvest for subsistence and ceremonial fisheries within the Tribe's reservation on the lower Klamath River (Weitchpec downstream to the ocean); these fisheries have been monitored since 1992. Harvest has ranged from 27 to 1,168 fish caught annually, and based on estimates of upstream escapement (in-river spawners and hatchery returns), is thought to amount to an average harvest rate of 4.4% for the period (D. Hillemeier pers. comm.).

3.6.12 ILLEGAL HARVEST

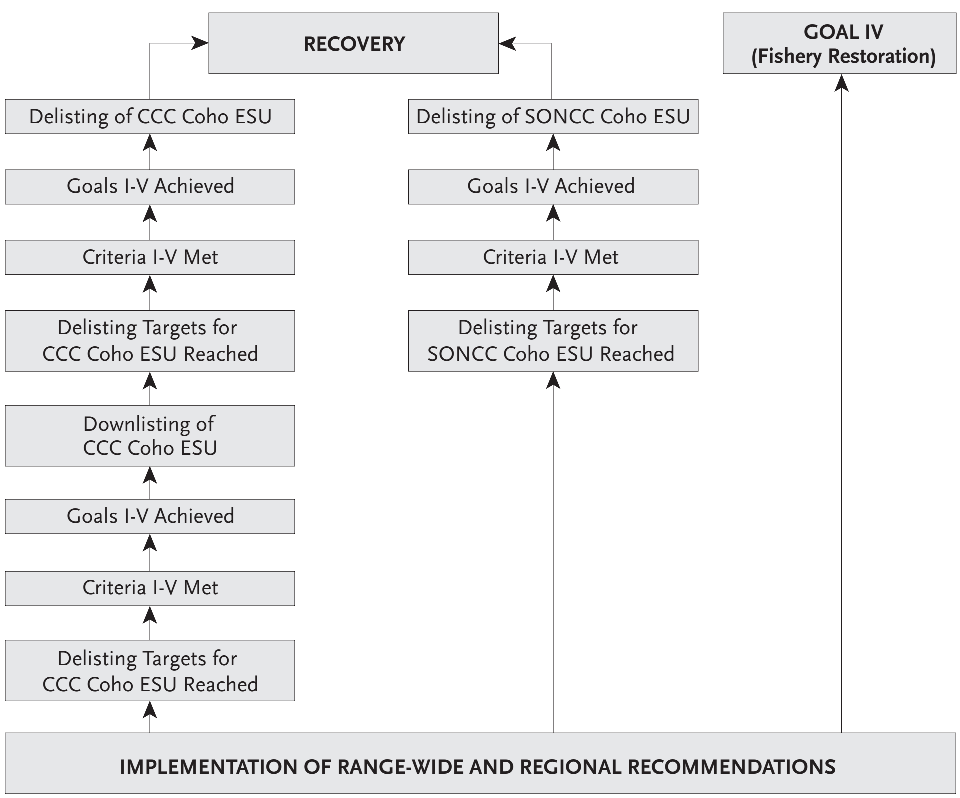
Illegal harvest can have an impact on populations of fishes in certain areas, although this depends on intensity, frequency and species of fish taken. The Wildlife Protection staff of the Department indicates that illegal harvest of both juvenile and adult coho salmon does occur, although most of the illegal take is due to anglers mistaking coho salmon for another species. Most of the violations involving the illegal take of adult coho salmon occur in the offshore sport fishery. Illegal harvest in inland waters is mostly opportunistic, meaning poachers will spear, net, gaff or snag whatever salmonid happens to be in the stream (T. Belt pers. comm.).

4 Recovery Goals and Delisting Criteria

The mandate of the Recovery Strategy is to achieve recovery of California coho salmon to the point where the regulations, or other protections for coho salmon listed under CESA are not necessary (FGC §2105), and the species can be delisted. For the Department to determine that the species has recovered to the point where delisting is warranted, certain "delisting criteria" must be met. For the CCC Coho ESU there are also "downlisting criteria" and their associated quantitative targets, which must be met in order to downlist the species from "Endangered" to "Threatened." This chapter describes the recovery goals, delisting criteria, and quantitative targets for these criteria by watershed recovery unit (see Chapter 6 for a description of recovery units). The Recovery Strategy incorporates an additional goal of restoring viable Tribal, recreational, and commercial coho salmon fisheries in California (see section 4.2).

The frameworks for recovering coho salmon (goals I to V) and restoring coho salmon fisheries (goal VI) are discussed in this chapter (see Figure 4-1). Research, monitoring, and adaptive management of coho salmon populations and recovery activities will be used to both improve the framework and measure progress towards these goals.

FIGURE 4-1: The process of coho salmon recovery and fishery restoration[a, b]



NOTES:
a. Delisting of CCC and SONCC Coho ESUs can occur independently.
b. Goal VI, though an explicit part of this Recovery Strategy, is not required for recovery.

4.1 FRAMEWORK FOR RECOVERY

The mandate of the Recovery Strategy is to achieve recovery of coho salmon populations and their habitat so the species is neither threatened nor endangered with extinction in either of the ESUs. Successful recovery means that the regulations or other protections for coho salmon listed under CESA would no longer be necessary. Achieving this mandate will take a combination of five principle recovery goals. These goals address either coho salmon populations directly or coho salmon habitat. The goals that address coho salmon populations (goals I to III) focus on protecting and increasing the number of coho salmon populations, and maintaining and expanding coho salmon distribution within both ESUs. Goals that address habitat (goals IV to V) focus on protecting existing habitat essential for coho salmon, and enhancing and restoring additional habitat.

The five recovery goals, as well as their downlisting and delisting criteria and associated quantitative targets, are outlined below and discussed in detail in section 4.1.1 (see also Figure 4-1). When recovery of a coho salmon ESU is achieved, that ESU can be delisted, i.e., formally removed from the California Code of Regulations (Title 14, §670.5). Because the CCC Coho ESU will be listed as endangered, it must first achieve downlisting from endangered to threatened before being delisted. The additional goal of restoring coho salmon fisheries (goal VI) is an integral and explicit part of the Recovery Strategy; however, while limited recreational fishing may be possible, goal VI cannot be wholly achieved until goals I to V have been achieved.

Recovery goals I to V were developed with the idea that each goal uniquely contributes to maximizing genetic diversity and population persistence in the face of environmental variation and stochastic events. The recovery goals apply to natural stocks of coho salmon as well as to coho salmon produced from recovery, conservation, and mitigation hatcheries. Achievement of goals I to V at the ESU level will signal the ability to downlist or delist coho salmon under CESA.

Recovery goals I to V and their associated criteria apply to both the CCC and SONCC Coho ESUs. The SONCC Coho ESU will be listed as threatened and so will require only one set of quantitative targets for delisting. Because the CCC Coho ESU will be listed as endangered, there are two sets of quantitative targets for measuring progress. The first set determines when the CCC Coho ESU can be downlisted from endangered to threatened. The second set will be for delisting. The quantitative targets are discussed in section 4.1.2. These targets represent the quantitative components of the otherwise qualitative criteria used to measure progress towards achievement of the recovery goals.

The inherent uncertainty of complex environmental and biological systems precludes the possibility of setting an exact timeline for successful coho salmon recovery. Some goals, such as restoring and enhancing habitat, may be achieved sooner than other goals. In addition, achieving delisting of the CCC Coho ESU is likely to take longer than delisting of the SONCC Coho ESU. The Department believes that, based on an approximate 50-year cycle of the PDO, the 3-year life cycle of coho salmon, and the estimate by the Oregon Department of Fish and Wildlife of needing more than two decades to measure coho salmon recovery in that State, a period of at least 21 years[1] represents a reasonable initial time period for evaluating the status and trend of coho salmon in California.

[1] Twenty-one years would allow for evaluation of 7 complete brood-year complements.

4.1.1 RECOVERY GOALS AND DELISTING CRITERIA

The five recovery goals are stated below and further described, with their accompanying delisting criteria and the methods for measuring each criterion's progress and status, in section 4.1.1.1.

GOAL I	Maintain and improve the number of key populations and increase the number of populations and brood years[2] of coho salmon.
GOAL II	Maintain and increase the number of spawning adults.
GOAL III	Maintain the range and maintain and increase the distribution of coho salmon.
GOAL IV	Maintain existing habitat essential for coho salmon.
GOAL V	Enhance and restore habitat within the range of coho salmon.

The Recovery Strategy includes an additional goal aimed at restoring coho salmon fisheries, although achieving this goal is not a necessary requirement for delisting and recovery. Goal VI addresses the newly adopted §2111(e) of the FGC and is discussed separately in section 4.2.

GOAL VI	Reach and maintain coho salmon population levels that allow for the resumption of Tribal, recreational, and commercial fisheries for coho salmon in California.

Each of the recovery goals I to V has one or more criteria to evaluate progress toward delisting and, ultimately, recovery. Specific, quantitative targets have been set, or will be set in the near-future, for evaluating whether a criterion has been met. Although the same qualitative criteria will be used to evaluate progress of both the CCC and SONCC Coho ESUs towards recovery, the quantitative targets for delisting of the CCC and SONCC Coho ESUs differ, as do the targets for downlisting of the CCC Coho ESU as compared to delisting of the CCC Coho ESU (see Figure 4-1).

Preliminary targets set in this Recovery Strategy are based on the best available information. Where there was not sufficient information to set preliminary targets, a timeline to set those targets is substituted and discussed below. Coho salmon are also Federally listed under ESA, and NOAA Fisheries is developing recovery goals and criteria for its Federal recovery plans. The Department's proposed timeline for development of the other quantitative targets in this Recovery Strategy parallels the timelines for each of NOAA Fisheries' two Technical Review Teams (TRTs) working on the coho salmon ESUs in California. The Department is collaborating with both TRTs, and when the TRTs release their public documents, the Department will update its quantitative targets, if appropriate.

Integrating Department and NOAA Fisheries timelines for criteria development will not delay the determination of delisting because a determination that delisting or downlisting is warranted will require a sustained trend over multiple coho salmon generations (at least seven generations, or 21 years), regardless of the metrics used. Updates and possible revisions to the targets will be a key component of the Recovery Strategy's annual progress reports.

[2] See section 2.5 for discussion of coho salmon brood years.

4.1.1.1 Recovery Goals, Delisting Criteria, and Progress Evaluation

GOAL I Maintain and improve the number of key populations and increase the number of populations and brood years of coho salmon.

For the purposes of recovery, key populations are defined as "populations of coho salmon that are thought to constitute biological refugia, source populations, or metapopulations."[3] Generally, key populations are those that occur in coho salmon habitat of relatively high quality, with a full complement of year-classes, or with abundances that are high relative to other populations within the same recovery unit, or that place them at an insignificant risk of extinction. As the Department, NOAA Fisheries, and other population investigations (McElhany et al. 2000) conclude their analyses, the term "identified viable salmonid populations" will replace "key populations."

Criterion 1 *Key coho salmon populations are maintained and improved, at target levels specified for the recovery unit.*

Methods for measuring the progress and status:

- Identify key populations within each ESU;
- Identify appropriate areas where coho salmon could establish populations;
- Apply actions and mechanisms for maintaining and improving key populations and establishing additional populations; and
- Develop and implement population monitoring, both inland and ocean.

Criterion 2 *Additional coho salmon populations are established at target levels specified for the recovery unit.*

Methods for measuring the progress and status are the same as for Criterion 1 above.

Criterion 3 *An increase in the number of brood years present has been attained and sustained, as specified for the recovery units (targets to be reported in 2004 and 2005).*

For both the CCC and SONCC Coho ESUs:

i. Increasing the number of brood years present from two to three (a full brood-year complement), as specified for the recovery unit;

ii. Increasing the number of brood years present from one to two of three brood years, as specified for the recovery unit; and

For the CCC Coho ESU only:

iii. For the CCC Coho ESU, increasing the number of brood years present from zero to one of three brood years, as specified for the recovery unit.

Because of the danger of extinction of the CCC Coho ESU, for the third criterion of this first goal the Department is setting the most basic target, establishing one brood year in streams that currently are believed to have none of the three brood years present. Because of better conditions in the SONCC Coho ESU, the Department is commencing with the higher expectation of increasing brood-year representation.

[3] Streams and rivers currently identified as maintaining key populations are listed in Appendix D.

Methods for measuring the progress and status:

- Identify brood-year representation in recovery units;
- Identify appropriate streams for re-establishment of missing brood years;
- Apply actions and mechanisms for re-establishing missing brood years; and
- Conduct brood-year analysis and population monitoring.

GOAL II Maintain and increase the number of spawning adults.

Criterion 1 *The specified number of spawning adults has been attained and sustained for the recovery unit.*

Methods for measuring the progress and status:

- Identify and apply actions and mechanisms for maintaining spawning habitat and other habitat important for adult coho salmon; and
- Monitor adult population status and trends.

GOAL III Maintain the range and maintain and increase the distribution of coho salmon.

This goal speaks to increasing the distribution of the species within its current range by increasing the number of occupied historic streams within each recovery unit. Increasing the distribution of coho salmon is inextricably linked with the success of achieving goals I, II, IV, and V, as well as increasing the percent of potential distribution occupied by coho salmon each year.

Criterion 1 *Current range of coho salmon is maintained.*

Methods for measuring the progress and status:

- Identify and apply actions and mechanisms to maintain current range and distribution; and
- Conduct population monitoring.

Criterion 2 *Current distribution of coho salmon is maintained.*

Methods for measuring the progress and status are the same as for Criterion 1 above.

Criterion 3 *An increase in distribution has been attained and sustained within each ESU, as specified for the recovery unit.*

i. *Coho salmon distribution within the CCC Coho ESU has been increased to at least 60% of historic streams to downlist; and*

ii. *Coho salmon distribution within the CCC and SONCC Coho ESUs has been increased each to at least 75% of historic streams to delist.*

Methods for measuring the progress and status:

- Identify areas feasible and appropriate for increasing distribution;
- Apply actions and mechanisms to increase distribution; and
- Conduct presence/absence monitoring.

GOAL IV Maintain existing habitat essential for coho salmon.

Criterion 1 *Habitat essential for coho salmon has been identified and protected, as specified for the recovery unit.*

Methods for measuring the progress and status:

- Analyze existing watershed assessments and plans;
- Gather necessary field data and conduct necessary mapping;
- Develop and apply a habitat quality index (HQI) based on a standard suite of measurable habitat quality parameters where HQIs currently do not exist;
- Identify and apply actions and mechanisms for protecting existing, essential habitat; and
- Monitor habitat condition.

GOAL V Enhance and restore habitat within the range of coho salmon.

Criterion 1 *Habitat benefiting coho salmon has been restored or enhanced, and then maintained, as specified for the recovery unit.*

Methods for measuring the progress and status:

- Identify areas feasible and appropriate to restore or enhance;
- Apply appropriate restoration or enhancement activities;
- Develop and apply HQIs where HQIs currently do not exist; and
- Monitor (a) coho salmon use of restored and enhanced habitat and effectiveness of restoration activities and (b) habitat condition.

Delisting targets for the SONCC Coho ESU, and downlisting and delisting targets for the CCC Coho ESU are summarized in Tables 4-1, 4-2, and 4-3, respectively.

4.1.1.2 Recovery Units

To facilitate monitoring of progress towards recovery, the Department divided each ESU into recovery units (see Chapter 6). The recovery units are groups of smaller drainages that are related hydrologically, geologically, and ecologically and are believed to function as unique and important components of the ESU.

Measuring progress toward recovery will be done at the recovery unit scale. The SONCC Coho ESU has been divided into 17 recovery units, while the CCC Coho ESU has been divided into six recovery units (Table 4-4). NOAA Fisheries is undergoing a similar process of defining recovery units and has not yet reported its findings. However, the Department has conferred with NOAA Fisheries, and the recovery unit delineations are consistent with its process at this time.

Ultimately, attaining recovery of coho salmon requires many actions and activities, which are contained in the recommendations. Prioritized tasks to achieve the recovery goals are listed in implementation schedules for the entire range as well as the SONCC and CCC Coho ESUs (Chapter 9), and the SSPP (Chapter 10). The Department believes that successful implementation of these tasks will lead to recovery of California coho salmon.

TABLE 4-1: Delisting targets for the SONCC Coho ESU

SONCC COHO ESU RECOVERY UNITS	DELISTING TARGETS								
	GOAL I			GOAL II	GOAL III			GOAL IV	GOAL V
	Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 1
Rogue/Winchuck rivers	8	TBD	2004	TBD	Maintain current condition.	Maintain current condition.	75	2005	2005
Smith River	27	10	2004	TBD			75	2005	2005
Shasta Valley	1	1	2004	TBD			75	2005	2005
Scott River	14	3	2004	TBD			75	2005	2005
Salmon River	5	4	2004	TBD			75	2005	2005
Middle Klamath River	31	11	2004	TBD			75	2005	2005
Lower Klamath River	33	1	2004	TBD			75	2005	2005
Trinity River	27	4	2004	TBD			75	2005	2005
South Fork Trinity River	5	1	2004	TBD			75	2005	2005
Mad River	15	5	2004	TBD			75	2005	2005
Redwood Creek	12	5	2004	TBD			75	2005	2005
Trinidad	9	TBD	2004	TBD			75	2005	2005
Eureka Plain	24	4	2004	TBD			75	2005	2005
Lower Eel-Van Duzen rivers	14	14	2004	TBD			75	2005	2005
South Fork Eel River	59	18	2004	TBD			75	2005	2005
Middle/Upper and North Fork Eel River	7	3	2004	TBD			75	2005	2005
Cape Mendocino	17	15	2004	TBD			75	2005	2005

NOTES:

TBD: To be determined

GOAL I Criterion 1: Number of streams or rivers currently identified as having populations to maintain or improve (streams listed in Appendix D).
Criterion 2: Number of streams or rivers currently identified as locations where populations could and should be established (Appendix D).
Criterion 3: The Department will report preliminary targets in 2004.

GOAL II The application of this goal to the SONCC Coho ESU is still to be determined (TBD) by the Department.

GOAL III Criteria 1+2: Both criteria require that current conditions (i.e., range and distribution, respectively) be maintained.
Criterion 3: Values are expressed as a percentage of suitable and historic streams with coho salmon presence detected.

GOALS IV+V Linear miles of stream/near-stream habitat targets will be set in 2005.

TABLE 4-2: Downlisting targets for the CCC Coho ESU

CCC COHO ESU RECOVERY UNITS	DOWNLISTING TARGETS								
	GOAL I			GOAL II	GOAL III			GOAL IV	GOAL V
	Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 1
Mendocino Coast	9	2004	2005	15,000	Maintain current condition.	Maintain current condition.	60	2005	633
Russian River	1	2004	2005	15,000			60	2005	50
Bodega-Marin Coastal	2	2004	2005	1,600			60	2005	26
San Francisco Bay	0	2004	2005	TBD			60	2005	TBD
San Mateo	0	2004	2005	1,350			60	2005	47
Big Basin	1	2004	2005	1,450			60	2005	47

NOTES:

TBD: To be determined

GOAL I Criterion 1: Number of streams or rivers currently identified as having populations to maintain or improve (streams listed in Appendix D).

Criterion 2: Number of streams or rivers currently identified as locations where populations could and should be established (Appendix D). Targets to be determined by 2004.

Criterion 3: The Department will report preliminary targets in 2005.

GOAL II Criterion 1: Numbers of spawning adults.

GOAL III Criterion 3: Percentage of suitable and historic streams with coho salmon presence detected.

GOALS IV Criterion 1: Linear miles of stream/near-stream habitat targets will be set in 2005.

GOALS V Criterion 1: River miles.

TABLE 4-3: Delisting targets for the CCC Coho ESU

CCC COHO ESU RECOVERY UNITS	DELISTING TARGETS								
	GOAL I			GOAL II	GOAL III			GOAL IV	GOAL V
	Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 1
Mendocino Coast	TBD	TBD	2005	TBD	Maintain current condition.	Maintain current condition.	75	2005	633
Russian River	TBD	TBD	2005	TBD			75	2005	50
Bodega-Marin Coastal	TBD	TBD	2005	TBD			75	2005	26
San Francisco Bay	TBD	TBD	2005	TBD			75	2005	TBD
San Mateo	TBD	TBD	2005	TBD			75	2005	47
Big Basin	TBD	TBD	2005	TBD			75	2005	47

NOTES:

TBD: To be determined

GOAL I Criterion 3: The Department will report preliminary targets in 2005.

GOAL III Criterion 3: Percentage of suitable and historic streams with coho salmon presence detected.

GOALS IV Criterion 1: Linear miles of stream/near-stream habitat targets will be set in 2005.

GOALS V Criterion 1: River miles.

TABLE 4-4: Recovery units within the SONCC and CCC Coho ESUs

SONCC COHO ESU RECOVERY UNITS	CCC COHO ESU RECOVERY UNITS
Rogue/Winchuck rivers	Mendocino Coast
Smith River	Russian River
Shasta Valley	Bodega-Marin Coastal
Scott River	San Francisco Bay
Salmon River	San Mateo
Middle Klamath River	Big Basin
Lower Klamath River	
Trinity River	
South Fork Trinity River	
Mad River	
Redwood Creek	
Trinidad	
Eureka Plain	
Lower Eel/Van Duzen rivers	
South Fork Eel River	
Middle/Upper Fork Eel River	
Cape Mendocino	

4.1.2 DELISTING AND DOWNLISTING TARGETS

The quantitative targets for the various downlisting and delisting criteria are discussed below, although they were introduced earlier and presented in Tables 4-1, 4-2, and 4-3. For all delisting criteria for the CCC Coho ESU, other than increasing distribution (goal III, criterion 3) and enhancing and restoring habitat (goal V), the Department and recovery teams have not developed preliminary targets. The Department believes some level of accomplishment and evaluation of downlisting needs to occur before meaningful delisting targets for most recovery goals can be established. Development of delisting targets for the CCC Coho ESU could begin during the first twenty years of recovery activities within the range of the CCC Coho ESU.

4.1.2.1 Targets for Coho Salmon Populations: Goals I, II, and III

Preliminary targets for maintaining and improving existing populations (goal I, criterion 1) have been established for all 17 watershed units in the SONCC Coho ESU. Preliminary targets for establishing additional populations (goal I, criterion 2) have been set for 15 of the 17 units; the Department still is evaluating appropriate targets for the Rogue/Winchuck rivers and Trinidad recovery units. These targets are shown in Table 4-1, and the streams and rivers are listed in Appendix D. For all but one recovery unit (i.e., San Francisco Bay) of the CCC Coho ESU, preliminary downlisting targets have been set for maintaining and improving existing populations (goal I, criterion 1). Targets have not been set for delisting for this criterion, and targets have not been set for either down- or delisting for establishing additional populations (goal I, criterion 2). The Department and recovery teams anticipate developing the remaining downlisting targets for criteria 1 and 2 in 2004. Downlisting and delisting targets for the CCC Coho ESU are shown in Table 4-2 and Table 4-3, respectively, and key streams and rivers are listed in Appendix D.

The list of rivers and streams in Appendix D is preliminary and does not represent an all-inclusive set of drainages for all recovery units. Therefore, recovery units in which no streams have been identified for maintenance, improvement, or establishment of key populations are not necessarily devoid of such streams. Revisions of these lists will be part of the periodic Recovery Strategy updates to the Commission, beginning in 2004.

Information the Department is gathering through ongoing presence/absence surveys will be used to establish targets for expansion of brood years in each recovery unit (goal I, criterion 3) for both ESUs. The Department will report its brood-year targets for the SONCC Coho ESU in 2004 and for the CCC Coho ESU in 2005.

Preliminary downlisting targets have been established only for attaining and sustaining spawning adults (goal II) for the CCC Coho ESU (Table 4-2). The Department is continuing to evaluate and gather information to refine these targets and will report any revisions in its annual report to the Commission. Based on the need and feasibility, the Department is evaluating whether it will apply goal II to the SONCC Coho ESU. The Department will consult with NOAA Fisheries, other agencies and organizations, and the recovery teams and report its preliminary decision in 2005.

Two of the three criteria under goal III (range and distribution) address maintaining current conditions: criterion 1 (range) and criterion 2 (distribution). As with its brood-year analysis, the Department anticipates reporting more specific information on current distribution in its annual report to the Commission.

Targets for increasing the distribution (goal III, criterion 3) have been established for delisting both ESUs (Tables 4-1 and 4-3) and for downlisting the CCC Coho ESU (Table 4-2). The downlisting target for the CCC Coho ESU (i.e., 60%) corresponds approximately to the current distribution within the SONCC Coho ESU, and the preliminary delisting target (i.e., 75%) currently is identical for both ESUs. The Department does not foresee revising these targets until the initial trends are measurable or until and unless the Federal TRTs develop appreciably different targets in their recovery plans.

4.1.2.2 Targets for Coho Salmon Habitat: Goals IV and V

The data collection and analysis necessary for determining habitat essential for coho salmon have not been completed across the range of either ESU. To set most of the specific targets for habitat protection (goal IV) and enhancement and restoration (goal V), the Department is in the process of compiling existing information on habitat location and condition, identifying past and current habitat restoration, determining where additional field work or analysis is necessary, and identifying habitat essential for coho salmon in each recovery unit.

Each goal has a single criterion to evaluate the achievement of the goal. For both goals, the metric is linear miles of stream/near-stream habitat. Goal IV refers to maintaining existing, suitable to optimum habitat, and goal V refers to enhancing and restoring other coho salmon habitat. For the purpose of delisting the SONCC or CCC Coho ESU, preliminary targets have not been set for either criterion (Table 4-1 and Table 4-3).

For the purpose of downlisting the CCC Coho ESU, the Department and recovery teams have not set the preliminary target of maintaining existing habitat (goal IV) but have established preliminary targets for enhancing and restoring habitat (goal V, Table 4-2) for all but one of the recovery units.

Preliminary delisting targets not yet established for the SONCC Coho ESU (goals IV and V) and downlisting targets for the CCC Coho ESU (goal IV) will be set by 2005. The Department does not anticipate setting preliminary delisting targets for the CCC Coho ESU until status information on the progress of downlisting targets is available.

4.2 FISHERIES RESTORATION GOAL

An additional goal[4] of the Recovery Strategy is to restore coho salmon numbers to the point where viable Tribal, recreational, and commercial fishing (viable coho salmon fishery) can occur. This goal cannot be fully achieved until the prior five goals have been achieved and the species is delisted (see Figure 4-1). To achieve this goal, the Department will collaborate with the appropriate tribes, the Federal government, and stakeholders.

GOAL VI Reach and maintain coho salmon population levels that allow for the resumption of Tribal, recreational, and commercial fisheries for coho salmon in California.[5]

Coho salmon population levels allowing for a viable coho salmon fishery will exceed the numbers necessary for recovery. Hence, restoration of a viable coho salmon fishery would occur some time after delisting has been achieved. Restoration of viable recreational and commercial fisheries would be implemented and monitored through fishing regulations governed by the Commission and the Pacific Fisheries Management Council (PFMC) and not by the Department through CESA. The PFMC is an organization composed of representatives from California, Oregon, Washington, the Federal government, affected Tribal governments, the ocean sport and commercial fishing industries, and ocean conservation organizations. Restoration of a viable Tribal fishery would be implemented by Tribal governments and the Federal government, and the Department, other State agencies, and other stakeholders would assist whenever appropriate and requested.

Recovery goal VI meets the new CESA requirement, set forth in 2003, which states that in order to approve a recovery strategy, the Commission must find, among other things, that the Recovery Strategy would recover a formerly commercially valuable species to a level of abundance that would permit commercial use of that species (FGC §2111(e). This requirement does not affect the primary recovery goal of this Recovery Strategy or the delisting criteria.[6]

FGC §2084 allows the Commission to authorize take by hook and line for sport or to authorize incidental take pursuant to FGC §2080 *et seq*. or §2800 *et seq*. The Department and recovery teams discussed the potential for selective recreational and Tribal coho salmon fisheries, specifically hatchery coho salmon in the Klamath and Trinity rivers basin. The feasibility of such fisheries or other selective fisheries could be evaluated in the future, and the Commission's authorization of such a fisheries or incidental take is not based on achieving any of the downlisting or delisting goals.

After delisting is achieved, the Department, appropriate tribes, the Federal government, and stakeholders, including the recovery teams, would determine how to continue implementation of appropriate elements of the Recovery Strategy pursuant to and consistent with other applicable local, State, and Federal law and voluntary measures.

The Department's preliminary timelines for establishing and evaluating coho salmon fisheries are based on initial monitoring of coho salmon inland recovery activities, fishing, man-

4 This additional goal meets the requirements of FGC §2111(e), which was added by SB 216 (Statutes 2003 Chap. 854). This goal does not affect the first objective of the Recovery Strategy or the goals to achieve delisting. The author of SB 216 notes in a letter, dated September 12, 2003 (published in the Senate Journal on September 13, 2003) that FGC § 2111(e) "does not change the primary goal of the Recovery Strategy program as set forth in §2105 of the Fish and Game Code...Therefore, if a species has recovered to the point that the regulatory requirements or other protections for species listed pursuant to CESA are no longer necessary, then no permit pursuant to CESA would be required for incidental take of the species, even if the species has not achieved a level of abundance that would permit resumption of commercial use."

5 A decision by the Commission to authorize take by hook and line for sport pursuant to FGC §2084 or to authorize incidental take pursuant §2080 *et seq*. or §2800 *et seq*. of the FGC, is not predicated upon the attainment of any of the Recovery Strategy goals or criteria.

6 See Footnote 2, Chapter 1, Introduction for more detail on FGC §2111(e).

aging fishing, and potential fisheries issues in response to ocean conditions (see Chapter 3). The Department believes that it will require two decades or more of evaluation to adequately model coho salmon populations in context of salmon population status and trend monitoring and variable ocean conditions. The Department will establish coho salmon assessment and monitoring (see Chapter 5) and base it on the three-year life history of coho salmon. For all of these reasons and the fact that estimating long-term ocean condition cycles can take several decades, the Department believes the minimum timeline for its first evaluation would be 21 years. The steps for re-establishing recreational and commercial fishing are described below.

4.2.1 RECREATIONAL FISHING

Criterion 1 *Limited recreational fishing commences in selected areas and continues for a determined number of years once adult populations have exceeded population levels described in recovery goals I and II.*

Areas will be selected based on the relative health of coho salmon runs and the presence of recreational fishing opportunities and interest.

Methods for measuring the progress and status:

- Select areas, annual timing and duration, and initial number of seasons of coho salmon recreational fisheries;
- Open selected coho salmon recreational fishery;
- Conduct coho salmon population monitoring; and
- Conduct fisheries surveys.

Criterion 2 *The recreational fishery is expanded to the fullest extent feasible for additional years once it is documented that the limited recreational fishery has not significantly reduced levels or compromised the viability of coho salmon in each ESU over initial years of fishing.*

Methods for measuring the progress and status:

- Identify feasible and appropriate areas for extension of fishery;
- Expand coho salmon recreational fishery;
- Conduct coho salmon population monitoring; and
- Conduct fisheries surveys.

Criterion 3 *A permanent recreational fishery is attained when the expanded recreational fisheries have not significantly reduced sustained levels of coho salmon in each ESU over the initial years of fishing.*

Methods for measuring the progress and status:

- Resume permanent coho salmon fishery;
- Conduct coho salmon population monitoring; and
- Conduct fisheries surveys.

4.2.2 COMMERCIAL FISHING

There are two essential issues dealing with coho salmon recovery for the commercial fishing industry. The primary issue is to recover coho salmon so that current regulations on the Chinook salmon fishery to reduce coho salmon by-catch are made less restrictive. A secondary issue is to re-establish a coho salmon commercial fishery.

Criterion 1 *Experimental limited ocean harvesting of coho salmon is established when it has been determined that elimination of by-catch restriction for commercial harvest of other species has not significantly reduced sustained levels of coho salmon in each ESU over the initial years of fishing.*

Methods for measuring the progress and status:

- Evaluate area, timing, duration, and degree of experimental coho salmon commercial fishery;
- Open experimental commercial coho salmon fishery;
- Conduct coho salmon population monitoring;
- Conduct fisheries surveys; and
- Conduct focused, financed, experimental commercial fishing. This might involve financing a limited number of commercial vessels to specifically investigate the ability to and impact of commercial fishing for coho salmon.

Criterion 2 *Commercial harvest of coho salmon is established when it has been determined that the experimental commercial fishery has not significantly reduced sustained levels of coho salmon in each ESU over the initial years of harvest.*

Methods for measuring the progress and status:

- Evaluate feasible expansion of coho salmon commercial fishery;
- Expand coho salmon commercial fishery;
- Conduct coho salmon population monitoring; and
- Conduct fisheries surveys.

5 Elements Necessary for Recovery

The FGC identifies three elements necessary to achieve the goals of the Recovery Strategy: a) availability and use of public lands for the conservation, protection, restoration, and enhancement of the species; b) methods of public and private cooperation[1]; and c) procedures and programs for notice, education, research, monitoring, and strategy modification. An additional element is the regulatory role in recovery. These elements are discussed in the following sections. Strategy management and modification are discussed in Chapter 12.

5.1 ROLE OF PUBLIC LANDS

The range of coho salmon in California is predominantly under private ownership (63%). Public lands encompass the remaining 37% of the species' range, or approximately 8,125 square miles. Approximately 4,375 square miles of these public lands are located within watersheds where coho salmon have been identified as consistently present (Figures 5-1 and 5-2).

Coho salmon recovery is dependent upon the role of private lands, by virtue of the extent of private lands within the range of the species. The Recovery Strategy seeks to achieve species conservation in ways which are consistent with private property rights. Recovery efforts must incorporate maximum use of existing public lands to approach recovery objectives. It is incumbent on the Department to coordinate with other public agencies to promote and implement coho salmon recovery goals and actions on public lands. Below is a summary of the responsibilities of various Federal, State, and local governments.

5.1.1 FEDERAL LANDS

Federal lands within the range of the coho salmon are administered by the U.S. Forest Service (USFS), National Park Service (NPS), Bureau of Land Management (BLM), Department of Defense (DOD), USFWS, Department of Energy, and Bureau of Reclamation (USBR). Under sections 7(a)(1) and 7(a)(2) of the ESA, Federal agencies shall carry out their programs for the conservation of endangered and threatened species and ensure their actions, authorizations, and funding are not likely to jeopardize their continued existence or adversely modify their critical habitat.

5.1.1.1 U.S. Forest Service

USFS lands encompass approximately 6,563 square miles and include the Klamath, Mendocino, Shasta-Trinity, and Six Rivers National forests. These lands represent 81% of the public lands in the SONCC Coho ESU and play a key role in the recovery of coho salmon.

Congress has directed the USFS to manage national forests for multiple uses and benefits, including protection and management of natural resources, forestry and range land management and research, and community assistance and cooperation with State and local govern-

[1] The Department has identified watershed programs, groups, and other resources currently involved in making watershed improvements that may benefit salmonids. Details about this effort are in Appendix E: Watershed Groups and Gap Analysis.

ments. All Forest programs, activities, and projects are reviewed for possible effects on endangered and threatened species, species proposed for listing, and sensitive species. The purpose of the reviews is to ensure that USFS actions do not contribute to the loss of viability for any native or desired non-native plant or animal, and to comply with the ESA.

The USFS has developed an Aquatic Conservation Strategy, a fundamental component of the Northwest Forest Plan (USDA Forest Service 1997), to restore and maintain the ecological health of watersheds and aquatic ecosystems contained within them on public lands. The strategy was developed to protect salmon and steelhead habitat on Federal lands managed by the USFS and BLM within the range of Pacific Ocean anadromy. This conservation strategy uses several methods to further the goal of maintaining a “natural” disturbance regime.

5.1.1.2 U.S. Bureau of Land Management

BLM lands encompass approximately 516 square miles and include the Headwaters Forest Reserve and the Kings Range Conservation Area.

The Headwaters Forest Reserve is co-managed by the BLM and the State of California to protect the stands of old-growth redwoods that provide habitat for the Federal and State threatened marbled murrelet, and the headwaters that serve as habitat for the coho salmon and other fisheries.

The BLM is responsible for managing the nation’s public lands and resources in a combination of ways that balance recreational, commercial, scientific, and cultural interests (i.e., multiple use) and strives for sustained yields of renewable and non-renewable resources, including range, timber, minerals, recreation, watershed, fish and wildlife habitat, wilderness and natural, scenic, and cultural values. The BLM manages the use of these lands to ensure that, wherever possible, the burden of conserving fish, wildlife, and plant species falls on the public lands and not on adjacent private lands.

The BLM administers public lands within a framework of numerous laws. The most comprehensive of these is the Federal Land Policy and Management Act of 1976 (FLPMA). All Bureau policies, procedures and management actions must be consistent with FLPMA and the other laws that govern use of the public lands, including the ESA.

5.1.1.3 U. S. National Park Service

NPS lands encompass approximately 249 square miles and include Redwood National Park, Point Reyes National Seashore, Muir Woods National Monument, and Golden Gate National Recreation Area.

The purpose of the NPS is “...to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of future generations” (16 USC 1:1916). This mandate is combined with the NPS mission and responsibilities as a Federal agency to protect, conserve, and contribute to the recovery of candidate, threatened, endangered species.

5.1.1.4 U. S. Department of Defense

DOD lands encompass approximately 86.8 square miles and include various military facilities, the majority of which are located in the San Francisco Bay Area.

The Sikes Act authorizes the DOD to manage natural resources on military lands, and 1997 amendments to the Act provide many opportunities for the DOD to enhance its management. All military installations with significant natural resources are required to develop and implement Integrated Natural Resources Management Plans in cooperation with the USFWS and the appropriate state wildlife agency.

FIGURE 5-1: Land ownership in the SONCC Coho ESU

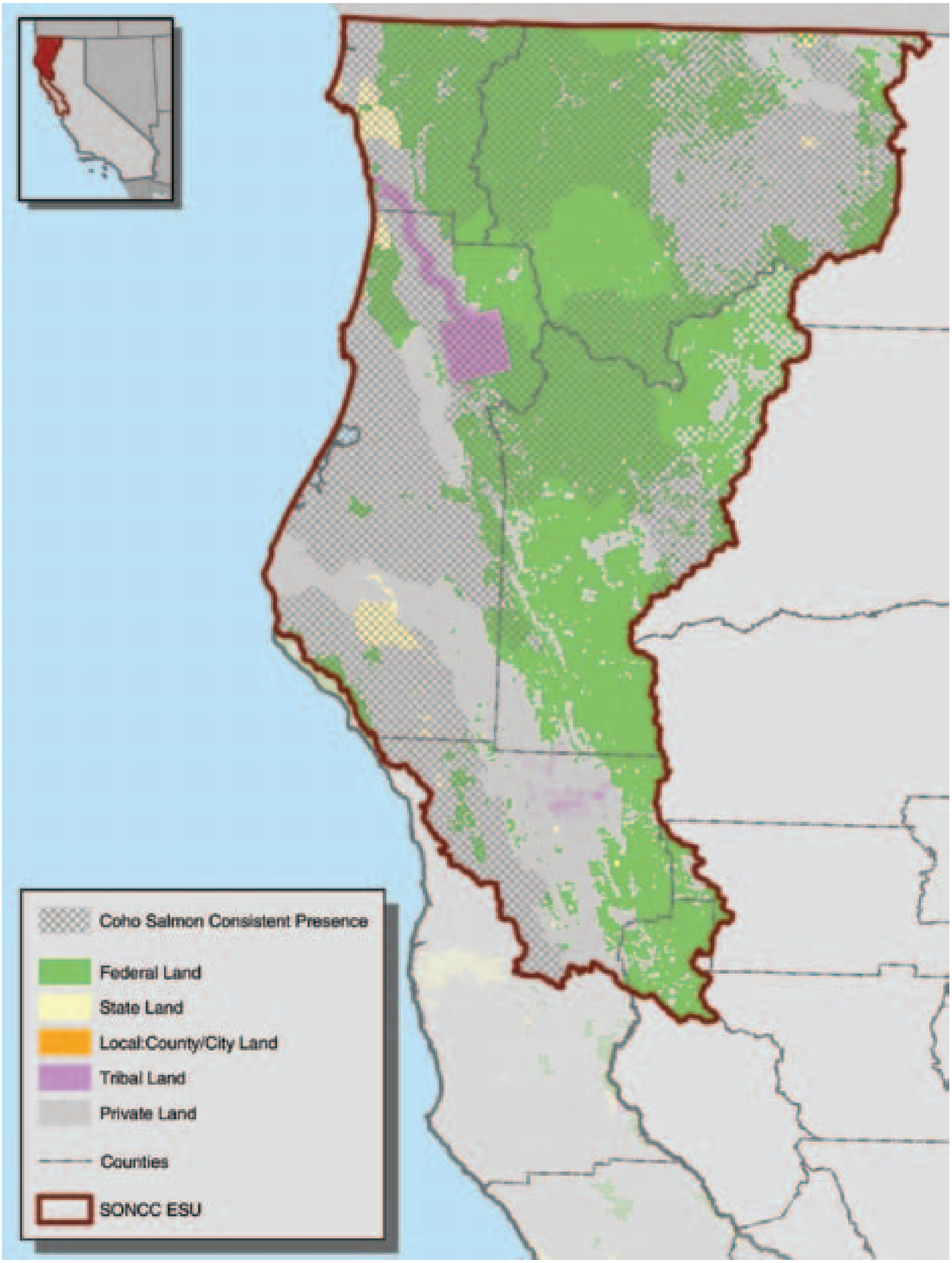


FIGURE 5-2: Land ownership in the CCC Coho ESU

The U. S. Army Corps of Engineers (USACE), which is under the DOD, operates two reservoirs within the range of coho salmon, Lake Mendocino and Lake Sonoma, that are both in the Russian River basin. The USACE also owns, and funds Department operation of, the Don Clausen Hatchery at Lake Sonoma.

5.1.1.5 U.S. Fish and Wildlife Service

USFWS lands encompass 32.0 square miles and include Humboldt Bay National Wildlife Refuge on the north coast and San Pablo Bay, Marin Islands, and Don Edwards San Francisco Bay National Wildlife Refuges in the San Francisco Bay Area.

The USFWS is charged with protecting endangered and threatened species under their jurisdiction and restoring them to a secure status in the wild. Responsibilities of the USFWS Endangered Species program include listing, reclassifying, and delisting species under the ESA; providing biological opinions to Federal agencies on their activities that may affect listed species; overseeing recovery actions; providing for the protection of important habitats in National Wildlife Refuges; providing grants to states to assist with their endangered species conservation programs; and international coordination.

5.1.1.6 U.S. Bureau of Reclamation

USBR lands encompass approximately 0.45 square miles in Siskiyou County and include the Klamath and Trinity River Projects in the range of the SONCC Coho ESU. The mission of the USBR is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. USBR facilities are managed to fulfill water user contracts and protect and enhance conditions for fish, wildlife, land, and cultural resources.

5.1.2 STATE LANDS

The State of California administers approximately 550 square miles of public lands within the range of coho salmon, including lands managed by the Department of Parks and Recreation (DPR), Department of Forestry and Fire Protection (CDF), State Lands Commission (SLC), and the Department.

5.1.2.1 California Department of Parks and Recreation

DPR lands encompass approximately 420 square miles and include more than 270 park units within the range of the coho salmon. DPR lands are managed to provide for the health, inspiration, and education of the people of California, by helping to preserve the State's extraordinary biological diversity, protecting its most valued natural and cultural resources, and creating opportunities for high-quality outdoor recreation.

5.1.2.2 California Department of Forestry and Fire Protection

CDF lands encompass 79.6 square miles and include the Jackson and Soquel Demonstration State Forests. CDF's responsibilities are to protect the people of California from fires; respond to emergencies; and protect and enhances forest, range, and watershed values providing social, economic, and environmental benefits to rural and urban citizens. CDF's mission emphasizes the management and protection of California's natural resources; a goal that is accomplished through ongoing assessment and study of the State's natural resources and an extensive CDF Resource Management Program. CDF oversees enforcement of the Forest Practice Rules (FPRs), which regulate timber harvesting on private lands.

CDF manages demonstration State forests for commercial timber production, public recreation, and research and demonstration of good forest management practices. Jackson

Demonstration State Forest is managed to prevent "take" of listed species, and to allow aquatic habitat recovery to proceed. Target species include the coho salmon.

5.1.2.3 California State Lands Commission

SLC lands encompass approximately 42.6 square miles located in approximately 54 areas, ranging in size from six to 1,559 acres. They are distributed throughout the coho salmon range. The SLC serves the people of California by providing stewardship of the lands, waterways, and resources entrusted to its care through economic development, protection, preservation, and restoration. The SLC has primary responsibility for the surface management of all sovereign and school lands in California. This responsibility includes the identification, location, and evaluation of the State's interest in these lands and its leasing and management.

Public and private entities may apply to the SLC for leases or permits on State lands for many purposes including marinas, industrial wharves, dredging, sand mining, tanker anchorages, grazing, rights-of-way, bank protection, recreational uses, etc. SLC staff review such applications and make recommendations to the SLC for action.

5.1.2.4 California Department of Fish and Game

Lands owned and/or managed by the Department encompass more than 7.8 square miles and include approximately 150 designated wildlife areas, ecological reserves, conservation easements, and fishing accesses.

The Department is the State agency charged with protecting and managing California's fish, wildlife, and their habitats. Department lands designated as wildlife areas are managed to protect and enhance habitat for wildlife species, and to provide the public with wildlife-related recreational uses. These lands provide habitat for a wide array of plant and animal species, including many listed as threatened or endangered. In contrast, Department lands designated as ecological reserves are managed to provide habitat for threatened or endangered species or species of special concern.

5.1.3 COUNTY AND CITY LANDS

Local government lands total approximately 105 square miles within the range of coho salmon. Local governments set forth the obligations of local projects, both public and private.

5.2 FUNDING FOR PRIVATE AND PUBLIC COOPERATION

Voluntary cooperation between private and public sectors is a critical aspect of coho salmon recovery, because political boundaries and property lines have no bearing on coho salmon occurrence. Private lands comprise approximately 63% of the total land within the range of the coho salmon. Approximately 36% of all lands in coho salmon range are private agricultural and forested lands. Cooperative efforts to maintain and restore coho salmon habitat on private land are usually more effective in watersheds where there are large contiguous parcels of forest and agricultural lands, in comparison to watersheds with multiple small ownerships and a relatively high human population density. This is only one of the benefits of having productive resource and community-based landowners maintaining lands in a contiguous and open landscape.

The Department supports economically and environmentally sustainable management of forest and agricultural lands in the range of coho salmon to reduce the potential for conversion to residential or commercial development. In particular, the timely and effective recovery of coho salmon on private lands should include programs to provide appropriate technical and financial assistance to landowners. At present many groups and programs exist to facilitate landowner outreach, education, planning, funding, and implementation of actions aimed at protecting and improving habitat for anadromous salmonids. The CRT report to the Director presented a partial list of voluntary and cooperating groups and activities focused on recovery of coho salmon by watershed.

5.2.1 EXISTING PROGRAMS

A diverse array of existing State and Federal funding programs is available to local watershed groups, individual landowners, and other stakeholders to assist in addressing the needs of California's watersheds. For example, grant programs administered by the Department, local Resource Conservation Districts (RCDs), the SWRCB, NOAA Fisheries, and numerous other groups provide assistance for fish habitat enhancement and water quality improvement projects that are consistent with coho salmon habitat recovery needs. It is extremely important that these grant programs continue to be funded to foster existing partnerships and to restore habitat.

5.2.1.1 Fisheries Restoration Grants Program

The Fisheries Restoration Grants Program (FRGP) is the Department's primary program for funding fisheries improvement projects, education, organizational support and planning in salmon and steelhead watersheds and streams. Public agencies, non-profit organizations, tribes and private entities living and working in watersheds from the Oregon border to the Mexican border are receiving grants to restore salmon and steelhead populations.

Funds for the FRGP come from the Salmon and Steelhead Trout Restoration Account (Proposition 40), Commercial Salmon Stamp Account, Steelhead Catch-Restoration Card sales, and Proposition 13. Additional funding comes from the Federal Pacific Coastal Salmon Recovery Fund, a six-year program established at the request of the governors of the states of California, Oregon, Washington, and Alaska, with the support of the California Congressional Delegation, in the Fiscal Year 2000 Consolidated Appropriation Act Public Law 106-113. This Federal funding is administered through the FRGP in accordance with a Memorandum of Understanding among the California Resources Agency (Resources Agency), the Department, and NOAA Fisheries.

Types of projects eligible for funding by the Fishery Restoration Grants Program include:

- Instream habitat restoration, bank stabilization, barrier modification;
- Fish ladders and screening of diversions;
- Watershed restoration (upslope);
- Riparian restoration;
- Watershed evaluation, assessment, and planning;
- Conservation easements for riparian buffer strips;
- Project maintenance;
- Watershed organization support;
- Education and technical training;
- Project monitoring for completed projects;
- Monitoring to provide baseline and/or trend data;
- Cooperative rearing;
- Water conservation measures; and
- Water measuring devices.

The FRGP is an applicant proposal-driven process. The Department solicits proposals for projects annually. The proposals are evaluated by Department staff. Projects are scored based on several factors, including their merit, the number of anadromous salmonid species benefited, and if those species are endangered, threatened, or candidate species under ESA or CESA. The proposals and staff evaluations are then provided to the California Coastal Salmonid Peer Review Committee, whose members include representatives of county governments, sport and commercial fisheries, Tribal governments, agriculture, forestry, public water agencies, and the academic and research community. The peer review committee considers the proposals and makes funding recommendations to the Director, who makes the final funding decisions.

The FRGP has been in place since 1981 and has invested more than $120 million, supported more than 2000 projects, involved more than 600 partners, and worked in over 2500 coastal streams. Annual funding in the program is currently in the $20 million range.

5.2.1.2 California Department of Conservation Grant Program

Through its Division of Land Resource Protection (DLRP), the Department of Conservation (DOC) plays a major role in protecting California's farmland, open space, and related resources. Financial assistance is offered to local governments and landowners for farmland and open space protection through programs that provide:

- Property tax incentives for retaining agricultural and open space land uses;
- Grants for the purchase of agricultural conservation easements; and
- Funding for conservation projects conducted by RCDs.

DOC's RCD grant program provides financial assistance, administrative education through California Conservation Partnership training programs, and information and technical support through the department's publications and technical assistance program. Additional financial assistance is offered through competitive conservation project grants to RCDs and technical assistance is offered in the form of liaison services, training, and outreach efforts.

5.2.1.3 Environmental Enhancement and Mitigation Program

The Environmental Enhancement and Mitigation Program offers a total of $10 million each year for grants to local, State, and Federal government agencies and to non-profit organizations for projects to mitigate the environmental impacts caused by new or modified State transportation facilities. Individual grants are usually limited to $250,000. State gasoline tax monies fund the Environmental Enhancement and Mitigation Program. Grants are awarded in three categories:

- *Highway Landscape and Urban Forestry:* Projects designed to improve air quality through the planting of trees and other suitable plants;
- *Resource Lands:* Projects for the acquisition, restoration, or enhancement of watersheds, wildlife habitat, wetlands, forests, or other natural areas; and
- *Roadside Recreational:* Projects for the acquisition and/or development of roadside recreational opportunities.

Program Procedures and Criteria, including specific application dates and funding limits, are generally published by the Resources Agency each year in September. The Resources Agency evaluates project proposals and provides a list of recommended projects to the California Transportation Commission by April 15th each year for consideration. The California Department of Transportation (Caltrans) administers the approved grant agreements.

5.2.1.4 Department of Water Resources Grant Program

The Department of Water Resources (DWR) administers grant and loan funding associated with legislation and several general obligation bond laws. Grant and loan funding may be provided for local studies, programs, and projects to better manage California's water resources. These funds are being made available for water conservation and groundwater management purposes through the:

- Safe Drinking Water, Clean Water, Watershed Protection, and Flood Protection Bond Act (Proposition 13);
- Local Water Supply loan program authorized under the Water Conservation Bond Law of 1988 (Proposition 82); and
- Local Groundwater Management Assistance Act of 2000 (AB 303).

5.2.1.5 California Coastal Conservancy Program

The California Coastal Conservancy works with local governments, other public agencies, nonprofit organizations, and private landowners to purchase, protect, restore, and enhance coastal resources, and to provide access to the shore. The California Coastal Conservancy has a current annual budget of over $185 million and since 1975, has invested well over $500 million to complete its projects, and has been funded primarily by State general obligation bonds and from the State's general fund. To date, the Coastal Conservancy has undertaken more than 950 projects along the 1,100 mile California coastline and around San Francisco Bay. Coastal Conservancy projects include the following:

- Land acquisition;
- Public access;
- Resource restoration;
- Resource enhancement;
- Urban waterfront improvement and restoration;
- Land use conservation and site reservation;
- Agricultural land preservation; and
- Non-profit support.

5.2.1.6 Watershed and Nonpoint Source Pollution Control Programs

Watershed/Nonpoint Source grants are offered through the SWRCB Division of Financial Assistance, in partnership with CALFED, the EPA, the California Coastal Commission, and the Resources Agency. These grants are made available through funding from Proposition 13, the Federal Clean Water Act section 319, and Proposition 50. Although the specific focus area of some of these programs are outside the range of coho salmon, other programs to improve water quality within the range of coho salmon, especially projects to reduce fine sediment input to streams, will be important for coho salmon recovery.

Nonpoint Source Pollution Control Program (Water Code, Division 25, Chapter 7, Article 2) (Proposition 13): The Nonpoint Source Pollution Control Program provides grant funding to local public agencies and nonprofit organizations formed by landowners for projects that protect the beneficial uses of water throughout the State through the control of nonpoint source pollution.

Coastal Nonpoint Source Pollution Control Program (Water Code, Division 25, Chapter 7, Article 5) (Proposition 13): The program provides grants to municipalities, local public agencies, nonprofit organizations, and educational institutions for coastal nonpoint source projects that restore and protect the water quality and environment of coastal waters, estuaries, bays, and near shore waters and groundwater.

N*onpoint Source Implementation Program* (Federal Clean Water Act §319): The 319 Nonpoint Source Implementation Program provides grant funding for projects to implement measures and practices that reduce or prevent nonpoint source pollution to ground and surface waters. In particular, proposals that implement measures to achieve pollutant load reductions and address TMDL implementation are favored in the selection process. Grants are available to municipalities, local public agencies, educational institutions, nonprofit organizations or tribes. Funds cannot be used for activities undertaken pursuant to a NPDES permit (including stormwater).

CALFED Drinking Water Quality Program (Propositions 13 and 50): The Drinking Water Quality Program is focused on improving the quality of Central Valley and Delta water sources used for drinking water. Thus, projects eligible for Drinking Water Quality Program funding will generally be located in the watersheds of the Central Valley Regional Board (Region 5). Projects funded through Proposition 13 must meet the minimum requirements of both the Proposition 13 Nonpoint Source Pollution Control Program and the DWQP, whereas projects funded through Proposition 50 only need to meet the requirements of the Drinking Water Quality Program.

Watershed Protection Program (Water Code, Division 25, Chapter 5, Article 2) (Proposition 13): Grants are available to municipalities, local agencies, or nonprofit organizations to develop and implement local watershed management plans to reduce flooding, control erosion, improve water quality, and improve aquatic and terrestrial species habitats.

CALFED Watershed Program (Propositions 13 and 50): The Watershed Program will support activities that provide benefits to the areas within the CALFED Solution Area. Projects funded through the Proposition 13 allocation must meet the minimum requirements of both the Proposition 13 Watershed Protection and the CALFED Watershed Programs, whereas projects funded through Proposition 50 only need to meet the requirements of the CALFED Watershed Program.

5.2.1.7 Farm Bill Grants

The Farm Security and Rural Investment Act of 2002 (Farm Bill) authorizes $180 billion over seven years, including more than $17 billion for programs to assist landowners protect soil, water, and air quality; support fish and wildlife habitat conservation; purchase conservation easements for agricultural and wildlife purposes; and support improved forest management on non-industrial forestlands. While funding is subject to annual appropriations, Farm Bill grants have the potential to significantly benefit coho salmon. Within the range of coho salmon in California, the various Farm Bill programs allocated $5.45 million in 2002 and $9.60 million in 2003.

The Natural Resources Conservation Service (NRCS) is responsible for providing technical and financial assistance to implement conservation programs in the Farm Bill. In recent years, the Department and other State agencies have played a key partnership role with the NRCS to expand and encourage private land conservation efforts throughout California. Through this working relationship, the ability to leverage Federal and State resources on a landscape level can help facilitate coho salmon recovery efforts. With the active participation and cooperation of RCDs, rural landowners can take advantage of the diverse conservation programs available through the Farm Bill.

Key watershed conservation programs available in the Farm Bill through the NRCS include the following:

Environmental Quality Incentives Program (EQIP): EQIP promotes agricultural production and environmental quality as compatible goals. Through this voluntary program, farmers and ranchers may receive financial and technical help to install or implement structural and management conservation practices on their land. Cost sharing (up to 75 %) or incentive payments can be provided for a wide range of practices, including nutrient management, livestock waste handling, conservation tillage, terraces, and filter strips. EQIP is unique among farm conservation programs in its heavy focus on livestock producers.

Nationwide, EQIP is slated to receive $5.8 billion in funding for fiscal years (FY) 2002-07 and a total of $9 billion over ten years. Funding is phased up to $1.3 billion annually by FY 2007, compared with annual funding of roughly $200 million per year under the 1996 Farm Act.

EQIP's focus is on livestock producers, with 60% of funding earmarked for these producers, up from 50% in the 1996 Farm Act. Limits on the size of participating livestock operations, which excluded operations with more than 1,000 animal units, are eliminated in the 2002 Act. Payments are limited to a total of $450,000 per operation over the six-year life of the Act. Participating livestock operations are required to develop a comprehensive nutrient management plan.

Funding for conservation on working agricultural land is increasing relative to funding for land retirement. Because past conservation funding focused on land retirement, increased funding for working land constitutes a significant change in overall conservation program emphasis. EQIP and the newly initiated CSP are slated to receive new funding of $11 billion over ten years. The Congressional Budget Office estimates that increasing Conservation Reserve Program (CRP) and Wetlands Reserve Program (WRP) acreage caps will increase land retirement spending by $3 billion over the same period (from the April 2002 baseline). Expansion of working land programs will make a broader array of conservation options available to a larger group of producers. The increase in the number of programs available may provide the flexibility needed to develop conservation systems that deliver environmental gains at the lowest possible cost.

Changes in EQIP bid assessment procedures, however, may reduce the overall level of environmental benefit per dollar of program expenditure. Although "optimization of environmental benefits" is cited as a purpose of the program, the requirement to maximize environmental benefits per dollar of program expenditure is eliminated. Eliminating priority areas will make it more difficult to target EQIP funds to areas with the greatest environmental need. The ability of producers to enhance prospects for enrollment and reduce program cost by lowering bids (bidding down) is eliminated, increasing the cost of some contracts.

Wetland Reserves Program: WRP restores wetland, upland and riparian complexes to improve habitat for migratory birds. The objectives of this program are to purchase conservation easements from willing sellers, restore and protect wetlands in agricultural settings, and assist landowners with the restoration of wetland hydrology to enhance fish and wildlife habitat.

Conservation Reserve Program: Established in its current form in 1985 and administered by USDA's Farm Services Agency, CRP provides farm owners or operators with an annual per-acre rental payment and half the cost of establishing a permanent land cover, in exchange for retiring environmentally sensitive cropland from production for ten to 15 years. In 1996, Congress re-authorized CRP for an additional round of contracts, limiting enrollment to 36.4 million acres (56,875 square miles) at any time. The 2002 Farm Act increased the enrollment limit to 39 million acres (60,938 square miles). Producers can offer land for competitive bidding based on an Environmental Benefits Index during periodic signups, or can automatically enroll more limited acreages in practices such as riparian buffers, field windbreaks, and grass strips on a continuous basis. CRP is funded through the Commodity Credit Corporation.

To participate in the CRP, producers submit bids that specify practices to be used (e.g., grass, trees, wildlife habitat, filter strips) and the annual rental payment and cost sharing they are willing to accept for establishing these practices. Bids are ranked for selection using the Environmental Benefits Index, which incorporates six environmental factors (including soil erosion, water quality, and wildlife habitat) and contract cost. Contracts are for ten to 15 years.

In addition to the opportunity to enroll in the CRP under the general competitive signups, producers may bypass the competitive bid process and enroll acreage in specific conservation practices under the continuous CRP signup. These practices include:

- Filter strips;
- Riparian buffers;
- Shelter belts;
- Living snow fences;
- Field windbreaks;
- Grass waterways;
- Salt-tolerant vegetation; and
- Shallow water areas for wildlife.

Competitive bidding is not used since the relatively small acreage devoted to one of these practices provides a positive environmental impact for a much larger area. Hence, if the applicant is willing to accept no more than a set per-acre payment for an eligible practice on eligible land, acceptance is automatic and is possible year-round. Payments include a 20% incentive over the Commodity Credit Corporation's maximum rental rates for field windbreaks, grass waterways, filter strips, and riparian buffers, and a 10% incentive for land located within EPA-designated wellhead protection areas. In addition to the enhanced rental rates, 50% cost-sharing and a per-acre maintenance payment are provided.

In April 2000, USDA announced enhanced incentives for continuous signup participation. These include:

- A signing incentive payment of $100 to $150 per acre (depending on the length of contract) for filter strips, riparian buffers, grassed waterways, field windbreaks, shelter belts, and living snow fences;
- A practice incentive payment equal to 40% of cost-sharing for all continuous signup practices;
- Increased maintenance payments for certain practices;
- Updated marginal pastureland rental rates to better reflect the market value of such lands; and
- As of October 2001, about 1.5 million acres (2,343 square miles) had been enrolled in the continuous signup, with filter strips, vegetation to reduce salinity, and riparian buffers as the principal conservation practices. About half of the acreage is enrolled in the Midwest.

Wildlife Habitat Incentives Program: Encourages the voluntary establishment of high quality wildlife habitat on private lands. While some NRCS programs are specifically designed for agricultural lands, the Wildlife Habitat Incentives Program offers technical and financial help for all private landowners or local units of government who wish to plan and develop upland, wetland, riparian, or aquatic habitat on their property.

Farmland Protection Program: Helps farmers keep their productive land in agriculture. This program assists states, tribes, local governments and non-profit organizations by purchasing conservation easements for the purpose of limiting land conversion to non-agricultural uses.

Resource Conservation and Development Program: Assists communities to care for and protect their natural resources in a way that will improve the area's economy, environment and living standards. It provides a way for community members to initiate, sponsor, plan and implement projects that will make their area a better place to live.

Emergency Watershed Protection Program: Provides technical and financial assistance for watersheds ravaged by natural disasters. This program provides funding for work such as clearing debris from clogged waterways, restoring vegetation, and stabilizing riverbanks.

Conservation Technical Assistance: Provides technical assistance to voluntary participants interested in planning and carrying out conservation activities to address local natural resource issues. NRCS staff works with land-users and communities to provide resource solutions throughout the watershed. Conservation Technical Assistance provides the science-based technical assistance needed to create long-term resource solutions at the local level.

Conservation Security Program: The newly created Conservation Security Program will provide payments to producers for maintaining or adopting structural and/or land management practices that address a wide range of local and/or national resource concerns. As with EQIP, a wide range of practices can be subsidized. But the Conservation Security Program will focus on land-based practices and specifically excludes livestock waste-handling facilities. Producers can participate at one of three tiers; higher tiers require greater conservation effort and offer higher payments. The lowest cost practices that meet conservation standards must be used. By paying producers to maintain practices they have previously found to be profitable to undertake, Conservation Security Program payments are not necessarily intended to internalize environmental externalities but are certainly intended to support agricultural incomes.

5.2.1.8 NOAA Community-based Restoration Program

The Community-based Restoration Program's objective is to bring together citizen groups, public and nonprofit organizations, industry, corporations and businesses, youth conservation corps, students, landowners, and local government, State and Federal agencies to restore fishery habitat around the coastal U.S. The program funds projects directly, and through partnerships with national and regional organizations. Since 1996, the Community-based Restoration Program has funded over 600 restoration projects and has developed national and regional Habitat Restoration Partnerships with 19 organizations. NOAA Community-based Restoration Program has two direct Federal funding opportunities.

NOAA Community-based Restoration Program Individual Project Grants: The Community-based Restoration Program provides funds for individual grass-roots marine habitat restoration projects that will benefit living marine resources including anadromous fish species, commercial and recreational resources, and endangered and threatened species.

NOAA Community-based Habitat Restoration National and Regional Partnership Grants: Partnerships are a key element in community efforts to accomplish significant, on-the ground habitat restoration. Partnerships have significantly leveraged available NOAA funds through cash match and local contributions, including land, volunteer support, and other in-kind services such as technical assistance, earthmoving activities and local knowledge.

NOAA also has a community-based restoration partnership program that periodically announces funding opportunities throughout the year. The funding for these programs are matching funds.

5.2.1.9 A Targeted Incentive Program

For other habitat conservation efforts, State and Federal agencies have created special ventures to provide recovery incentives for Californians. For example, the Central Valley Habitat Joint Venture funds habitat acquisition, conservation easements and management agreements with landowners. The State also purchases easements through the Wetland Easement program and the California Waterfowl Habitat Program. A similar program could be developed for coho salmon recovery.

Another instrument that could be used to create incentives for coho salmon habitat restoration if funds were available would be a tax incentive program. For example, Oregon has a property tax credit available to land owners who maintain riparian buffers. Expanding this tax credit was an element of that State's coho salmon recovery program. A government agency could announce a tax credit that would be available to all landowners undertaking a particular set of conservation activities, perhaps indexed to account for the fact that activities in some watersheds are more valuable than in others. This would relieve some of the informational burden of ranking bids that exists in programs like the Community-based Restoration Program, and transfer risk to the private landowner. Landowners undertake activities before receiving compensation from the government in this scenario.

Incentives might also be provided to public stakeholders. The Oregon conservation plan provides bonuses to local governments that meet or exceed salmon restoration performance standards (State of Oregon 1997).

5.2.1.10 Other Programs

There are a variety of other grant programs that may be available to contribute to coho salmon recovery, including programs administered by NOAA Fisheries and other groups.

5.2.2 MINIMIZING SOCIAL AND ECONOMIC IMPACTS

Solutions to recover coho salmon will be determined and accomplished locally. A guiding principle must be cooperation and coordination to promote partnerships. Landowners must have opportunities available to them that provide flexibility as well as assurances that voluntary participation in coho salmon recovery programs will not create significant new burdens in their use of their land. A balance of options will foster greater cooperation and promote innovation. Solutions will be ecosystem-based and will provide equitable problem-solving at the watershed scale in a comprehensive manner.

5.2.3 VOLUNTARY INCENTIVES

An incentives-based approach will be critical to the success of a timely and effective coho salmon recovery. The voluntary commitment of landowner resources and time that are part of cooperative and incentives-based programs also helps to leverage public funds available for recovery.

This Recovery Strategy contains a description of actions and recommendations, including voluntary incentives and objective criteria for delisting to minimize the adverse social and economic impacts of implementation of the Recovery Strategy. Chapter 4 describes the objective criteria for delisting. Chapters 9 and 10 contain implementation schedules that detail actions and recommendations including voluntary incentives, actions, and programs.

5.3 OUTREACH AND EDUCATION

The awareness and cooperation of public and private landowners, conservation groups, planning agencies, stakeholders, and the general public is essential for coho salmon recovery. Outreach and educational programs detailing the life history and habitat requirements of the species, as well as the goals and objectives for recovery, are an important part of this Recovery Strategy.

The Department will develop and implement educational initiatives or products to complement the biological recovery efforts proposed in this document. Development, prioritization and, ultimately, implementation of these initiatives are dependent on the availability of human and financial resources. The Department will utilize and build upon existing Department educational programs, such as the Mobile Fish Exhibit, Fishing in the City, Project Wild Aquatic, and the Elkhorn Slough National Estuarine Research Reserve. The Mobile Fish Exhibit in the Department's Central Coast Region is uniquely suited to bringing the message of coho salmon recovery to citizens groups and other stakeholders.

5.3.1 RECOVERY STRATEGY RECOMMENDATIONS

Priority will be given to educational activities that help to implement specific range-wide and regional coho salmon recovery recommendations with educational components, including recommendations that focus on water flow and conservation, water quality, sediments, land use, public outreach, and enforcement.

5.3.2 EDUCATION AND OUTREACH PLAN

The Department has a plan for education and outreach that focuses on providing notice to the public about the Recovery Strategy as well as information to interested and affected entities about coho salmon biology, definition and goals of recovery, and how recovery can be achieved. It includes elements outlined in this section below. Public and private landowners will be familiarized with coho salmon and their habitat occurring on their land, significance of the populations, and available conservation measures, including private land incentive programs.

For private lands with potential occurrences of coho salmon (i.e., lands with historic occurrences or otherwise within the range of the species), permission will be sought from landowners to conduct surveys or other recovery activities requiring access to coho salmon habitat. If populations of salmon are identified, landowners will be informed of their significance and encouraged to follow land use guidelines that protect the species and its habitat.

5.3.2.1 School Curricula

The Department will develop and disseminate educational materials for use in public and private schools. These materials would include concepts of coho salmon biology, endangered species, habitat conservation and restoration, and coho salmon recovery efforts in California.

Educational materials should be compatible with current California Science Standards. Grade-specific concepts related to coho salmon that have been identified by the Department's Classroom Aquarium Education Coordination Project to correlate with California Science Standards: physical/behavioral adaptations that affect survival (Life Science grade 3); food webs with producers/consumers (Life Science grade 4); physiology and organ systems (Life Science grade 5); ecology (Life Science grade 6); cell biology, genetics, and evolution (Life Science grade 7); and chemistry (Life Science grade 8). Educational material for use in schools may also include a teacher's information packet listing sources of information and knowledge about the coho salmon recovery process in California.

5.3.2.2 Interpretive Media

The Department may prepare brochures targeted at specific audiences and containing pertinent coho salmon recovery information. Potential target audiences include landowners, consumers of household products, legislators, educators, and watershed restoration groups. The brochures would be made available at appropriate information centers such as public libraries and watershed group headquarters, and in association with suitable outreach efforts such as public appearances or Department demonstrations.

Depending on availability of resources, the Department may prepare a coho salmon recovery video containing a synopsis of the California coho salmon listing history, threats to survival, recovery efforts, and useful contacts. The videotape could be used as a media tool of a range-wide coho salmon public relations campaign and in association with local outreach efforts.

Department grant funds support public educational interpretive exhibits. For example, the development of a comprehensive education and interpretive plan for the Warm Springs Dam and Don Clausen Fish Hatchery describes the management history and restoration/recovery efforts with the Russian River watershed. The work funded under this proposal comprises Phase I of a larger project. Phase II (design, fabrication and installation of the exhibits developed in phase I) will commence if/when funding through the Department grant program has been secured.

5.4 ASSESSMENT, MONITORING, AND RESEARCH

The Recovery Strategy consists of a series of prioritized actions designed to restore coho salmon to their former range at appropriate abundance levels. The coho salmon monitoring program is a framework to: a) track the performance of coho salmon recovery efforts, and b) evaluate the condition of coho salmon populations, habitats and the effects of human activities on them. Both physical and biological elements will be monitored to track the status and trends of fish populations and habitats.

5.4.1 PROGRAM FRAMEWORK

A monitoring program framework will be established and will include the following elements, which are briefly described below. Each is essential for the effective implementation, long-term maintenance, and dependability of a monitoring program.[2]

5.4.1.1 Scientific Planning and Prioritization

Careful and deliberate planning must be the foundation for a monitoring program. The Department and cooperating agencies and organizations have been developing some key components of anadromous salmonid monitoring, including recovery activity implementation and effectiveness, validation, and coastal population monitoring. The monitoring program should be established to ensure an effective and efficient program. Because there are many factors that are in need of monitoring, prioritization is also an essential element requiring early attention.

[2] Based, in part, on the CALFED Science Program's Comprehensive Monitoring, Assessment, and Research Program (2000)

The following components will be established and implemented through the planning and prioritization process:

1. Selection of appropriate metrics;
2. Determination of minimum data sets required to describe baseline conditions;
3. Selection of regional areas and independent populations for monitoring;
4. Development of sampling frameworks and sampling design;
5. Independent scientific review;
6. Standardized monitoring protocols;
7. Preparation and distribution of written protocols; and
8. Training and quality control for monitoring protocols.

The many variables in need of assessment, monitoring, and research (outlined in Table 5-1) will be evaluated and assessed at various spatial and temporal levels to determine the priorities for monitoring. It is likely that some priorities will differ by ESU, watershed, and local levels as well as over the time of coho salmon recovery (see below).

5.4.1.2 Evaluating Current Monitoring

Along with establishing the monitoring framework and scientific protocols, current monitoring efforts will be evaluated for their applicability to coho salmon recovery. Local and regional monitoring efforts already exist. The role and utility of these efforts should be acknowledged, and monitoring efforts beneficial to an overall monitoring program should be integrated. In addition, an inventory is an effective process for identifying the scope and focus of ongoing efforts, the gaps in coverage and data, and differences and applicability of ongoing efforts based on differing objectives of each monitoring effort. Information from historical, baseline, and real-time monitoring will be necessary, especially for establishing the foundation for habitat and population status and trend monitoring.

5.4.1.3 Data Management

Because coho salmon exist without regard to political or property lines, it is important to obtain data about coho salmon and their habitat from both public and private lands. The Department's ability to collect data from private lands is limited in many circumstances by a policy requiring landowner consent (FGC §857). Such consent is often withheld from the Department because of landowner concerns about confidentiality and the risk that if site-specific information is publicly disclosed, it will be misused or misinterpreted by others. A policy regarding data collection and disclosure that addresses these concerns would aid the Department's ability to protect and recover coho salmon. Such a policy is particularly important in that approximately 46% of the land in the SONCC Coho ESU and 86% of the land in the CCC Coho ESU that is privately owned.

The management of monitoring information will be essential. It will require dedicated effort and staff to house, compile, and distribute information to responsible and affected organizations and individuals. Important components to data management will be quality control, assessment, and appropriate application of the monitoring information. Assurances of confidentiality and use, and data reliability, will be important considerations for data management.

5.4.1.4 New Research

There are many uncertainties concerning coho salmon recovery. Evaluation of previous and ongoing assessments and monitoring will not only identify future assessment and monitoring needs, but will also indicate issues and uncertainties that require research. These issues will need to be prioritized. Research into coho salmon biology and ecology, and land use practices

TABLE 5-1: Partial outline of potential ecological and land management variables for coho salmon recovery strategy assessment, monitoring, and research

I. HYDRODYNAMICS AND SEDIMENT TRANSPORT

II. SYSTEM PRODUCTIVITY
- A. PRIMARY PRODUCTIVITY
- B. INVERTEBRATE
- C. FISH
- D. NUTRIENT CYCLING

III. FLUVIAL GEOMORPHOLOGY
- A. SEDIMENT (embeddedness, suspended)
- B. TURBIDITY
- C. SUBSTRATE PARTICLE SIZE
- D. LWD CYCLING
- E. LAND SLIDING AND DEBRIS FLOW

IV. HYDROLOGY
- A. FLOW (rate, timing, quantity)
- B. TEMPERATURE
- C. OTHER WATER QUALITY (i.e., DO)

V. ECOLOGICAL COMMUNITIES
- A. RIPARIAN COMMUNITY
  1. Vegetation composition
  2. Invertebrate composition
  3. Vegetation condition
  4. LWD recruitment
- B. NEARSHORE OCEAN CONDITION
- C. ESTUARINE
  1. Condition
  2. Fish use

VI. WATER USE
- A. EFFICIENCY
- B. TRANSFER
- C. STORAGE

VII. LAND USE
- A. EFFECTS ON HABITAT
- B. EFFECTS ON FISH
- C. LAND USE CHANGE TRAJECTORIES
- D. ECONOMIC CONSIDERATIONS
  1. Land use and owners
  2. Local jurisdictions

VIII. FISHING

IX. BARRIERS TO MIGRATION

X. FISH POPULATION
- A. RANGE
- B. DISTRIBUTION
- C. COHORT REPLACEMENT
- D. ABUNDANCE
- E. FISH HEALTH

XI. RECOVERY EFFORTS
- A. IMPLEMENTATION
- B. EFFECTIVENESS
- C. VALIDITY (fish response)

XII. COHO SALMON ECOLOGY
- A. DISEASE
- B. COMPETITION
- C. GENETICS

XIII. POLLUTANTS (TYPE AND SOURCE)

and environmental effects on coho salmon and habitat, will aid the Department in revising and refining both the monitoring program and overall recovery goals.

5.4.1.5 Program Reporting

The Recovery Strategy's monitoring program will have a reporting component by which the general public, landowners, local watershed groups, counties, government agencies, and State legislature can know the status and trend of coho salmon and the results of recovery activities.

Confidence regarding the validity and utility of information resulting from monitoring and research is essential to scientific credibility, public participation, and success in coho salmon recovery. The results and progress of the monitoring program will be subject to scientific review.

5.4.2 ASSESSMENT

In several watersheds, different types and levels of assessment have been done or are ongoing. In many other areas within the range of coho salmon, status information is sparse to non-existent. To evaluate the condition of fish populations, habitat condition, effects from land activity, effects of natural phenomena, and results of recovery efforts, an assessment of these conditions must occur prior to commencing a monitoring program. Baseline information will allow for comparison against changes over the time during the implementation of recovery activities. A baseline condition also will allow for evaluating trend and status. The monitoring program will evaluate historic and current information, identify gaps, and develop a strategy for assessing various conditions in the watersheds. Assessment needs will be prioritized.

5.4.3 MONITORING

The monitoring program for coho salmon will focus on two essential elements: 1) the status and trend of coho salmon and habitat, and 2) the performance of coho salmon recovery efforts. Monitoring will require a long-term commitment as well as annual collection of data on the fish populations, habitat condition, and physical and biological response to recovery actions intended to conserve and restore coho salmon populations and the habitats upon which they depend. An important component to the strategy to establishing a comprehensive monitoring program is to develop and implement standardized, robust field protocols. Monitoring can be divided into several categories, including:

- *Performance measures*. Performance measures are metrics used to track and measure progress of programmatic efforts relative to their goals on an annual basis. Performance measures, if consistently utilized, will begin to identify the long term trends needed to determine the ecological effectiveness of the program and will help ensure that resources are targeted and spent wisely.
- *Trend monitoring*. Trend monitoring evaluates how environmental conditions or populations change over time. The focus of trend monitoring is generally broad in scope, such as an entire ESU or species or extensive, geographic area, such as a large watershed or basin.
- *Implementation monitoring*. Implementation monitoring serves to document what recovery actions are taken and to evaluate whether those recovery actions are being implemented as planned. For habitat restoration, implementation monitoring provides baseline information before and immediately after a project occurs.
- *Effectiveness monitoring*. Effectiveness monitoring evaluates the effects of recovery actions, specifically if the recovery activities are having the desired effects.

This is largely a measure of physical responses to habitat restoration treatments and fisheries management actions. Response should be assessed against pre-established effectiveness criteria and evaluated with respect to the degree which they are obtained.

- *Validation monitoring*. Validation monitoring evaluates how a population, species, or biotic community responds to recovery actions. In the context of the Recovery Strategy, the focus will be on the response of coho salmon at stream reach, watershed, and ESU levels and will focus on each life-stage.

5.4.3.1 Three-tiered Monitoring Framework

Any monitoring program must be able to evaluate conditions at various scales and allow those involved (i.e., State and Federal agencies, counties, watershed organizations, landowners) to participate. In addition, the monitoring itself and the results and information generated must be defensible both scientifically and legally and must be acceptable to the counties and local communities where coho salmon occur. This will require good data on the distribution, abundance, and population health of coho salmon throughout California. A significant monitoring effort sustained over several decades will be required.

The State of Oregon has demonstrated that such a monitoring effort can be successfully initiated through the Oregon Plan for Salmon and Watersheds (Oregon Plan), which includes a three-tiered system for estimating the abundance of adult salmon in coastal watersheds. It also includes targeted studies of juvenile abundances and habitat. In the 1990s, Oregon developed a specific monitoring approach based on stratified random sampling; this method was much more accurate than previous methods based on "index reaches," and is being used to monitor coho salmon. Oregon has thus demonstrated that a statistically rigorous monitoring approach is possible. The benefit of such an approach is that it delivers unbiased estimates of trends and abundance in salmonid stocks.

The *Oregon Plan* three-tiered framework:

Tier I is a broad-scale (i.e., ESU) assessment of ecosystem health. The intent is for data from Tier I to be used to stratify sampling at the more-detailed Tier II level. Tier I would probably require surveys at a frequency of once every 5 years for each sampling site. Candidate indicators to be measured are:

- *Biological attributes*. Fish presence/absence, distribution, percent of habitat occupied, genetic composition, invertebrate community health (the ones coho salmon need), habitat condition and key habitat elements (spawning and nursery areas, riparian condition).
- *Environmental attributes*. Geology/soils, land cover, digital elevation models, sedimentation/suspended sediment, water temperature, flow, and supply, and LWD recruitment.
- *Threat/Impact attributes*. Land use, roads, stochastic events (e.g., ocean conditions, drought), and barriers to migration.

Tier II is the level at which the status and trends in coho salmon population health are carried out. Annual measures of abundance would be based on a spatially-balanced random-sampling plan. Preliminary data to be collected are:

- *Adults*. Adults, spawners, redds, age structure, sex, hatchery fraction;
- *Juveniles*. Instream or emigrating, age/size class, fish condition; and
- *Habitat*. Macroinvertebrates, fish assemblage, DO, pH, nutrients/pollutants, solids, metals/toxins, temperature, channel form, valley form, valley width, geomorphic channel, channel substrate, canopy cover, LWD, riparian vegetation, land use and land cover, diversions, erosion processes, channel modification, and instream flow.

Data from Tier II would ideally be used as a control for Tier III data, which measures response of environmental conditions and salmonid populations to habitat restoration and other recovery actions (effectiveness and validation monitoring). The overall design of the Tier II portion of the coho salmon recovery plan could be modeled on Oregon's rotating panel design, which distributes sampling effort in time and space in a way that is intended to optimize the dataset's utility for detecting trends and status. It is also possible that a nested hierarchy of basin sampling and subsampling may be desirable.

Tier III is monitoring carried out for individual restoration projects and for a suite of related restoration treatments. It is used to assess and evaluate the effectiveness of restoration actions. The resulting information may then be assessed using comparisons with baseline and/or reference data collected in Tier II.

5.4.3.2 Monitoring of Coho Salmon

To understand the current and potential future condition of coho salmon populations and habitat, there are certain, specific monitoring elements that will be the foundation to the overall monitoring program. These elements will be coordinated with local monitoring efforts and integrated with each other, and will span the entire range and distribution of coho salmon. Status and trend monitoring, implementation and effectiveness monitoring of recovery efforts, and validation monitoring of coho salmon response constitute the core of the State's coho salmon monitoring program. Conceptual models likely will be developed and utilized in the monitoring.

Status and Trend Monitoring. The first essential monitoring requirement for coho salmon will be to understand the status and trend, primarily at the ESU level. To do this, establishing the baseline condition of coho salmon populations and habitat and ongoing monitoring of coho salmon populations will be necessary. This monitoring information will be directly tied to the Department's ability to recommend downlisting, uplisting, or delisting of either ESU.

In 2003, the Department and cooperating agencies began to develop a coastal salmonid monitoring plan. The objective of the plan is to develop statistical sampling designs to estimate status and trends in coastal California salmonid population and habitat conditions at the ESU or other appropriate spatial scale. This plan will be the foundation for population status and trend monitoring for coho salmon.

Implementation and Effectiveness Monitoring. Local and regional restoration activities will be the core to coho salmon recovery efforts. Tracking, measuring, and understanding these activities will be critical to making wise use of limited resources and time and in making improvements in recovery and restoration actions based on past results.

In 2001, through the FRGP, efforts began the Coastal Salmonid Restoration Monitoring and Evaluation Program (CSRMEP). CSRMEP is developing implementation and effectiveness monitoring protocols to evaluate restoration efforts with the goal of improving and conserving coastal anadromous salmonid habitat. Components of this effort currently underway will:

a. Complete monitoring protocol development;
b. Field-test all protocols;
c. Complete a data management support system;
d. Provide training in protocol usage; and
e. Begin testing the implementation of a comprehensive restoration effectiveness monitoring program.

Validation Monitoring. Validation monitoring evaluates whether and to what degree a specific practice accomplishes goals and objectives. In addition, validation monitoring is invaluable for verifying hypotheses regarding coho salmon ecology and recovery, and conceptual models predicting the relationship between different ecological and land management variables. Validation monitoring is indispensable in determining the success of "...actions taken in an attempt to improve the status of salmon (or a specific stock of salmon)..." (Botkin et. al. 2000).

Starting in 2002, the FRGP began to develop validation monitoring protocols for anadromous salmonid recovery activities in California. The goal is to develop standardized validation monitoring protocols to assess and evaluate the response of salmon and steelhead to restoration and management efforts aimed at conserving and restoring anadromous salmonids in coastal California watersheds. These validation monitoring protocols will serve as the foundation for coho salmon Recovery Strategy validation monitoring. It is anticipated that protocols will be developed and ready for field testing by 2005.

5.4.4 NEW RESEARCH

Evaluation of previous and ongoing assessments and monitoring will not only identify future coho salmon assessment and monitoring, it will also indicate biological issues and uncertainties that require research. Like assessment and monitoring needs, coho salmon research will need to be prioritized. Future research into the biology of coho salmon (e.g., genetics, estuary use), effects of land use practices (e.g., urbanization, forestry) and environmental processes (e.g., climatic variation in ocean condition, woody debris cycling) on coho salmon populations and habitat will aid the Department in revising and refining both the monitoring program and overall recovery goals. The CRT identified some priority research issues, and the Department in collaboration with the recovery teams, will continue to identify and prioritize research needs.

5.4.5 ASSESSMENT, MONITORING, AND RESEARCH RECOMMENDATIONS

Assessment, monitoring, and research are important to coho salmon recovery. Recommendations for range-wide monitoring, research and assessment that will contribute to recovery of coho salmon are set forth in the range-wide implementation schedule in Chapter 9.

5.5 REGULATORY ROLE IN RECOVERY

Improving implementation and enforcement of existing laws and regulations (Table 5-2) by and among various State, Federal, and local governments can contribute significantly to the recovery of coho salmon. This was recognized by the CRT. Therefore, many recovery actions call for improved implementation and/or enforcement of specific laws and regulations. Other recovery actions call for improved coordination among government agencies in implementing, enforcing, and streamlining the permit processes to promote activities that will benefit coho salmon.

TABLE 5-2: Existing laws, regulations, and permits that contribute to coho salmon recovery

STATE LAWS AND REGULATIONS

LAWS AND REGULATIONS	GENERAL DESCRIPTION[a]
Recovery Strategy Pilot Program, Fish & Game Code §2105 *et seq.*	Sets forth requirements for Recovery Strategy. Sets forth criteria for Commission approval of Recovery Strategy. Authorizes inclusion of guidelines for issuance of memoranda of understanding under FGC §2081. Provides that the Recovery Strategy itself shall have no regulatory significance, shall not be considered to be a regulation for any purpose, and is not a regulatory action or document.
Fully Protected Species, Fish & Game Code §3511, 4700, 5050, 5515.	Prohibits take and possession of specified fully protected species, except collecting for "necessary scientific research" as authorized by the Commission. No provision of the FGC or any other provision of law shall be construed to authorize the issuance of permits or licenses to take any fully protected species.
California Endangered Species Act (CESA), Fish & Game Code §2080 *et seq.*	Prohibits take of California-listed and candidate species, except as otherwise authorized.
Natural Community Conservation Planning Act, Fish & Game Code §2080 *et seq.*	Authorizes take of any species whose conservation and management is provided for in an approved natural community conservation plan.
Lake and Streambed Alteration Protection, Fish & Game Code §1600 *et seq.*	Prohibits any person from substantially diverting or obstructing the natural flow, or substantially changing the bed, bank, or channel of any river, stream or lake without first notifying the Department of the activity. Prohibits a person from commencing any activity until: 1. The Department has found that it will not substantially adversely affect existing fish and wildlife resources; or 2. The Department's proposals as to measures necessary to protect fish and wildlife resources (as agreed to), or the decision of a panel of arbitrators, have been incorporated into the activity. Where the Department has found the activity will substantially adversely affect existing fish and wildlife resources, prohibits any person from engaging in the activity unless it is conducted in accordance with the department's proposals (as agreed to) or the decisions of the panel of arbitrators. The Department shall not condition a streambed alteration agreement on the receipt of another State or Federal permit.
Water Pollution, Fish & Game Code §5650.	Prohibits anyone from depositing in, permitting to pass into, or placing where it can pass into the waters of the State, specified items and "any substance or material deleterious to fish, plant life, or bird life," except a discharge or release expressly authorized by and in compliance with a WAR or waiver or in compliance with a Federal permit issued a water quality certification issued by the State Water Resources Control Board or regional board after public hearing.
Commission Regulations, Fish & Game Code §316.5.	Authorizes Commission to "prohibit the taking or possessing of salmon in the same manner as the taking or possessing of salmon is prohibited by Federal law or by rules or regulations adopted by the United States Secretary of Commerce, notwithstanding any other provision of this code."
Examination of Dams, Fish & Game Code §5930.	Requires the Department, from time to time, to examine all dams in all rivers and streams in the State naturally frequented by fish.
Fishways, Fish & Game Code §5931.	Provides that if, in the opinion of the Commission, there is not free passage for fish over and around any dam, the Department shall cause to be furnished suitable fishway plans and order the owner in writing to provide the dam, which shall be completed to the Department's satisfaction.
Additional Fishways, Fish & Game Code §5932.	Requires that when article 2 (dams and structures) has been complied with, if in the opinion of the Commission changed conditions make additional structures desirable for free passage of fish, the Department may make such additional structures and necessary expenditures.
Dam Construction and Enlargement, Fish & Game Code §5933.	Requires the Commission to be given a copy of any application to DWR for new dam or enlargement of dam. If the Commission deems fishway necessary for preservation and protection of fish and construction and operation of fishway is practicable, it shall set a date for hearing. Where the Commission finds after hearing fishway is necessary and practicable, prohibits construction without prior written approval of Commission.
Fishway Maintenance, Fish & Game Code §5935.	Requires owner of any dam upon which a fishway has been provided shall keep the fishway in repair and free from obstructions to passage of fish at all times.
Fish Passage, Fish & Game Code §5937.	Requires owner of any dam to allow sufficient water at all times to pass through a fishway, or in the absence of a fishway, allow sufficient water to pass over, around, or through the dam, to keep in good condition any fish that may be planted or exist below the dam.

continued

TABLE 5-2: Existing laws, regulations, and permits that contribute to coho salmon recovery (continued)

STATE LAWS AND REGULATIONS (continued)

LAWS AND REGULATIONS	GENERAL DESCRIPTION[a]
Hatchery in Lieu of Fishway, Fish & Game Code §§5938, 5940, 5941.	Provides that when in the opinion of the Commission a fishway is impracticable, Commission may order owner of the dam to equip a hatchery to Department plans and specifications. After the hatchery is constructed, The Department shall operate it without further expense to dam owner. However, dam owner shall permit the use of free water for the hatchery. If dam generates electricity, the dam owner shall permit the use of free electricity for the hatchery.
Fish Planting in Lieu of Fishway, Fish & Game Code §5942.	Authorizes the Commission to order dam owner in lieu of fishway, hatchery, equipment to plant, under Department supervision, young of fish that naturally frequent waters of the stream or river, at such times, in such places, and in such numbers as the Commission may order.
Screening Diversions Deleterious to Salmon and Steelhead, Fish & Game Code §6100.	Requires dam owners to screen any new diversion of water from any stream having populations of salmon and steelhead which is determined by the Department to be deleterious to salmon and steelhead. Authorizes the Department to make onsite investigation prior to proposing measures necessary to protect fishlife. Prohibits commencement of diversion until the Department has determined the protective measures have been incorporated into plans and construction of diversion.
Suction Dredging, Fish & Game Code §5653 *et seq.*	Prohibits suction dredging in rivers, streams, and lakes of the State, except as authorized.
Z'Berg-Nejedly Forest Practice Act, Pub. Res. Code §4511 *et seq.* Forest Practice Rules, CCR Title 14, §895 *et seq.*	Regulates timber operations on industrial and non-industrial timberlands. Sets forth requirements for timber operations and timber harvest plan review.
Surface Mining and Reclamation Act, Pub. Res.Code §2710 *et seq.*	Requires for all mining operations an approved reclamation plan and financial assurances to cover estimated reclamation costs.
Porter-Cologne Water Quality Control Act, Water Code §13000 *et seq.*	Requires persons proposing to discharge waste that could affect the waters of the State to file a Report of Waste Discharge with the appropriate Regional Water Quality Control Board. RWQCB will either issue a Waste Discharge Requirement or waive the requirement.
Streamflow Protection, Pub. Res. Code §10000 *et seq.*	Authorizes the Department to develop, review, and/or propose streamflow requirements or modifications to streamflow requirements, and initiate studies therefore.
California Environmental Quality Act, Pub. Res. Code §21000 *et seq.*	Requires environmental review and public disclosure of environmental impacts.
FEDERAL LAWS AND REGULATIONS	
Endangered Species Act, 16 U.S.C. §1531 *et seq.*	Prohibits take of ESA-listed species, except as authorized under the ESA. Take can be authorized through section 7 and section 10. Section 7 requires Federal agencies to consult whenever any undertaken, permitted, or funded by a Federal agency will result in take of an endangered species or destruction of critical habitat. Section 7 results in an incidental take statement, allowing incidental take, subject to reasonable and prudent measures. Section 10 provides for issuance of permits to persons authorizing incidental take.
U.S. Army Corps 404 Permit, Clean Water Act, 33 U.S.C. §1344.	Regulates discharge of dredged or filled material from a point source into the waters of the US, through: 1. General or individual permit, or 2. Letter of Permission issued by the US Army Corps of Engineers. Exemptions under §404(f)(1) and 33 CFR §323.4 include normal farming, silviculture, ranching, certain construction or maintenance of farm roads or forest roads.
Section 10 Rivers and Harbors Act 33 U.S.C. §403.	Regulates work or structures in, or affecting, the course, condition, or capacity of navigable waters of the US through: 1. General or individual permit, or 2. Letter of Permission issued by the US Army Corps of Engineers.
Section 401 Water Quality Certification, Clean Water Act, 33 U.S.C. §1341.	Requires an applicant for a Federal license or permit to conduct any activity that may result in any discharge into navigable waters to provide the Federal licensing or permitting agency a certification or waiver of certification from the State in which the discharge originates or will originate that the discharge will meet the State's water quality standards. Prohibits granting of any license or permit if the State denies certification.
TMDLs, CWA §303(d) 33 U.S.C. §1313.	Requires establishment of TMDLs for point sources and non-point sources for listed impaired water bodies. TMDLs are not enforceable, except through a State implementation plan (basin plan). To date, the Garcia River TMDL is the only one that has been incorporated into a basin plan.

continued

TABLE 5-2: Existing laws, regulations, and permits that contribute to coho salmon recovery (continued)

FEDERAL LAWS AND REGULATIONS (continued)

LAWS AND REGULATIONS	GENERAL DESCRIPTION[a]
Fish and Wildlife Coordination Act, 16 U.S.C. §661 *et seq.*	Requires Federal agencies to consult with the Fish and Wildlife Service and State fish and game agencies before undertaking or approving projects that control or modify surface water projects.
Data Quality Act, Public Law 106-554.	Pursuant to the Data Quality Act, the Office of Management and Budget (OMB) issued guidelines to Federal agencies providing policy and procedure guidance for ensuring and maximizing the quality, objectivity, utility, and integrity of information (including statistical information) disseminated by Federal agencies. The guidelines require procedures for persons who may be affected by such information to request corrections to information that does not conform to the guidelines. OMB directed all Federal agencies to issue implementing guidelines. NOAA and FWS, among other Federal agencies have issued guidelines. Both NOAA's and USFWS's guidelines include objectivity standards. These guidelines apply to third-party information (such as information from states) that the agencies use. The guidelines acknowledge and do not override other compelling interests such as privacy, trade secrets, intellectual property, and other confidentiality protections established by law. Where these considerations preclude full transparency, then "especially rigorous robustness checks" will be applied.
National Environmental Policy Act, 42 U.S.C. §4321 *et seq.*	Requires environmental review and public disclosure.
Santa Cruz County Riparian Corridor Protection Ordinance, County Code Chapter 16.30.	Defines, protects and determines boundaries of riparian corridors for permits and exemptions.

PLANS AND PERMITS PURSUANT TO STATE, FEDERAL AND LOCAL LAWS

PLANS AND PERMITS	GENERAL DESCRIPTION[a]
Pacific Lumber Company Habitat Conservation Plan	Provides mitigation that contributes to recovery of coho salmon.
Water Quality Control Plan for North Coast Region	Provides water quality standards for beneficial uses in North Coast Basin, including Garcia River TMDL. Prohibits unauthorized discharges in violation of the basin plan.
Water Quality Control Plan for San Francisco Bay Region	Provides water quality standards for beneficial uses in San Francisco Bay Region. Prohibits unauthorized discharges in violation of the basin plan.
Humboldt County, USACE Letter of Permission 96-1 for Gravel Mining and Excavation Activities Within Humboldt County	Authorizes gravel mining and excavation activities within Humboldt County subject to specified conditions.
Humboldt County Extraction Review Team (CHERT)	Independently reviews gravel mining and extraction plans and issues recommendations therefore.
Sonoma County Aggregate Resources Management	Authorizes gravel mining in Sonoma County, but defers to the Department concurrence of project conditions through the Streambed Alteration Agreement process under FGC §1600 *et seq.*
Del Norte, US Army Corps of Engineers Letter of Permission 96-2 for Gravel Mining and Excavation Activities within Del Norte County	Authorizes gravel mining and excavation activities within Del Norte County subject to specified conditions.

[a] General descriptions are provided for convenience of the reader. The descriptions are not intended to be exhaustive. For details, the reader should refer to the actual statute, regulation, ordinance, and/or document itself, and any applicable case law.

6 Recovery Units and Watersheds

The Department has subdivided each coho salmon ESU into watershed recovery units (recovery units). The recovery units are groups of smaller drainages related hydrologically, geologically, and ecologically, and that are thought to constitute unique and important components of the ESU. The concept of the recovery unit allows flexibility across the landscape; once a recovery unit has met and sustained recovery targets, more attention can be focused elsewhere.

To provide consistency with existing resource databases, recovery units were aligned with the geographic divisions of the CALWATER 2.2a system, the standard watershed mapping system used by the State of California. The CALWATER classification system includes (from largest to smallest) hydrologic regions, hydrologic units (HUs), hydrologic areas (HAs), hydrologic subareas (HSAs), and planning watersheds.

The HUs, and in some instances the HAs within the recovery units, are described below under each ESU. HSAs are also described where environmental conditions are distinct from the hydrologic unit and specific recovery recommendations are warranted.

6.1 RECOVERY UNITS IN THE SONCC COHO ESU

The SONCC Coho ESU has been divided into 17 recovery units (Figure 6-1). The recovery units generally correspond with CALWATER hydrologic units, with the exception of the Klamath, Trinity, and Eel river systems, which were further refined at the hydrologic area level. These recovery units, and the watershed delineations within each recovery unit, are listed in Table 6-1. Hydrologic subareas are illustrated in Figure 6-2 and watershed conditions are described below.

6.1.1 ROGUE RIVER AND WINCHUCK RIVER HYDROLOGIC UNITS

These two HUs are located mostly in Oregon. Portions of the Illinois River, a tributary to the Rogue River (Figure 6-3), and the Winchuck River (Figure 6-4) are located in California.

6.1.1.1 Illinois River HSA

A very small portion of the Illinois River HSA is located in eastern Del Norte County, California (Figure 6-3). The main drainages of the Illinois River HSA in California are Elk Creek, the East Fork Illinois River, and Dunn Creek. Portions of these drainages are in the Siskiyou National Forest, and the rest is in private ownership. Timber production is the main land-use activity. Coho salmon have been found in the above-listed drainages as well as a few of their main tributaries in recent Department surveys. Problems for coho salmon recovery in these drainages include inadequate pool structure due to insufficient existing and recruitable conifer LWD and excessive fine sediment.

6.1.1.2 Winchuck River HSA

The South Fork Winchuck River is the only portion of the Winchuck River HSA located in California (Figure 6-4). The primary land use in the South Fork drainage is industrial timber production. Coho salmon were found in the South Fork in recent Department surveys.

TABLE 6-1: Recovery units and CALWATER watersheds in the SONCC Coho ESU

RECOVERY UNIT	HYDROLOGIC UNIT (HU)	HYDROLOGIC AREA (HA)	HYDROLOGIC SUBAREA (HSA)
Rogue and Winchuck rivers	Winchuck River	Winchuck River	Winchuck River
	Rogue River	Illinois River	Illinois River
		Applegate River	Applegate River
Smith River	Smith River	Lower Smith River	Smith River Plain
			Rowdy Creek
			Mill Creek
		South Fork Smith River	South Fork Smith River
		Middle Fork Smith River	Middle Fork Smith River
		North Fork Smith River	North Fork Smith River
		Wilson Creek	Wilson Creek
Lower Klamath River	Klamath River	Lower Klamath River	Klamath Glen
			Orleans
Salmon River		Salmon River	Lower Salmon
			Wooley Creek
			Sawyers Bar
			Cecilville
Middle Klamath River		Middle Klamath River	Ukonom
			Happy Camp
			Seiad Valley
			Beaver Creek
			Hornbrook
			Iron Gate
			Copco Lake
Scott River		Scott River	Scott Bar
			Scott Valley
Shasta Valley		Shasta Valley	Shasta Valley
Trinity River	Trinity River	Lower Trinity River	Hoopa
			Willow Creek
			Burnt Ranch
			New River
			Helena
		Middle Trinity River	Douglas City
			Weaver Creek
		Upper Trinity River	Upper Trinity River
South Fork Trinity River		South Fork Trinity River	Grouse Creek
			Hyampom
			Forest Glen
			Corral Creek
			Hayfork Valley

continued

TABLE 6-1: Recovery units and CALWATER watersheds in the SONCC Coho ESU (continued)

RECOVERY UNIT	HYDROLOGIC UNIT (HU)	HYDROLOGIC AREA (HA)	HYDROLOGIC SUBAREA (HSA)
Redwood Creek	Redwood Creek	Orick	Orick
		Beaver	Beaver
		Lake Prairie	Lake Prairie
Trinidad	Trinidad	Big Lagoon	Big Lagoon
		Little River	Little River
Mad River	Mad River	Blue Lake	Blue Lake
		North Fork Mad River	North Fork Mad River
		Butler Valley	Butler Valley
		Ruth	Ruth
Eureka Plain	Eureka Plain	Eureka Plain	Eureka Plain
Lower Eel and Van Duzen rivers	Eel River	Lower Eel River	Ferndale
			Scotia
			Larabee Creek
		Van Duzen River	Hydesville
			Bridgeville
			Yager Creek
South Fork Eel River		South Fork Eel River	Weott
			Benbow
			Laytonville
Middle-Upper Eel River		Middle Main Eel River	Sequoia
			Spy Rock
		Upper Main Eel River	Outlet Creek
			Tomki Creek
			Lake Pillsbury
		Middle Fork Eel River	Eden Valley
			Round Valley
			Black Butte River
			Wilderness
Cape Mendocino	Cape Mendocino	Oil Creek	Oil Creek
		Capetown	Capetown
		Mattole River	Mattole River

Potential problems for coho salmon recovery in this river include inadequate pool structure due to insufficient existing and recruitable conifer LWD and excessive fine sediment.

6.1.2 SMITH RIVER HYDROLOGIC UNIT

The Smith River (Figure 6-4) is California's fourth largest coastal river, with a watershed of approximately 610 square miles in California and 115 square miles in Oregon. At its terminus, the Smith River flows through an agriculturally developed coastal plain and enters the Pacific Ocean four miles south of the Oregon border. The mainstem Smith River is fed by three forks, the North, South, and Middle.

The Smith River estuary is an important rearing habitat for juvenile salmonids. The precipitous upper canyon areas are forested in fir, spruce, cedar, and pine with groves of tall redwoods in Redwood National and State parks. Second and third growth trees inhabit the majority of merchantable timberlands in the basin. A large portion of the Smith River watershed supports a unique flora, which exists on unusual soils derived from ultramafic parent materials.

Historically, salmon were very abundant in the rivers and streams of the Pacific Northwest and the Smith River was no exception. In the late 19th and early years of the 20th century, runs of salmon in the Smith River sustained the operation of a cannery near its mouth. Some cannery records dating from the 1890s documented the processing of 50 tons of salmon per year (Bartson 1997). Coho salmon are currently found throughout the HU, although their numbers are typically small.

Problems facing anadromous salmonids in the Smith River include amount of available habitat, degraded condition of riparian vegetation, poor LWD recruitment, altered estuarine environment, excess sediment, compacted stream gravels, and fish passage.

6.1.2.1 Mill Creek HSA

Mill Creek, which enters the Smith River approximately 15 river miles from the mouth, encompasses 36.9 square miles. The main tributaries to Mill Creek include West Branch Mill, East Fork Mill, and Bummer Lake Creek. Numerous first and second order tributaries feed these streams. Much of the basin was historically managed for timber production, but it is now entirely under public ownership and managed by Redwood National Park and DPR.

Mill Creek is one of the most productive tributaries for salmon and steelhead in the entire Smith River watershed. All species of salmonids present in the Smith River basin can be found in the Mill Creek watershed.

Problems facing anadromous salmonids in the Mill Creek HSA include poor LWD recruitment, barriers to fish passage, degraded riparian vegetation, and sediment input from the existing road network.

6.1.2.2 Wilson Creek HSA

Wilson Creek is a tributary to the Pacific Ocean located approximately four miles north of the Klamath River mouth. The lower section of this coastal watershed lacks an estuary. The creek runs directly into a semi-protected section of coastline where wave action at the creek's entrance is cushioned by exposed rocks. The lower channel is intermittent during the summer, thus emigrating smolts have a discrete window in which to leave the watershed.

Coho salmon juveniles and smolts have been found in appreciable numbers during Wilson Creek dive counts and electrofishing from 1995 to 2000. Their numbers have been highly variable with strong years from 1995 to 1998 and weak years from 1999 to 2000, which may have been related to low observed adult escapement numbers (SRCO 2002).

Problems facing anadromous salmonids include inadequate in-stream habitat complexity, degraded riparian vegetation, and excess sediment input.

FIGURE 6-1: Recovery units in the California portion of the SONCC Coho ESU

FIGURE 6-2: Hydrologic Subareas in the California portion of the SONCC Coho ESU

FIGURE 6-3: Rogue River and Klamath River Hydrologic Units

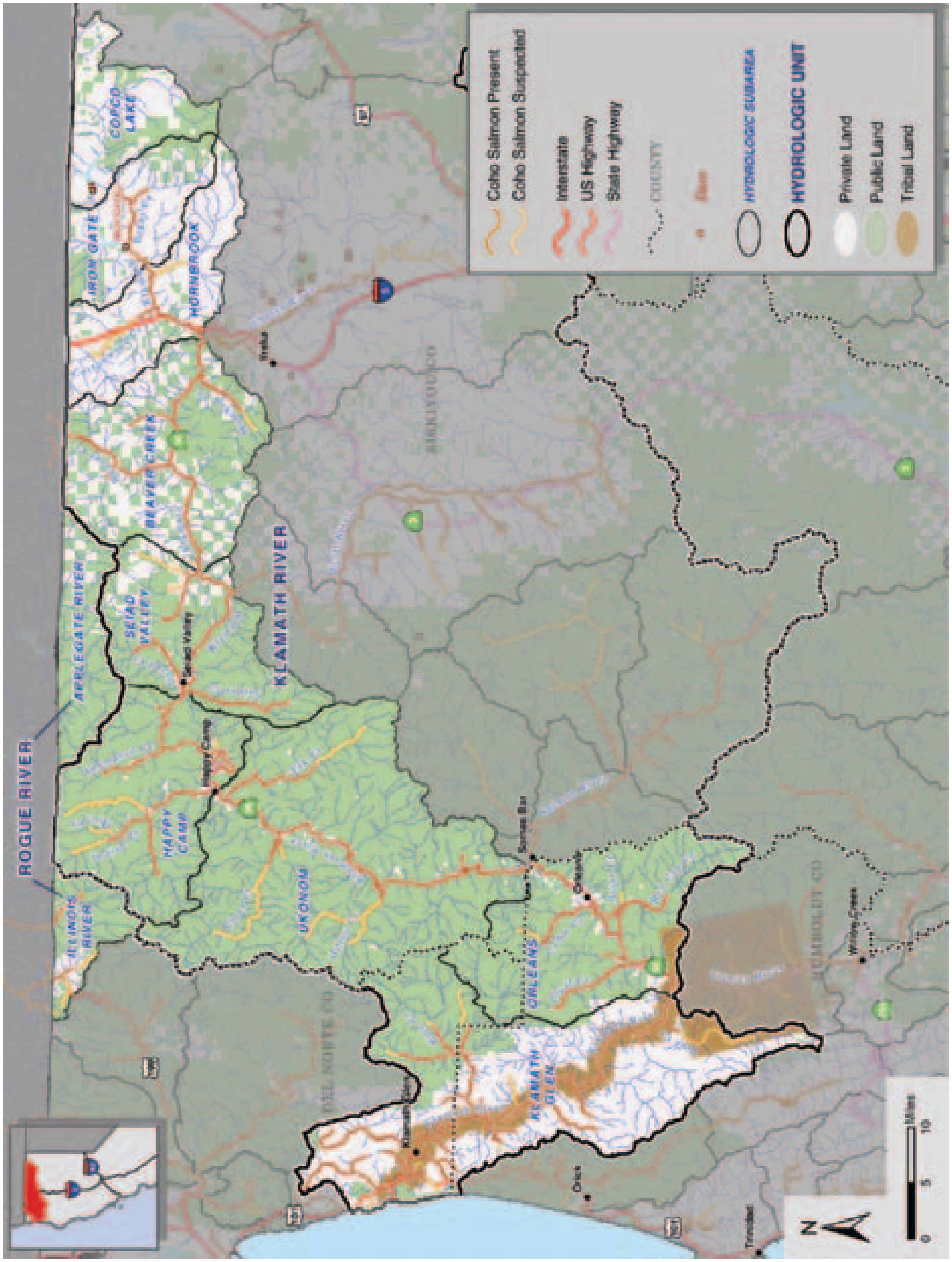


FIGURE 6-4: Winchuck River and Smith River Hydrologic Units

6.1.3 KLAMATH RIVER HYDROLOGIC UNIT

The origin of the Klamath River is at the outflow of Upper Klamath Lake, north of Klamath Falls, Oregon (Figure 6-3). The Upper Klamath River Basin has been highly modified over the past 90 years, with 80-90% of historic wetlands reclaimed for agricultural, urban, and other development. On average, approximately 289,000 acre-feet of water are diverted near the outlet of Upper Klamath Lake and the Klamath River to provide irrigation deliveries to 275 square miles of farmland within the Klamath Project. An additional 44,000 acre-feet of water are diverted to serve 44 square miles of land in the lower Klamath Lake Wildlife Refuge. Approximately 16% of the diverted water is returned to the Klamath River in a slightly more nitrified State during some months of the year. The return water represents approximately 9% of the water passing through the Keno Dam, Oregon.

The Middle Klamath River extends from Iron Gate Dam downstream to the mouth of the Salmon River; the Lower Klamath River is from the mouth of the Salmon River to the mouth of the Klamath River at the Pacific Ocean. It is California's second largest river, draining a watershed of approximately 1,531 square miles. The Klamath River HU has 1,832 miles of waterways. Major tributaries include the Trinity, Salmon, Scott, and Shasta rivers. Numerous other tributaries enter the Klamath River along its length.

Upper Klamath Lake is shallow and hypereutrophic, causing the water of the Klamath River at this point to be poor in quality for much of the year and to be listed by the EPA as impaired for temperature, dissolved oxygen, and nutrients. Anadromous fish have been blocked from the upper basin since 1910 when Copco #1 Dam construction was started. Habitat alteration and water diversions have degraded Klamath River water quality, reduced total annual discharge, and altered the magnitude, timing and duration of flow so that more water runs downstream during winter months and less during the spring and summer than occurred historically.

Information on adult coho salmon returns to the Klamath basin is spotty prior to the construction of Iron Gate and Trinity River hatcheries. Coho salmon were thought to spawn in most tributaries to the Klamath from the mouth to at least Bogus Creek (CDFG 1979). During the 1960s, coho salmon escapement for the mainstem and its minor tributaries (excluding the Shasta, Scott, Salmon and Trinity rivers) was estimated at 8,000.

Problems facing anadromous salmonids in the Klamath River include an altered hydrograph, high summer water temperatures, lack of access to available habitat, erosion and sedimentation, degraded condition of riparian vegetation, depleted LWD, unscreened water diversions, legacy impacts from historical timber operations and mining, and agricultural conversion.

6.1.3.1 Klamath Glen HSA

The Klamath Glen HSA is located between the mouth at the Pacific Ocean and the confluence of the Trinity River. Recent presence/absences survey in this HSA, have indicated that coho salmon are present in much of their historic habitat.

Problems facing coho salmon in the Klamath Glen HSA include feral cattle in lower Blue and Bear creeks impacting riparian vegetation and increasing streamside erosion, excessive sedimentation and erosion due to removal of up to 90% of cover from some tributaries, low habitat diversity, loss of confluence connectivity, and reduced habitat quantity and complexity. Many deep areas of the estuary have been filled by excessive sedimentation, which may affect the mixing zone and impact food availability for juvenile salmonids. Rearing duration may be shorter due to loss of estuary habitat.

6.1.3.2 Orleans HSA

The Orleans HSA is located between the confluence of the Trinity River and the confluence of the Salmon River. Recent present/absence surveys have found coho salmon in many of the main tributaries that enter the Klamath River in this HSA.

The main problems facing coho salmon in the Orleans HSA include potential impacts from timber harvest, water diversions, gravel extraction, stream channelization and excessive sediment input, elevated summer water temperatures, and impaired connectivity to tributaries.

6.1.3.3 Ukonom HSA

The Ukonom HSA is located between the confluence of the Salmon River and the confluence of Indian Creek. Recent presence/absence surveys indicate that coho salmon are no longer found in a number of tributaries that they historically inhabited.

Problems facing anadromous salmonids in this HSA include barriers to migration, elevated water temperatures, undersized culverts in the Elk Creek watershed, unstable spawning gravels, depleted LWD, unscreened water diversions, increased erosion, and discharge of acid, heavy metals, and cyanide from the Siskon Mine in the Dillon Creek watershed.

6.1.3.4 Happy Camp HSA

The Happy Camp HSA is located between the confluence of Indian Creek and the confluence of Grider Creek.

Problems facing anadromous salmonids include increased turbidity, acid and heavy metal contamination from Grey Eagle Mine, elevated water temperatures in some tributaries, degraded quantity and quality of riparian vegetation, depleted LWD, unscreened water diversions, and disrupted natural movement of watershed products (water, LWD, sediment) and fish due to culverts and road crossings in the Thompson Creek Watershed.

6.1.3.5 Seiad Valley HSA

The Seiad Valley HSA is located between the confluence of Grider Creek and the confluence of Horse Creek.

Problems facing anadromous salmonids include increased turbidity in Walker Creek, elevated water temperatures in some tributaries, degraded riparian vegetation in Seiad Creek, depleted LWD, unscreened water diversions, disrupted natural movement of watershed products (water, LWD, sediment) and fish due to road culverts and crossings in Seiad Creek and Grider Creek.

6.1.3.6 Beaver Creek HSA

The Beaver Creek HSA is located between the confluence of Horse Creek and the Shasta River. Problems facing anadromous salmonids in this HSA include high sediment levels in Beaver Creek as a result of the extensive road systems in the watershed, lack of LWD needed for habitat complexity in Beaver Creek, and degraded riparian vegetation.

6.1.3.7 Hornbrook HSA

The Hornbrook HSA is located between the confluence of the Shasta River and the Confluence of Little Bogus Creek. Problems facing coho salmon include a major impoundment on Cottonwood Creek and summer diversions that dry some reaches. In addition, spawning gravels in Cottonwood Creek were depleted during the construction of Interstate 5.

6.1.3.8 Iron Gate HSA

The anadromous portion of the Iron Gate HSA is located between the confluence of Little Bogus Creek and the Iron Gate Dam. Problems facing coho salmon include water diversions, barriers to fish passage, and sedimentation on Bogus Creek.

6.1.3.9 Copco Lake HSA

The Copco Lake HSA is located upstream of Copco Lake and beyond anadromous waters. Therefore the problems facing coho salmon are the inability of migrating salmon to pass Iron Gate Dam.

6.1.4 SALMON RIVER HYDROLOGIC AREA

The Salmon River is located in remote northwestern California in the Klamath Mountains (Figure 6-5). It is a major tributary to the Klamath River and drains an area of 751 square miles. Elevations in the watershed range from about 500 to 9,000 feet above sea level. The area contains steep slopes along much of the river, and tributary streams flow through isolated remote canyons with moderate to high gradients. The riverbed is formed by bedrock and boulder controls, but some alluvial reaches contain gravel and cobble substrates. The headwaters originate in the pristine Marble Mountain, Russian, and Trinity Alps wilderness areas, administered by the Shasta-Trinity and Klamath National Forests. There are approximately 1,414 miles of streams within the watershed, of which 740 miles are perennial in nature. The Salmon River watershed contains one of the most species-diverse temperate forests in the world. There are fourteen different recognized wildlife habitat community types present in the watershed.

Nearly the entire Salmon River watershed is under Federal ownership and administered by the USFS. Management activities are strongly influenced by the Northwest Forest Plan with over 25% of the watershed identified as Late Successional Reserve. The Salmon River has been identified as a Key Watershed under the Klamath River Watershed Assessment.

Historically, coho salmon habitat was estimated to include 105 miles along the Salmon River and its tributaries (CDWR 1965). More recent estimates suggest that coho salmon have access to about 85 miles (CH2M HILL 1985) in this HA. DWR estimated historical coho salmon runs in the Salmon River at 2,000 fish (CDWR 1965). The Department's annual coho salmon spawning escapement estimate for the early 1960s was 800 fish (CDFG 1965). Between 1985 and 1991, the Department operated a weir in the Salmon River near its mouth and recorded a low of two coho salmon in 1985 and a high of 75 coho salmon in 1987.

Problems facing coho salmon in the Salmon River watershed include invasive exotic species, barriers to fish passage, depleted LWD, high sediment loads from the extensive road system, large wildfires, limited riparian function due to mine tailings, unscreened water diversions, and unstable spawning gravels.

6.1.4.1 Lower Salmon HSA

Problems facing coho salmon include excessive sediment from roads and landslides, streambed instability in Nordheimer Creek from aggradation during the flood of 1964, and habitat degradation in Crapo Creek and an upper reach of Nordheimer Creek caused by sediment input following forest fires.

6.1.4.2 Wooly Creek HSA

Wooly Creek is a designated wilderness and provides habitat conditions largely unaffected by human influence.

6.1.4.3 Sawyers Bar HSA

Problems facing coho salmon in the Sawyers Bar HSA include sediment input from roads, marginal summer water temperature resulting from the broad unvegetated flood plain and riparian areas, and waste discharge from mine tailings.

6.1.4.4 Cecilville HSA

Problems facing coho salmon in the Cecilville HSA include lack of deep pools for adult holding and juvenile rearing, marginal summer water temperature resulting from broad, unvegetated flood plain, impacts from past hydraulic mining, and lack of potential winter rearing habitat, particularly cover in slow velocity areas.

6.1.5 SHASTA VALLEY HYDROLOGIC AREA

The Shasta Valley HA is part of the Klamath River HU and consists of one HSA, the Shasta Valley HSA (Figure 6-6), which covers approximately 794.8 square miles.

The Shasta River originates in the higher elevations of the Eddy Mountains, southwest of the town of Weed in Siskiyou County, California. It flows approximately 50 miles in a northerly direction, passing through the Shasta Valley. After leaving the valley, it enters a steep-sided canyon where it flows for seven river miles before emptying into the Klamath River, 176.6 river miles upstream from the Pacific Ocean.

The river drains a portion of the Cascade Province to the east and a portion of the Klamath Province to the west. Numerous springs and a number of small tributaries enter the Shasta River as it passes through the Shasta Valley. Glacial melting from Mt. Shasta and precipitation provide the principle source of recharge for the river. Major tributaries include Parks Creek, Big Springs Creek, Little Shasta River, and Yreka Creek. The highest point in the watershed is Mt. Shasta at an elevation of over 14,000 feet. Where the Shasta River enters the Klamath River, the elevation is just over 2,500 feet.

Seventy-two percent of the watershed is in private ownership. Access to the river and its tributaries is limited to a few miles of the lower Shasta River still in public ownership, at public road crossings, and at locations where few landowners provide access. The portion (approximately three river miles) of the Shasta River that passes through Shasta Canyon is in BLM ownership. It is afforded protected status as an Area of Critical Environmental Concern.

One instream mining permit is located on the Shasta River. Agriculture, silviculture, and timber management are the most prominent land uses. Coho salmon runs in the Shasta Valley HA averaged little more than 1,000 fish annually in the late 1950s (CDFG 1959). In the early 1960s, the runs were estimated to average 600 fish (CDFG 1979). Current counts are lower than these earlier estimates.

Problems facing coho salmon in the Shasta River HSA include reduced summer flows, loss of channel maintenance flows, fish access limitations, high water temperatures, low levels of DO, elevated nutrient levels, turbidity, limitation on spawning gravel quantity, loss of spawning gravel quality, loss of riparian habitat, barriers to fish passage, unscreened water diversions, legal and illegal harvest, lack of funding for planning and studies necessary to precede restoration or fill data gaps, lack of on-the-ground access for studies, and dangerously low population numbers of coho salmon.

6.1.6 SCOTT RIVER HYDROLOGIC AREA

The Scott River is one of four major tributaries of the Klamath River, entering the Klamath at river mile (RM) 143 at an elevation of 1,580 feet (Figure 6-7). The Scott River HA includes two HSAs, the Scott Valley HSA and the Scott Bar HSA. The Scott River watershed is a large area

FIGURE 6-5: Salmon River Hydrologic Area

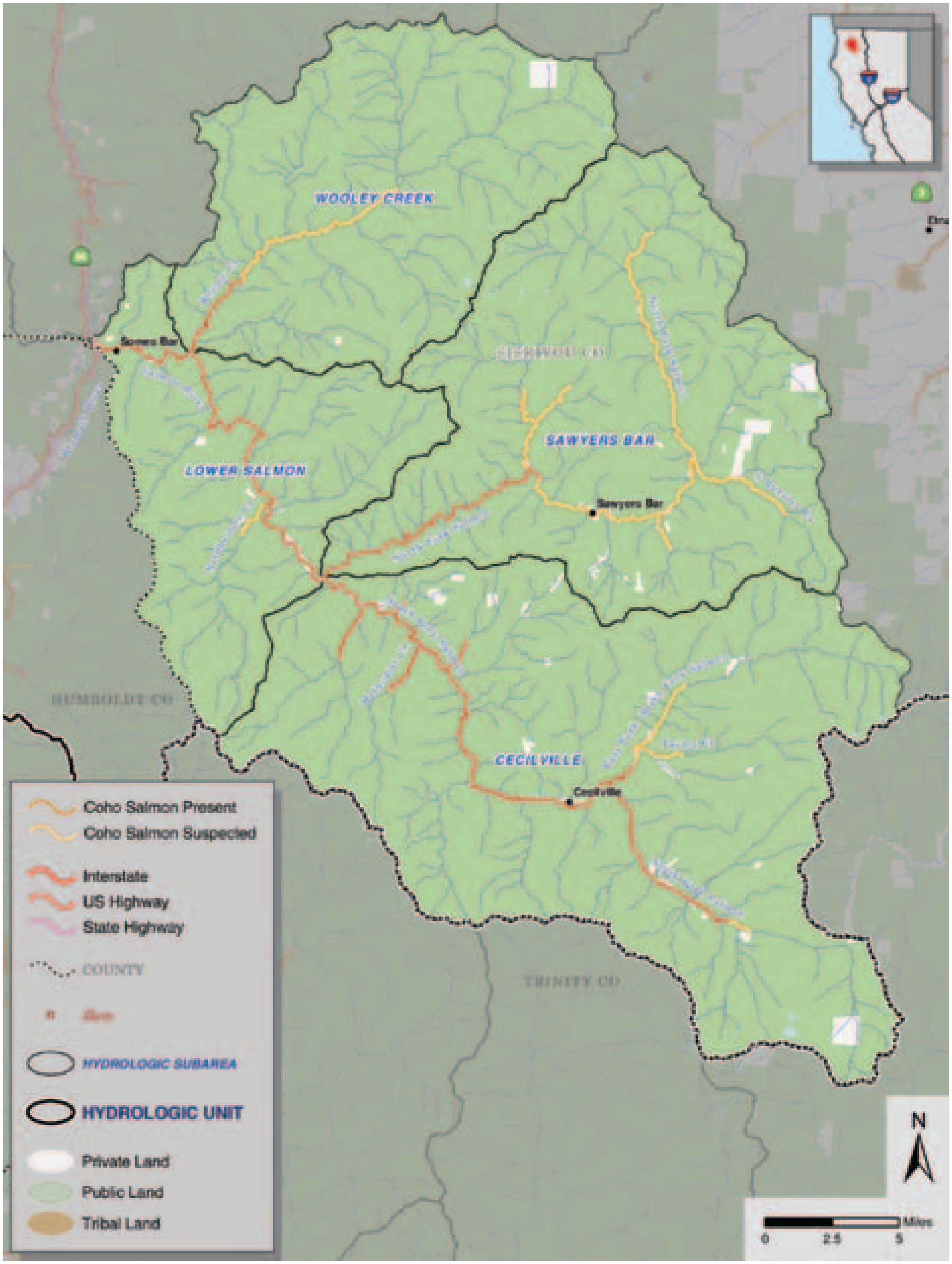
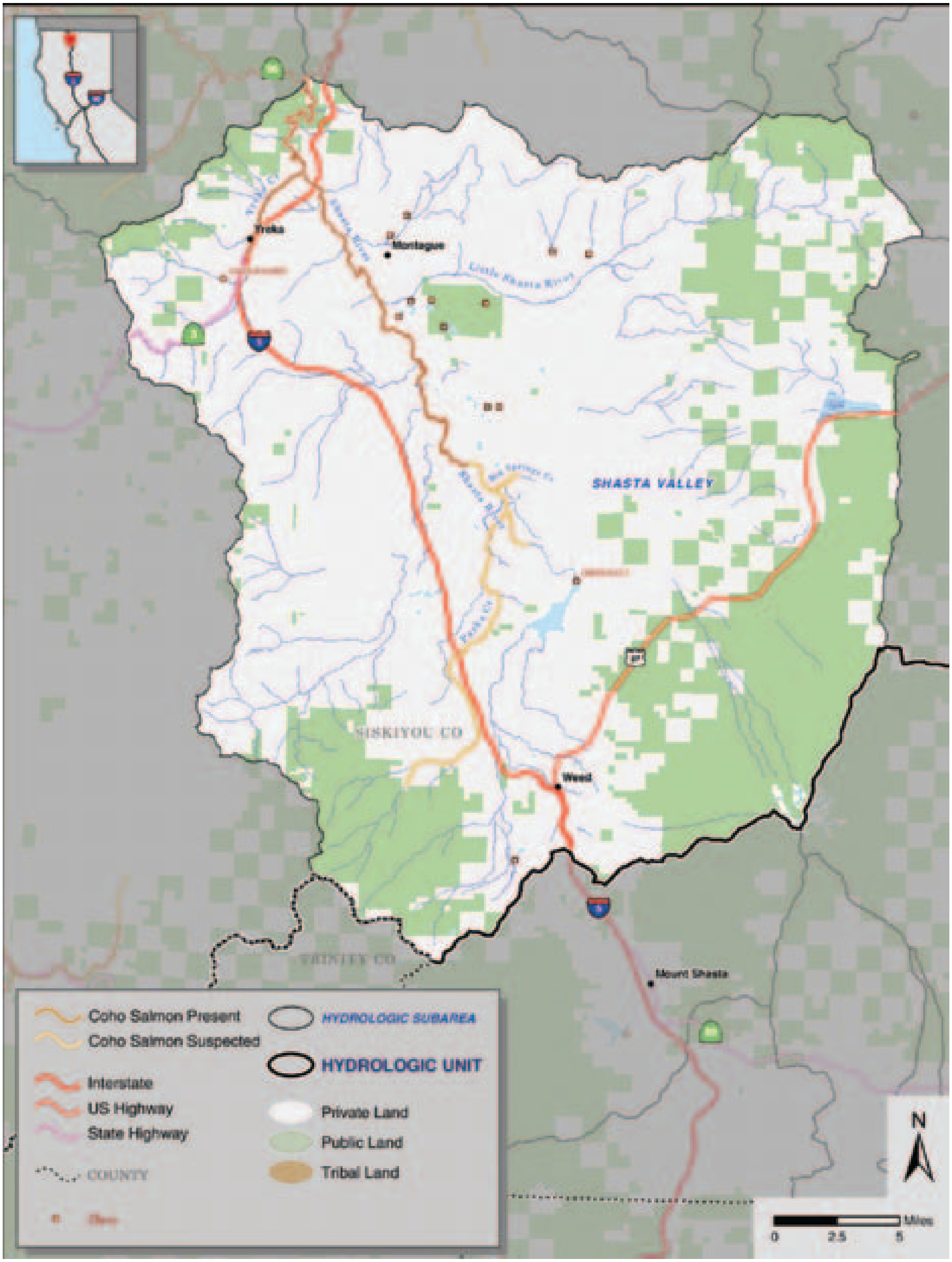


FIGURE 6-6: Shasta Valley Hydrologic Area



with substantial variation in geology, geomorphology, and climate. The watershed drains approximately 813.5 square miles. Major tributaries to the 58-mile-long Scott River are Shackleford/Mill, Kidder, Etna, French, and Moffett creeks and the South and East Forks Scott River. Native vegetation consists of mixed-conifer forest on the western mountain slopes, with scattered meadows and brush, while extensive areas of brush, oaks, western juniper, and annual grasses cover the eastern mountains. The Scott River is part of the Klamath Mountain Province, which encompasses land in both Oregon and California.

The Klamath National Forest manages approximately 35% of the total Scott River watershed area. The remaining 65% is under other public management or private ownership. The mainstem in Scott Valley is predominantly surrounded by irrigated farmland (50 square miles) and rangeland (80 square miles) comprising 16% of the watershed. Remaining areas are predominantly privately owned and Federally managed timberlands.

The Department estimated that during the early 1960s, the Scott River's population of coho salmon was about 800 fish (CDFG 1965).

Problems facing coho salmon in the Scott Valley HSA include reduced stream flows caused by drought and exacerbated by human activities; high water temperatures; limited rearing areas during spring, summer, and fall; restricted access to spawning habitat in extreme drought years; increased disconnect between tributaries and mainstem starting in early July; stranding of juveniles; lack of sufficient summering habitat in tributaries; sedimentation of rearing pools and spawning gravels as a result of the cumulative effects of upslope land management; lack of riparian cover in some tributary reaches; and lack of instream structure for coho salmon rearing.

6.1.7 TRINITY RIVER HYDROLOGIC UNIT

The Trinity River is the largest tributary to the Klamath River, draining approximately 2,037.8 square miles in Humboldt and Trinity counties (Figure 6-8). The headwater streams originate in the pristine wilderness of the Trinity Alps and Trinity Mountains located in eastern Trinity County. From its headwaters, the river flows 172 miles south and west through Trinity County, then north through Humboldt County and the Hoopa Valley and Yurok reservations until it joins the Klamath River at Weitchpec, about 40 river miles from the Pacific Ocean. Anadromous fish passage is blocked by Lewiston Dam approximately RM 112, upstream from the mouth of the Trinity River.

Most of the Trinity River watershed is in public ownership (69% of the land is managed for public multiple uses, 7% as protected lands). Only 24% of the watershed is in private ownership. Two tribes, the Hoopa Valley and Yurok, have reservations located all, or in part, within the Trinity River basin. Both of theses tribes have, and continue to, subsist on anadromous fish runs. Much of their culture is derived from resources found within the basin.

Historically, gold mining was an important economic activity, and today the watershed supports limited suction dredging. A few in-stream mining permits are located on the Trinity River. Commercial timber harvest supports the largest industry within the watershed. The Trinity River supports many recreational uses including fishing, white-water rafting, swimming, sightseeing, birding, and camping. The smaller communities located along the river cater to, and depend on, these activities. Approximately 70% of the Trinity's flow at Lewiston (RM 112) is diverted to the Central Valley Project. This diversion is also used to generate electrical power at several dams, including Lewiston, along its course.

Estimates of coho salmon run-size, spawner escapement and angler harvest have been conducted in the Trinity River since 1977. Estimates are generated using mark-recapture methods. Fish are trapped and tagged at a mainstem trapping weir near the town of Willow Creek

(RM 30). Recoveries occur at Trinity River Hatchery (TRH), the upper-most point of migration. Mean run-size (grilse and adults combined) between 1977 and 1999 was 15,959 coho salmon.

Problems facing coho salmon in the Trinity River HU include degradation of spawning and winter rearing habitat due to sedimentation and past land-use practices, sparse spawning gravel recruitment, high summer water temperatures due to diversion of natural flow of Lewiston Dam, lack of deep pools, water diversions, irregular timing of flows, fragmentation of populations, possible genetic swamping from presumably inferior hatchery strains, migration barriers, water quality problems and unscreened diversions.

6.1.7.1 Douglas City HSA

The Douglas City HSA includes the mainstem of the Trinity River and its tributaries from Browns Creek upstream to Lewiston Dam. Problems facing coho salmon in the Douglas City HSA include unscreened water diversions, barriers to fish passage, reduced riparian function due to agricultural and grazing impacts, and sedimentation from near-stream roads.

6.1.7.2 Grouse Creek HSA

The Grouse Creek HSA includes the South Fork of the Trinity River and its tributaries from the confluence with the Trinity River mainstem up stream to Eltapom Creek. Problems facing coho salmon in the Grouse Creek HSA include impacts from past mining and impacts associated with a large network of forest roads.

6.1.7.3 Hyampom HSA

The Hyampom HSA includes the South Fork of the Trinity River and its tributaries from Eltapom Creek up stream to Hayfork Creek. Historical data show that the South Fork Trinity River and its larger tributaries were once important spawning grounds for coho salmon. The frequency and size of coho salmon runs in the South Fork are not well documented, though they have been reported to migrate as far upstream as Hyampom.

Problems facing coho salmon in the Hyampom HSA include sediment load, unstable stream banks, migration barriers, low flows, lack of pools and cover resulting from large-scale water diversions and other land-use practices, lack of high quality rearing habitat, and a substantial change in channel morphology.

6.1.7.4 Hayfork HSA

The Hayfork Valley HSA includes Hayfork Creek upstream of Little Creek. Coho salmon are thought to have been extirpated in this HSA.

Problems in the Hayfork Valley HSA include mass wasting, erosion caused by fire, excessive stored sediment, migration barriers, low flows, lack of pools and cover due to large-scale water diversions, water pollution, and lack of high quality rearing habitat.

6.1.8 MAD RIVER HYDROLOGIC UNIT

The Mad River HU drains an area of approximately 496.9 square miles (Figure 6-9). The Mad River basin is divided into four hydrologic subareas: Blue Lake HSA, including the estuary; North Fork HSA covering the North Fork Mad River; Butler Valley HSA for the midsection of the mainstem Mad River; and Ruth HSA, for the upper Mad River.

BLM and the USFS manage 39% of the watershed. The remaining 61% is in private ownership with two timber companies owning about half of the privately owned land. Gravel mining operations are located on the lower Mad River near the coastal plain.

There has been an estimated decline in Mad River coho salmon populations of at least 70% over the last 40 years. Returns of adult coho salmon at the Mad River Hatchery indicate a

FIGURE 6-7: Scott River Hydrologic Area

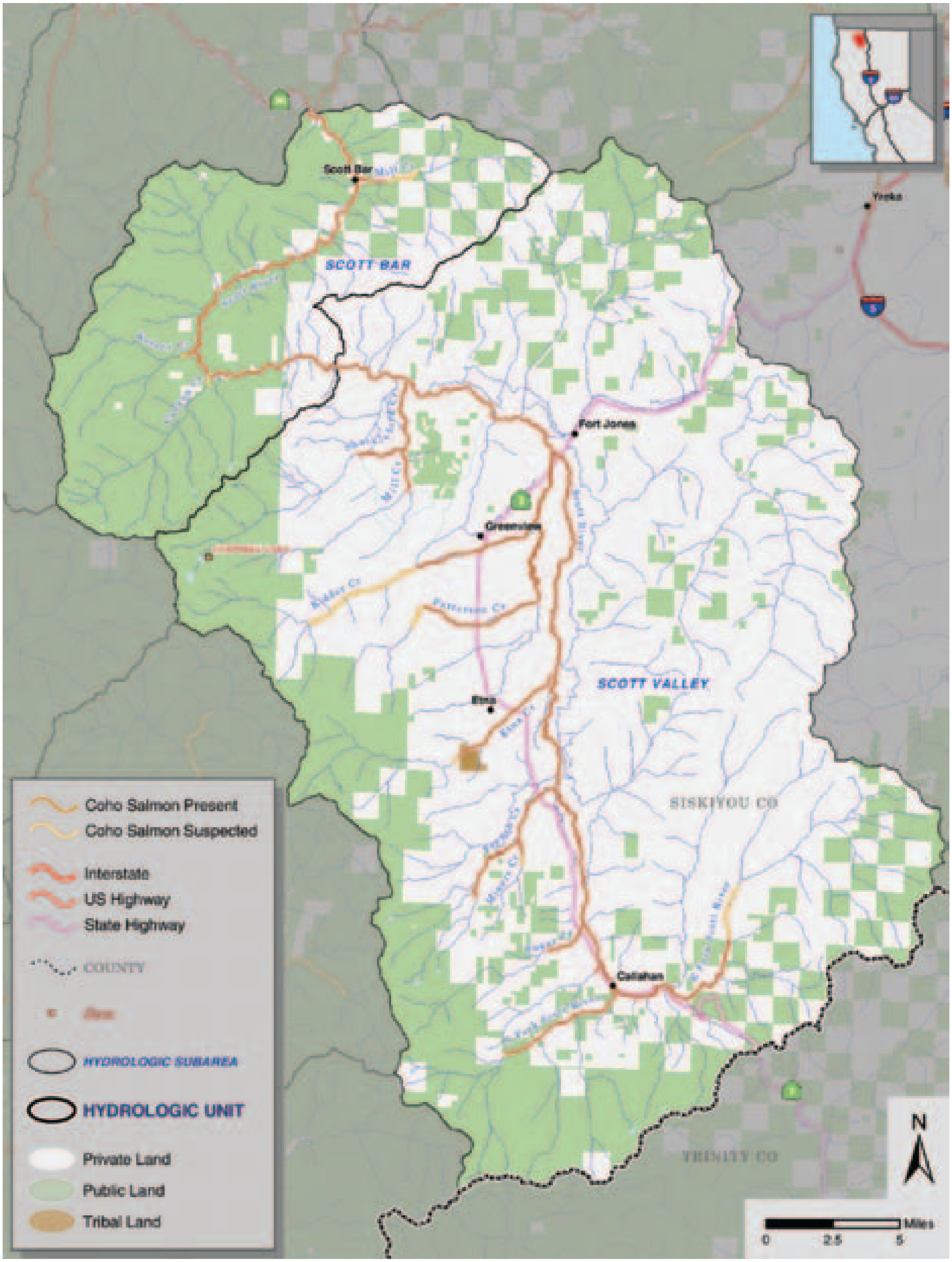
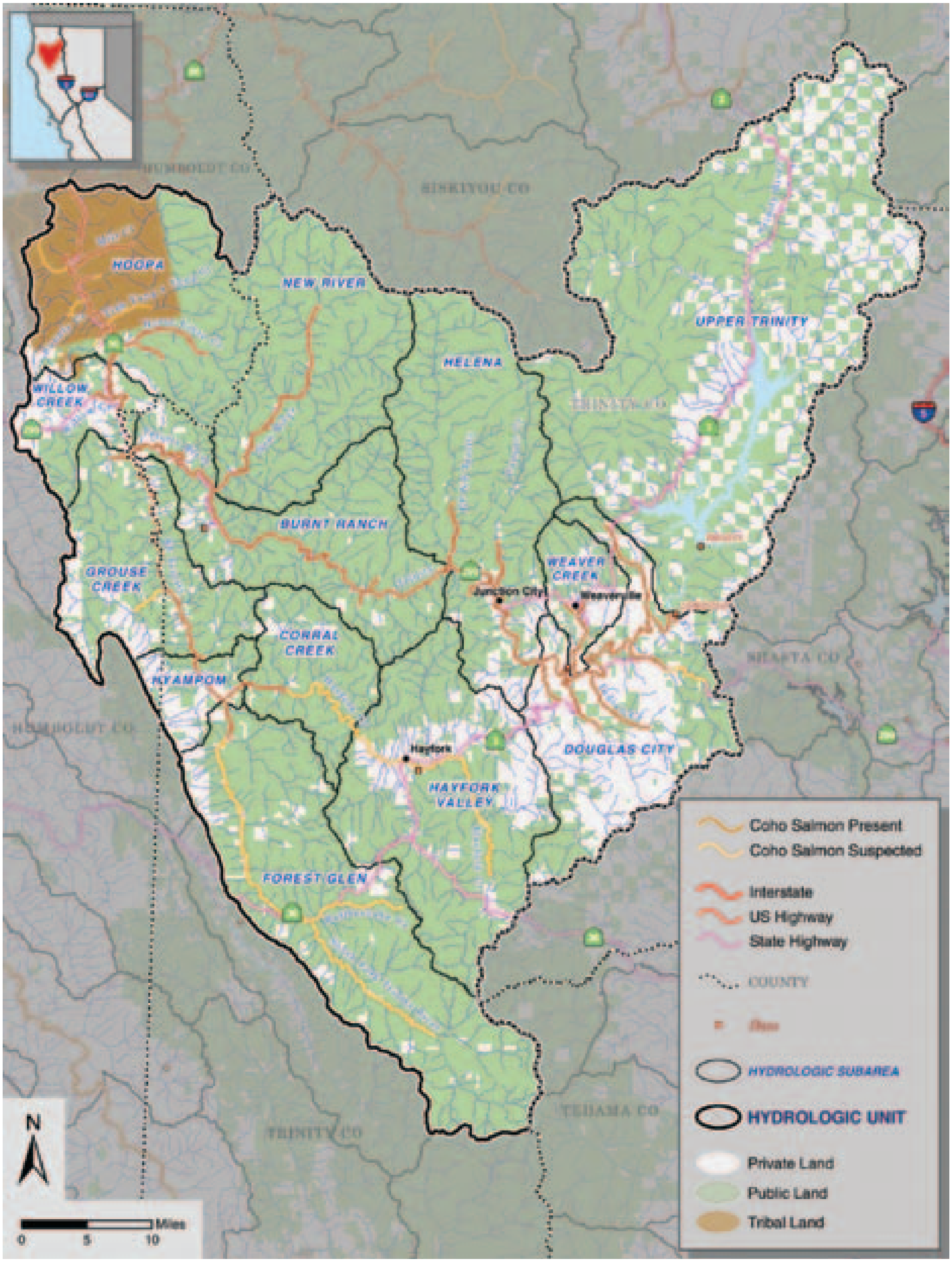


FIGURE 6-8: Trinity River Hydrologic Unit



decline in recent years. Important tributaries to the Mad River that support annual runs of coho salmon include Lindsay Creek in the Blue Lake HSA and Cañon Creek in the Butler Valley HSA. Juvenile coho salmon numbers in Cañon Creek have been highly variable in the recent years. Coho salmon do not appear to have been historically present in the Ruth HSA.

The Mad River is listed under the CWA §303(d) as impaired for sediment, turbidity, and temperature. Problems for coho salmon recovery in the Mad River basin include reduction in habitat diversity by aggradation and lack of conifer LWD, high fine sediment loading (in part from high road concentration in watershed), and high water temperatures throughout the basin.

6.1.9 REDWOOD CREEK HYDROLOGIC UNIT

The Redwood Creek HU (Figure 6-10) covers an area of approximately 282 square miles. The HU is divided into three HSAs: Orick, encompassing the estuary and lower Redwood Creek; Beaver, encompassing middle Redwood Creek from above Devil's Creek to Lupton Creek; and Lake Prairie, encompassing upper Redwood Creek.

The North Coast Watershed Assessment Program completed a basin-wide assessment for Redwood Creek (NCWAP; Henly et al. 2002). The primary private land use in the Redwood Creek HU is timber production, especially in the middle and upper subbasins. In addition, livestock grazing occurs on some private lands. Much of the lower basin is public parkland, managed for protection and restoration of the old-growth redwood forest ecosystem.

Coho salmon principally inhabit the Prairie Creek watershed and tributaries of Redwood Creek located in the Orick HSA. The numbers of coho salmon in the Prairie Creek watershed had been supplemented with hatchery fish until 1992. Five other tributaries with coho salmon present include Elam, Tom McDonald, Bridge, Emerald (a.k.a. Harry Weir) and MacArthur creeks, all within the boundaries of Redwood National Park and Redwood State Park. The historic coho salmon range includes Coyote, Panther, Lacks, Minor, Karen, Strawberry, and Pilchuck creeks in the Beaver Creek HSA, and possibly some of the tributaries in the Lake Prairie HSA (Anderson 1988; Brown 1988; Neillands 1990; PCFWWRA 1995; Department 2001 surveys; and RNSP unpublished data). Historic presence of coho salmon juveniles has also been noted in the mainstem of Redwood Creek.

Electro-fishing conducted in the summer of 2001 did not produce any coho salmon in Bridge, Coyote, Karen, and Pilchuck creeks, nor in any other tributaries in the middle or upper portions of the basin that were sampled. In addition, no coho salmon were captured from the upper one third of the Redwood Creek watershed during a downstream migrant study conducted for the years 2000, 2001, or 2002 (Sparkman 2001 and pers. comm. 2002).

Redwood Creek is listed under CWA §303(d) as impaired for sediment and temperature. Potential problems for coho salmon recovery in the Redwood Creek basin include loss of critical habitat and periodic high temperatures in the estuary, elevated water temperatures in the mainstem and in tributaries due to lack of adequate canopy cover, reduction in habitat diversity by channel aggradation and lack of LWD, high fine sediment loading, and high turbidity levels (in part from high road concentration in watershed). The remaining structure of a small dam that was associated with the former Prairie Creek Hatchery acts as a partial fish barrier at certain flows on Lost Man Creek within the Orick HSA.

6.1.10 TRINIDAD HYDROLOGIC UNIT

The Trinidad HU (Figure 6-10) includes Freshwater, Big, Dry, and Stone coastal lagoons and their tributaries, the Little River drainage, and coastal streams from Strawberry Creek north to Freshwater Lagoon. These drainages extend ten miles inland and crest at an elevation of 2,800 feet at the divide with Redwood Creek. This HU is entirely within the zone of summer fog intrusion, and so, the vegetation reflects the strong coastal influence. Timber production is the main land use in the HU.

Coho salmon have historically occurred in Stone Lagoon, Big Lagoon and their major tributaries as well as Little River and its tributaries and Strawberry Creek. The presence of coho salmon and other anadromous salmonids in coastal lagoon streams depends on the winter timing of lagoon sand bar breaches. In some years flows are not sufficient to breach the sand bars and salmon are prevented from entering their natal streams.

Problems for coho salmon recovery in the Trinidad HU include high levels of instream fine sediment, stream channel aggradation, lack of instream LWD, insufficient levels of recruitable conifer LWD, poor estuary conditions (especially sedimentation), and existence of barriers to anadromy.

6.1.10.1 Big Lagoon HSA

The largest stream of the Big Lagoon HSA is Maple Creek. Coho salmon have been found in lower Maple Creek in years when the sand bar at Big Lagoon is open. Past impacts to the Maple Creek watershed include intensive logging from the 1940s through the 1960s and a large fire in 1945. The effects of historic removal of riparian overstory can still be observed in the dominance of alder canopy in several reaches.

6.1.10.2 Little River HSA

The drainage beyond the estuary is under the ownership of Simpson Resource Company and is undergoing second growth timber harvest through even-aged management practices. Although the current coho salmon population in the Little River drainage is depressed compared to historic estimates, numbers are believed to have been relatively stable over the last decade.

Sand bars rarely, if ever, close the mouth of Little River in the summer. While surveys indicate regular use of the Little River estuary by juvenile salmonids, habitat conditions are those of a heavily modified system. Most of the lower river channel in the estuary is confined between low levees and simplified to accommodate adjacent agricultural activities. The canopy, where present in this lower riparian zone, consists of a narrow strip of willows and some alders.

6.1.11 EUREKA PLAIN HYDROLOGIC UNIT

The Eureka Plain watershed (Figure 6-11), 275 miles north of San Francisco, contains a rare combination of natural and social attributes. Within the basin are the ancient redwoods of the Headwaters Forest, highly productive industrial timberlands, prime agricultural lands, functioning streams and wetlands, all of which are connected to the bay, its eel grass beds, and tidal marshlands. These natural features support some of the best remaining wild salmon runs in northern California, hundreds of aquatic organisms, shorebirds, and waterfowl species, in the midst of several urban and rural communities. At least two-thirds of the total watershed is steep and heavily forested, and is primarily owned by commercial timber companies.

Humboldt Bay is the largest estuary between San Francisco and Coos Bay, Oregon. The watershed is 223 square miles in size. Humboldt Bay, classified as a multi-watershed coastal lagoon, is separated from the ocean by long narrow sand spits and has a centrally channelized mouth to the Pacific Ocean. All of the main streams of the Eureka Plain watershed that flow into Humboldt Bay support wild populations of salmon, steelhead trout, and cutthroat trout.

A number of impairments to salmonid habitat exist in the Humboldt Bay watershed. Identified impairments include high instream sediment levels, stream channel aggradation and widening, lack of stream habitat structure (i.e., deep pools), high water temperatures, and loss of functioning estuary habitat. Observers have seen changes in the occurrence and magnitude of flooding and in the fish-community structure, such as avoidance of degraded tribu-

FIGURE 6-9: Mad River Hydrologic Unit

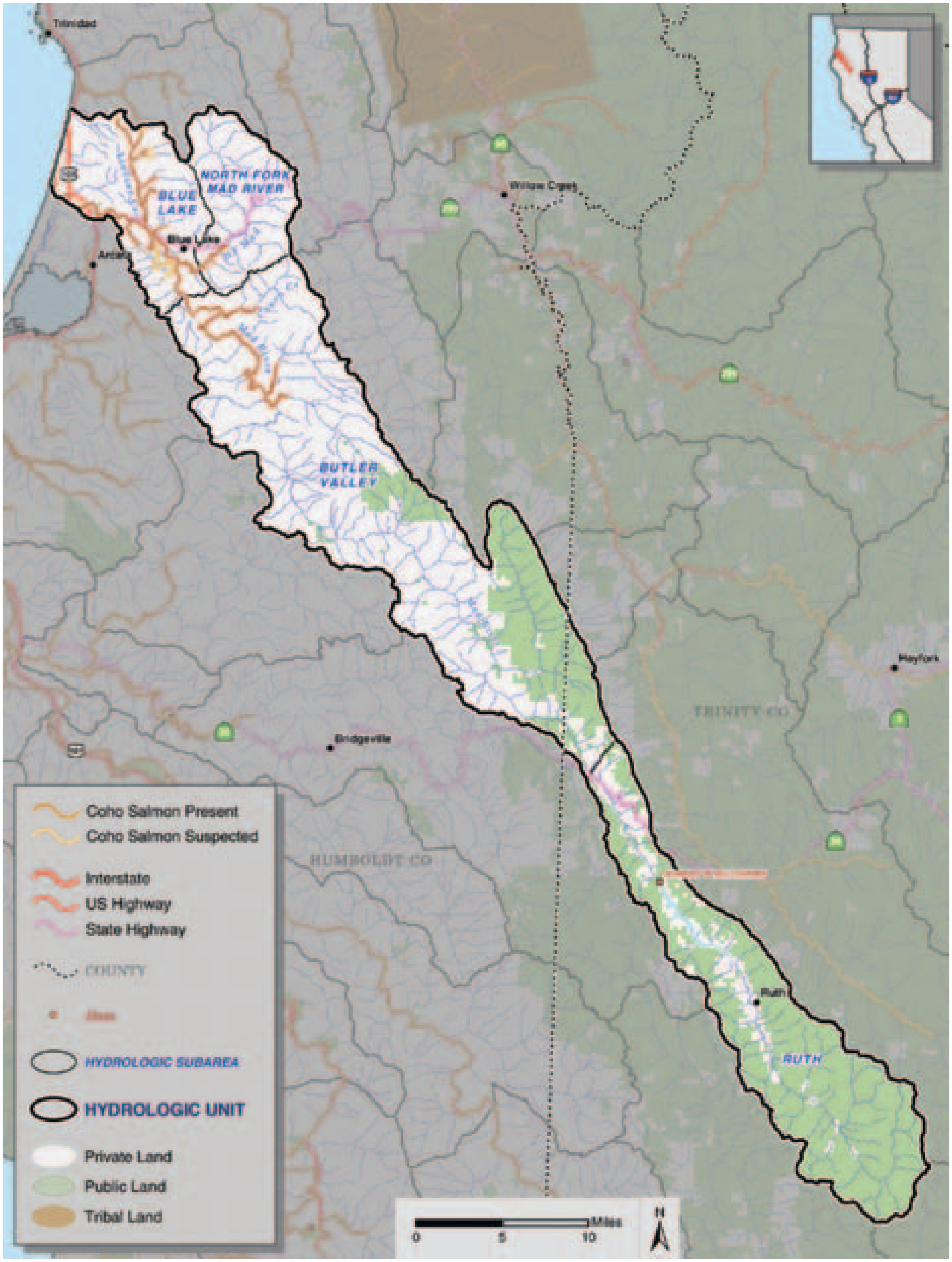
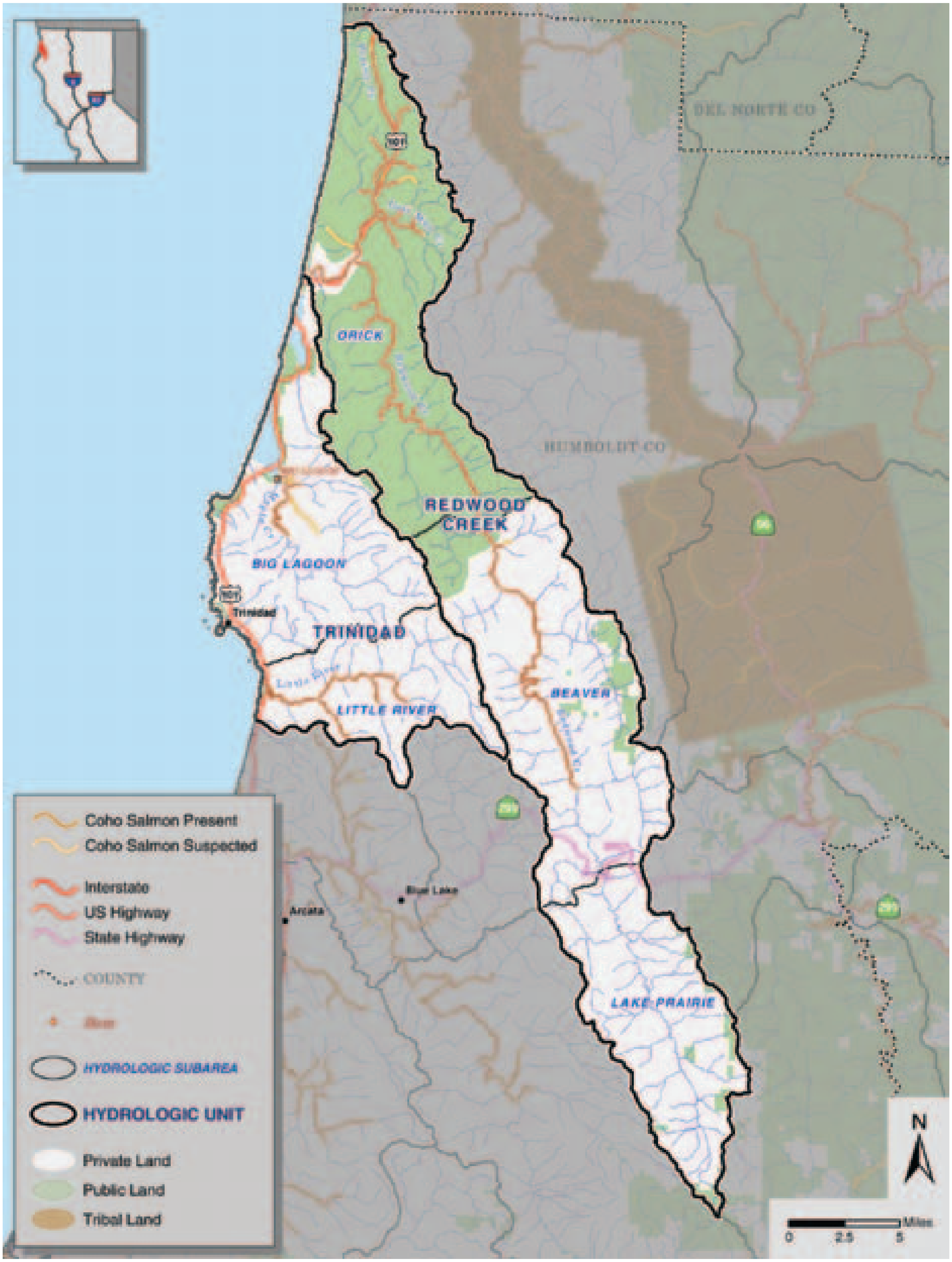


FIGURE 6-10: Redwood Creek and Trinidad Hydrologic Units



taries by spawning adults. Simplification of the stream channels has decreased the quantity and quality of aquatic habitat. Human made obstructions to upstream and downstream migration frequently restrict access of adult and juvenile salmonids to spawning and rearing habitat. Culverts and tide gates have been identified as fish passage barriers.

6.1.12 EEL RIVER HYDROLOGIC UNIT

The Eel River is the third largest river system in California, encompassing approximately 3,684 square miles within Humboldt, Mendocino, Trinity and Lake counties, and small portions of Colusa and Glenn counties (Figure 6-12). There are approximately 3,488 miles of streams within the Eel River watershed that contribute to a mean annual discharge of approximately six million acre-feet. Major subbasins of the Eel River system include the mainstem (1,477 square miles), North Fork (283 square miles), Middle Fork (753 square miles), South Fork (690 square miles), Van Duzen (428 square miles), and the estuary and delta (50 square miles). Other major tributaries include Kekawaka, Outlet, Tomki, Dobbyns, and Larabee creeks.

Principal features of the Eel River watershed are the rugged northwest-southeast trending ridges and canyons. The headwater peaks in the watershed are at elevations of 7,581 feet on Soloman Peak in Trinity County, 7,056 feet on Snow Mountain in Lake County, and 6,739 feet on Bald Mountain in Mendocino County. Three relatively flat valleys (Laytonville, Willits, and Round Valley) are located in the mountainous watershed. Lake Pillsbury is located on the mainstem, approximately 150 miles from the mouth and is 1,818 feet above sea level. Nearly flat alluvial valleys and tidal plains characterize the coastal area. Waters from the Eel River flow through its estuary to the Pacific Ocean approximately 14 miles south of the city of Eureka in Humboldt County.

The majority of the Eel River watershed is rural, with a number of small towns scattered throughout the watershed. Eighty-six percent of the Eel River watershed is held in private ownership. Significant land uses in the watershed are timber harvest, grazing, agriculture, in-channel gravel mining, recreation, and most recently, subdivision and residential development. There are 16 segments of the Eel River that are designated *wild, scenic,* or *recreational* in accordance with the Wild and Scenic Rivers Act.

Records indicate coho salmon were more widespread in the Eel River basin in the past. Coho salmon were once present in the North Fork Eel River and its tributary Bluff Creek. They were also present in the Middle Fork Eel River and its tributaries Rattlesnake, Mill, Grist, and Rock creeks (CDFG 1994). Coho salmon in the North Fork and Middle Fork Eel are believed to have been extirpated (Brown and Moyle 1991; CDFG 1994). Coho salmon were noticeably absent during recent surveys of many of the tributaries to the Van Duzen River, in contrast to past surveys conducted in those same streams. Similarly, recent surveys failed to find coho salmon in many of the smaller tributaries to the Eel River where coho salmon had been reported historically. Although coho salmon were recently confirmed in many of the South Fork Eel River tributaries, there were nearly as many streams in which coho salmon were not observed.

Problems facing coho salmon in the Eel River HU include potential impacts from approximately 10,000 miles of roads. Instream mining operations are located at number of sites in the watershed. Hydroelectric power production and water diversions also have a major impact. Scott Dam, built in 1921, is a barrier for all salmonids to the upper 29 miles of the mainstem Eel River and its tributaries. Cape Horn Dam, with a 9,258-foot-long upstream tunnel, is 12 miles below Scott Dam. It was built in 1908. An annual average of 160,000 acre-feet annually has been diverted to the Russian River drainage. Artificial fish passage barriers exist at some road crossings of streams. High summer water temperatures are common in the mainstem and many of the tributaries. The most recent stream habitat surveys conducted by the Department indicate that many of the tributary streams have low stream-habitat diversity and complexity, are lacking stream shade canopy cover, and are devoid of LWD recruitment. Predation by non-native fish such as the Sacramento pikeminnow may have a major impact on salmonids. The pikeminnow has displaced salmonids in summer rearing streams.

6.1.12.1 Ferndale HSA

The Ferndale HSA begins at the river mouth and extends upstream about 20 miles to the town of Rio Dell. This HSA includes the mainstem of the Eel River from the mouth up stream to Scotia. The area includes the communities of Ferndale, Fernbridge, Loleta, Fortuna, Alton, and Rio Dell. Major land uses include dairy ranches, timber, cattle ranches, gravel mining, and residential development. Much of the land is in private ownership with numerous family owned and operated ranches.

Problems facing coho salmon in the Ferndale HSA include sedimentation in the estuary, an increase in the average water temperature, decreased DO and fewer food organisms. In addition, runoff water carrying nutrients from animal waste to the estuary degrades water quality by encouraging the growth of algae, which further reduces the DO levels in the estuary.

6.1.12.2 Scotia HSA

The Scotia HSA includes tributaries to the Eel River from the town of Scotia to Dyerville where the South Fork Eel River enters the mainstem Eel River. This HSA is sparsely populated, although it contains several small towns including Pepperwood, Holmes, Shively and Redcrest. Small farming operations exist in the Eel River flood plain of these communities. Much of this HSA is owned by the Pacific Lumber Company and is managed for timber production under the conditions of their habitat conservation plan. The Scotia HSA also includes streams managed by Humboldt Redwoods State Park.

Problems facing coho salmon in the Scotia HSA include above optimum summer water temperatures, quantity and quality of pools, limited escape cover, sedimentation resulting from stream-bank failure and the road system, limited shade canopy, spawning gravel deficient in quality and/or quantity, large debris accumulations retaining large amounts of gravel that may need modification, grazing in riparian areas, and barriers to fish migration.

6.1.12.3 South Fork Eel River HA

The South Fork Eel River HA includes the Weott, Benbow, and Laytonville HSAs.

6.1.12.4 Weott HSA

The Weott HSA includes the lower reaches of the South Fork Eel River and its tributaries. Problems facing coho salmon in the Weott HSA include above optimum summer water temperatures, quantity and quality of pools, limited escape cover, sedimentation resulting from stream-bank failure and the road system, limited shade canopy, spawning gravel deficient in quality and/or quantity, large debris accumulations retaining large amounts of gravel that may need modification, grazing in riparian areas, and barriers to fish migration.

6.1.12.5 Benbow HSA

The Benbow HSA includes the middle reaches of the South Fork Eel River and its tributaries. Problems facing coho salmon in the Benbow HSA include above optimum summer water temperatures, quantity and quality of pools, limited escape cover, sedimentation resulting from stream-bank failure and the road system, limited shade canopy, spawning gravel deficient in quality and/or quantity, large debris accumulations retaining large amounts of gravel that may need modification, grazing in riparian areas, and barriers to fish migration.

FIGURE 6-11: Eureka Plain Hydrologic Unit

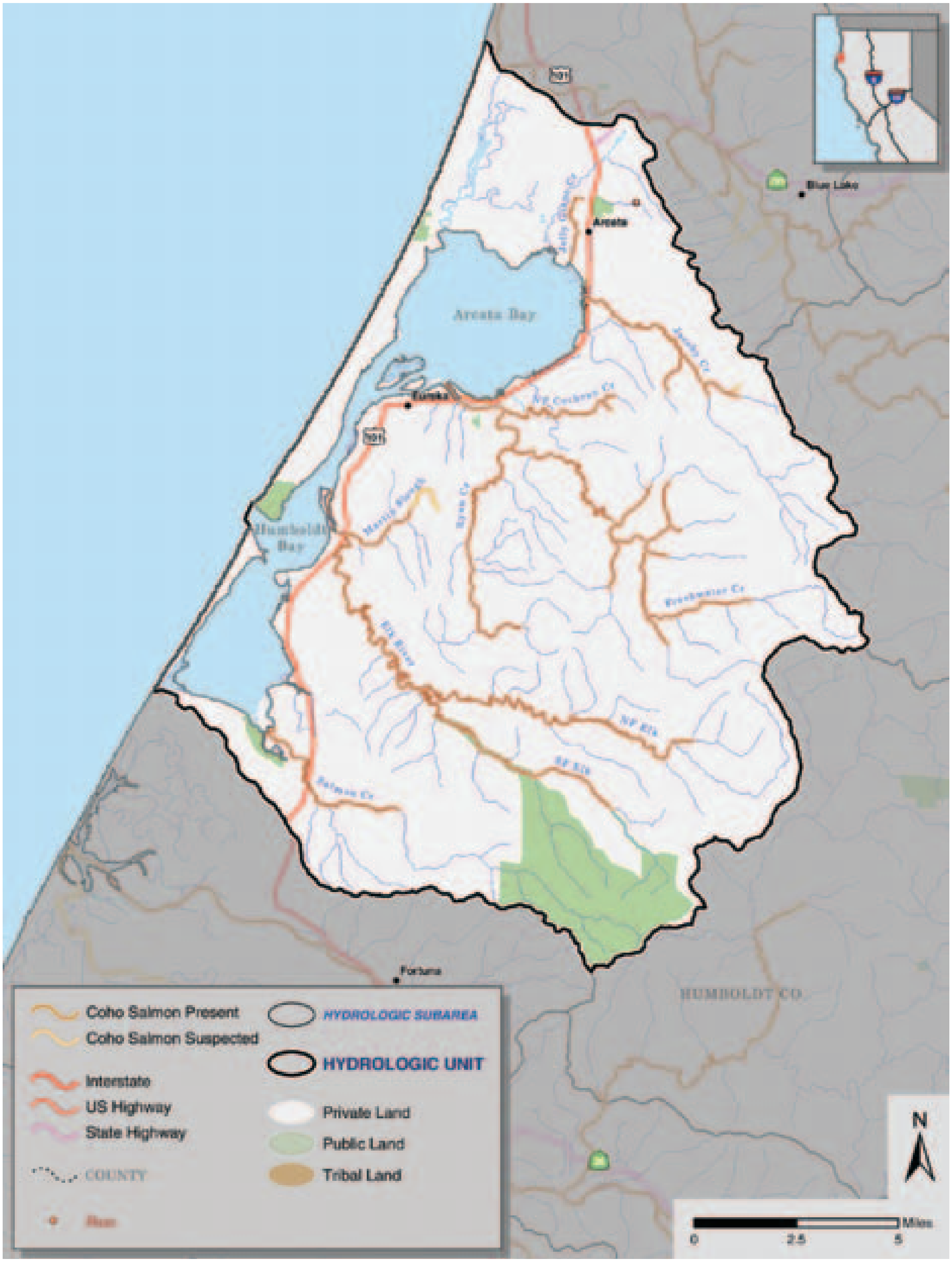


FIGURE 6-12: Eel River Hydrologic Unit

6.1.12.6 Laytonville HSA

The Laytonville HSA includes the upper reaches of the South Fork Eel River and its tributaries. The upper South Fork is primarily redwood forest and has good populations of coho salmon. The Ten Mile Creek watershed is in mixed conifer forest and rangeland managed for cattle production. Coho salmon are found in Ten Mile Creek and many of its tributaries.

Problems facing coho salmon in the Laytonville HSA include above optimum summer water temperatures, quantity and quality of pools, limited escape cover, sedimentation resulting from stream-bank failure and the road system, limited shade canopy, spawning gravel deficient in quality and/or quantity, large debris accumulations retaining large amounts of gravel that may need modification, grazing in riparian areas, and barriers to fish migration.

6.1.12.7 Outlet Creek HSA

Outlet Creek HSA includes the Outlet Creek watershed, a tributary to the upper mainstem of the Eel River. One of the longest migrating populations of coho salmon in California is found in the upper tributaries of Outlet Creek. Coho salmon have recently been observed in the tributaries to Little Lake Valley including Ryan, Willits, Baechtel, Broaddus, and Mill creeks. Many of these tributaries run through the City of Willits.

Problems facing coho salmon in the Outlet Creek HSA include above optimum summer water temperatures, quantity and quality of pools, limited escape cover, sedimentation resulting from stream-bank failure and the road system, limited shade canopy, spawning gravel deficient in quality and/or quantity, large debris accumulations retaining large amounts of gravel that may need modification, grazing in riparian areas, and barriers to fish migration. During 2003 surveys in Outlet Creek, no coho salmon were observed

6.1.13 CAPE MENDOCINO HYDROLOGIC UNIT

The Cape Mendocino HU (Figure 6-13) encompasses approximately 387 square miles of the northern California Coast Range and includes three watersheds: the Mattole River in the Mattole River HSA, Bear River in the Capetown HSA, and Oil Creek in the Oil Creek HSA.

The information regarding land use and coho salmon presence for the Mattole River HSA is presented in section 6.1.13.1 below. The Bear River and Oil Creek watersheds are entirely privately owned and are managed for timber production and rangeland. In 1996 and 2000, the Department surveyed most tributaries to Bear River. These surveys have documented suitable coho salmon habitat within several portions of the Bear River including portions of the South Fork Bear River, but presence of coho salmon has not been documented. The Department documented the presence of steelhead and Chinook salmon in the Bear River watershed as recently as June 13, 2001. There was one record of a young-of-the-year coho salmon in Oil Creek in 1994 (D. Halligan pers. comm.), but the drainage has not been surveyed regularly.

Problems for coho salmon recovery in the Cape Mendocino HU are deleterious summer water temperatures; high levels of fine sediment; and lack of deep pools, cover, other elements of habitat complexity, and suitable spawning gravels.

A small portion of the Mattole River's southern-most headwaters originates in Mendocino County, but the vast majority of the basin is within Humboldt County. The mainstem Mattole is approximately 62 miles long, and receives water from over 74 tributary streams. There are over 600 perennial stream miles in these watersheds.

Land uses in the Mattole River HSA include timber production, ranching, crop farming, and residential subdivision. Human activities such as road construction, grazing of livestock, and timber management, have interacted with natural geologic instability and sediment production, and major storm events (e.g., the 1964 flood) to impact aquatic habitats. Disturbances from an increasing human population include water diversions, conversion of near-stream areas to residential usage, removal of mature vegetation, widespread soil disturbance, construction of levees or armored banks, and the installation of dams and reservoirs that disrupt normal flow regimes and prevent free movement of salmonids and other fish.

NCWAP completed a basin-wide assessment for the Mattole River that divided the watershed into five subbasins: northern, eastern, southern, western and the estuary (Downie et al. 2002). For the sake of consistency, this Recovery Strategy uses the same organization.

6.1.13.1 Northern Subbasin of the Mattole River HSA

The *northern subbasin* of the Mattole River is located between the estuary and Honeydew Creek (RM 26.5) along the northeastern side of the Mattole mainstem. Eighteen perennial streams drain a watershed area of 98 square miles. The watershed is largely managed for timber production and cattle ranching. The town of Petrolia is located in this subbasin at the confluence of the North Fork Mattole River and the Mattole River. Several back-to-land homesteads are located near Petrolia. Controversies concerning old-growth timber harvest issues are focused on Rainbow and Long ridges in this subbasin. The Northern Subbasin appears to be the most impacted of the Mattole subbasins from a combination of land uses and naturally occurring geological processes. Although historical accounts indicate stream conditions were favorable for salmonid populations in the past, coho salmon were not found in the eight tributaries surveyed by the Department in 2001 or 2002.

6.1.13.2 Eastern Subbasin of the Mattole River HSA

The *eastern subbasin* of the Mattole River is located between Honeydew Creek (RM 26.5) and Bridge Creek (RM 52.1) along the eastern side of Wilder Ridge, and the Mattole mainstem above Bear Creek, for a distance of about 25.6 river miles. The watershed is largely managed for timber production and cattle ranching. Recent stream surveys indicate the presence of coho salmon in a few tributaries and steelhead throughout the eastern subbasin.

6.1.13.3 Southern Subbasin of the Mattole River HSA

The *southern subbasin* of the Mattole River is located south of Bridge Creek (RM 52.1) and McKee Creek (RM 52.8), near Thorn Junction, and continues upstream to the Mattole headwaters near Four Corners (RM 61.5), a distance along the mainstem Mattole of about 9.4 river miles. Much of the subbasin is subdivided into small parcels of rural development or managed for timber production. Domestic and agricultural water consumption has contributed to reduced summer flows. Recent stream surveys indicate the presence of coho salmon and steelhead trout throughout the southern subbasin. This subbasin supports coho salmon in more tributaries than the other Mattole River subbasins.

6.1.13.4 Western Subbasin of the Mattole River HSA

The *western subbasin* of the Mattole River is located between the Little Bear Creek in the estuary (RM 0.3) and the headwaters of the South Fork of Bear Creek (RM 50) along the western side of the Mattole mainstem and Wilder Ridge for a distance of about sixty miles. The watershed is largely managed for conservation and recreation in the King Range National Conservation Area. Recent surveys indicate the presence of coho salmon in a few tributaries and the presence of steelhead throughout. Instream habitat is showing signs of improvement due, in part, to the efforts of local stewardship.

6.1.13.5 Estuary Subbasin of the Mattole River HSA

The *estuary subbasin* located at the mouth of the Mattole River in comparison to the other subbasins is quite small, but important to salmonids throughout the summer months, being a vital

FIGURE 6-13: Cape Mendocino Hydrologic Unit

FIGURE 6-14: Recovery units in the CCC Coho ESU

transition step on the seaward migration of juveniles and the returning adult spawners. Although no specific recommendations were made for the estuary subbasin, estuary sedimentation problems would be improved by continuing the basin-wide road and erosion assessments and implementation of the resulting recommendations.

Problems for coho salmon recovery in all subbasins in the Mattole River HSA include high instream sediment levels; stream channel aggradation and widening; low-flow conditions, lack of habitat complexity such as deep pools; excessive water temperatures; and loss of functioning estuarine habitat.

6.2 RECOVERY UNITS IN THE CCC COHO ESU

The CCC Coho ESU has been divided into six recovery units (Figure 6-14) that are aligned with CALWATER HUs. These recovery units, and the watershed delineations within each recovery unit, are listed in Table 6-2. HSAs are shown in Figure 6-15 and watershed conditions are described below.

6.2.1 MENDOCINO COAST HYDROLOGIC UNIT

The Mendocino Coast HU (Figures 6-16 and 6-17) lies entirely within the CCC Coho ESU and is comprised of coastal watersheds in Mendocino and Sonoma counties that are west and south of the Eel and Mattole river basins, and west and north of the Russian River basin. The larger river basins in the HU include Ten Mile, Noyo, Big, Albion, Navarro, Garcia, and Gualala rivers. Numerous smaller streams drain directly to the Pacific Ocean. Total area of the HU is about 1,590 square miles. On the coast, air temperatures generally range from the high 30s to high 50s (°F) in winter, and from the low 50s to high 60s (°F) in summer. Average annual precipitation is about 40 inches on the coast and can be significantly higher on inland hill slopes.

The most common land use in this HU is timber production, although livestock grazing, irrigated agriculture (orchards, vineyards), parks (mainly California State parks), rural subdivisions, and urban areas also occupy smaller portions of the area. The Department operates the Noyo River Salmon Egg Collecting Station on the South Fork Noyo River. Adult coho salmon are trapped and spawned and the resulting eggs and young fish are reared at Mad River Hatchery in Humboldt County.

Coho salmon populations in the main river systems within this HU, such as the Albion, Ten Mile, Big, Noyo (including hatchery supplementation), Navarro, Garcia, and Gualala rivers, were estimated by the Department to be in the thousands during the 1960s. Recent presence surveys have been undertaken in an effort to determine where coho salmon may still persist.

Though water quality characteristics in the HU are generally adequate for salmonids, there are several problems potentially limiting salmonid survival. Several major stream systems in the Mendocino Coast region are on the CWA §303(d) list for sedimentation or siltation. High summer water temperatures are the most identifiable problem limiting distribution of coho salmon in some streams. None of the major streams have mainstem dams blocking large portions of salmonid habitat; however, man-made barriers to migration do exist, caused mainly by culverts designed and placed with insufficient consideration of fish passage. The lack of instream shelter (especially LWD), as well as water diversions and illegal harvest, may also limit production of coho salmon within the HU.

6.2.1.1 Albion River HSA

The Albion River HSA consists of the Albion River, all its tributary streams and several adjacent streams draining directly to the Pacific Ocean. The watershed area is 68.4 square miles.

TABLE 6-2: Recovery units and CALWATER watersheds in the CCC Coho ESU

RECOVERY UNIT	HYDROLOGIC UNIT (HU)	HYDROLOGIC AREA (HA)	HYDROLOGIC SUBAREA (HSA)
MENDOCINO COAST	Mendocino Coast	Rockport	Usal Creek
			Wages Creek
			Ten Mile River
		Noyo River	Noyo River
		Big River	Big River
		Albion River	Albion River
		Navarro River	Navarro River
			Greenwood Creek
			Elk Creek
			Alder Creek
		Point Arena	Brush Creek
		Garcia River	Garcia River
		Gualala River	North Fork
			Rockpile Creek
			Buckeye Creek
			Wheatfield Fork
			Gualala
		Russian Gulch	Russian Gulch
RUSSIAN RIVER	Russian River	Lower Russian River	Guerneville
			Austin Creek
		Middle Russian River	Laguna
			Santa Rosa
			Mark West
			Warm Springs
			Geyserville
			Sulphur Creek
		Upper Russian River	Ukiah
			Coyote Valley
			Forsythe Creek
BODEGA-MARIN COASTAL	Bodega	Salmon Creek	Salmon Creek
		Estero Americano	Estero Americano
		Estero San Antonio	Estero San Antonio
		Bodega Harbor	Bodega Bay
	Marin Coastal	Tomales Bay	Walker Creek
			Lagunitas Creek
			Inverness
		Point Reyes	Drakes Estero
		Bolinas	Bolinas

continued

TABLE 6-2: Recovery units and CALWATER watersheds in the CCC Coho ESU (continued)

RECOVERY UNIT	HYDROLOGIC UNIT (HU)	HYDROLOGIC AREA (HA)	HYDROLOGIC SUBAREA (HSA)
SAN FRANCISCO BAY	Bay Bridges	San Rafael	San Rafael
		Berkeley	Berkeley
		San Francisco Bayside	San Francisco Bayside
	South Bay	East Bay Cities	East Bay Cities
		Alameda Creek	Alameda Creek
		San Mateo Bayside	San Mateo Bayside
	Santa Clara	Fremont Bayside	Fremont Bayside
		Coyote Creek	Coyote Creek
		Guadalupe River	Guadalupe River
		Palo Alto	Palo Alto
	San Pablo	Novato	Novato
		Petaluma River	Petaluma River
		Sonoma Creek	Sonoma Creek
		Napa River	Napa River
		Pinole	Pinole
	Suisun	Fairfield	Benicia
			Suisun Creek
			Suisun Slough
			Grizzly Island
			Grizzly Island – in Delta
			Suisun Slough – in Delta
		Concord	Pittsburg
			Walnut Creek
			Martinez
			Pittsburg – in Delta
SAN MATEO	San Mateo	San Francisco Coastal	San Francisco Coastal
		San Mateo Coastal	Pacifica
			Half Moon Bay
			Tunitas Creek
		San Gregorio Creek	San Gregorio Creek
		Pescadero Creek	Pescadero Creek
		Año Nuevo	Año Nuevo
BIG BASIN	Big Basin	Santa Cruz	Davenport
			San Lorenzo
			Aptos-Soquel

Main Albion River tributary streams include Railroad Gulch, South Fork Albion River, and Marsh Creek. Important adjacent streams include Little River and Salmon Creek. During recent surveys (2000 to 2002), coho salmon were found consistently in the Albion River and many of its tributaries, as well as the Little River, Little Salmon Creek, and Big Salmon Creek.

6.2.1.2 Big River HSA

The Big River HSA consists of Big River, all its tributary streams, and several adjacent streams draining directly to the Pacific Ocean. The watershed area is 200.7 square miles. Main Big River tributaries include Two Log Creek, North Fork Big River, Martin Creek, Rice Creek, South Fork Big River, and Daugherty Creek. Important adjacent streams include Caspar Creek and Russian Gulch. During recent surveys (2000 to 2002), coho salmon have shown consistent presence in Caspar Creek and have been found less consistently in Doyle Creek, Russian Gulch, and the Big River and its tributaries.

6.2.1.3 Garcia River HSA

The Garcia River HSA consists of the Garcia River, all its tributary streams, and several smaller streams west of the Garcia basin that drain directly to the Pacific Ocean. The watershed area is 146.4 square miles. The main Garcia River tributaries include Hathaway Creek, North Fork Garcia River, South Fork Garcia River, Signal Creek, and Inman Creek. Streams draining directly to the Pacific Ocean include Schooner Gulch and Fish Rock Gulch. During recent surveys (2000 to 2002), coho salmon were found only in 2002 in the North Fork Garcia River as well as the South Fork Garcia River and its tributary, Fleming Creek.

6.2.1.4 Navarro River HSA

The Navarro River HSA consists of the Navarro River and all its tributary streams. The watershed area is 315.8 square miles. Main tributaries include North Fork Navarro River, Mill Creek, Indian Creek, Rancheria Creek, and Anderson Creek. The Navarro is the largest and most diverse basin in the HU.

Land uses include timber production near the coast, irrigated agriculture in Anderson Valley, and grazing on hill slopes of the eastern area. Melange geology in the eastern areas makes them less stable than coastal areas dominated by coastal belt geology. Coho salmon have recently been found in the Navarro River (2002 and 2003) and in some of its tributaries, including Marsh Gulch, Murray Gulch, Flume Gulch, Flynn Creek, and North Branch North Fork Navarro River (2000 to 2002).

6.2.1.5 Noyo River HSA

The Noyo River HSA consists of the Noyo River, all its tributary streams, and several adjacent smaller streams draining directly to the Pacific Ocean. The watershed area is 166 square miles. The main Noyo River tributaries include South Fork Noyo and North Fork Noyo. The more important adjacent streams include Pudding and Hare creeks. During recent surveys (2000 to 2002), the Noyo River and many of its tributaries, as well as Pudding and Hare creeks have shown consistent presence of coho salmon.

6.2.1.6 Ten Mile River HSA

The Ten Mile River HSA consists of the Ten Mile River, all its tributary streams, and several small adjacent streams draining directly to the Pacific Ocean. The watershed area is 129 square miles. The main tributaries include North Fork Ten Mile, Middle Fork (also known as Clark Fork) Ten Mile, and South Fork Ten Mile. The Ten Mile River originates in the Coast Range of Mendocino County and enters the ocean about nine miles north of Fort Bragg. Its main tributaries are the North and South Forks.

FIGURE 6-15: Hydrologic Subareas in the CCC Coho ESU

FIGURE 6-16: Mendocino Coast Hydrologic Unit (North)

The Ten Mile River flows mainly through coastal forests and grasslands. During recent surveys (2000 to 2002), coho salmon were found only in 2001 and 2002 in the Ten Mile River and most of its tributaries, although coho salmon were found all three years in Little North Fork Ten Mile River and Bear Haven Creek.

6.2.1.7 Gualala River HA

This HA consists of the Gualala River, all its tributary streams, and coastal streams south to Russian Gulch. The Gualala River watershed area is 298.4 square miles. The main Gualala River tributaries include North Fork Gualala River, Little North Fork Gualala River, Little North Fork Gualala River, Rockpile Creek, South Fork Gualala River, Buckeye Creek, and Wheatfield Fork Gualala River. The Gualala River begins on the western slope of the coastal ranges of Mendocino and Sonoma counties; the lower 3.5 miles of the mainstem form the common boundary of these counties. The South Fork Gualala River flows northwest along a rift valley formed by the San Andreas Fault, which parallels the coast for about 25 miles.

The surrounding topography is generally steep ridges and hills, covered with dense stands of redwood and Douglas-fir forest. Scattered along both forks of the river are sand and gravel bars, as well as stands of willow and alder. The river valley broadens at its mouth, south of the Highway 1 Bridge. In the vicinity of the bridge on both sides of the river are a few scattered freshwater marshes. The lower mile of the river is bordered by a broad grassland-covered bluff to the south and bluffs to the north.

On December 20, 2001, the USEPA established a sediment TMDL for the Gualala River based on the information contained in the Gualala Technical Support Document, prepared by Regional Board staff and their consultants. The purpose of the Technical Support Document, was to estimate current discharges of sediments to the surface waters of the Gualala River watershed, and to identify the reduction in discharges necessary for achieving water quality standards contained in the North Coast Region Water Quality Control Plan.

During recent surveys (2000 to 2002), coho salmon were found only in 2002 in some of the Gualala River tributaries, including the Little North Fork Gualala River, Dry Creek, and McGann Gulch.

6.2.2 RUSSIAN RIVER HYDROLOGIC UNIT

The Russian River HU (Figure 6-18) covers an area of approximately 1,485 square miles and includes about 240 named and numerous unnamed tributaries. The Russian River HU has been described extensively within the context of a fisheries restoration plan (CDFG 2002). In keeping with the format of that plan, the mainstem of the Russian River is described here as a separate entity, although this is not done for any of the other watersheds included in this Recovery Strategy.

Approximately 95% of the river's natural runoff, about 1,600,000 acre-feet, occurs between November and April. Summer flows are regulated by releases from Lake Mendocino (impounded by Coyote Dam) and Lake Sonoma (impounded by Warm Springs Dam). The Potter Valley Project also contributes up to 300 cfs to the river above Lake Mendocino. Mean daily temperatures can exceed 73°F in some sections of the river, causing stress to salmonids and promoting proliferation and persistence of predatory, warm-water fish species. Natural and man-made physical barriers such as bedrock constrictions and falls, debris jams, dams, road crossings, and culverts adversely affect fish migration.

Urban and industrial uses are concentrated around cities in Mendocino and Sonoma counties. Uses include high-technology industries, petroleum distribution plants, light manufacturing, wrecking and salvage yards, and industries related to construction. Santa Rosa is the chief commercial distribution center for the north coast of California. Other land uses such as timber harvest, agricultural production, livestock grazing, and gravel mining, have been present in the Russian River watershed for decades and continue today. Agriculture is still the dominant land use within the basin, with a recent trend of conversion of historic croplands, pasture for livestock, dairy lands, and forestlands to vineyards.

Coho salmon historically occurred in six of the 11 Russian River HSAs (Guerneville, Austin Creek, Geyserville, Mark West, Warm Springs, and Santa Rosa Creek HSAs). Of the four salmonid species that historically occurred in the watershed (Chinook salmon, pink salmon, coho salmon, and steelhead trout), pink salmon have been extinct since 1955, while the other three species are currently listed as threatened under the Federal ESA. Natural coho salmon production in the Russian River system was augmented through annual releases of about 70,000 yearlings produced at the Warm Springs Hatchery (WSH) between 1980 and 1998. The Department, NOAA Fisheries, and USACE initiated a captive coho salmon broodstock program at WSH in 2001. Using conservation hatchery principles, their goal is to restock selected streams within the Russian River basin with juvenile coho salmon derived from local natural spawning populations.

Potential problems for coho salmon recovery in the Russian River basin include barriers to migration, poor gravel quality, inadequate gravel quantity, lack of riparian stability, loss of native plant species, invasion of non-native plants, inappropriate water temperature, poor water quality, and an altered hydrologic regime. The river is listed as impaired for sediment on the 303(d) list of the CWA.

6.2.2.1 Russian River Mainstem

The mainstem of the Russian River extends for about 96 miles from the mouth to the headwaters of the river above Lake Mendocino. It is dominated by alluvial stretches in the lower, middle, and upper reaches, separated by bedrock sections of variable lengths. Factors specific to the mainstem that limit coho salmon production include barriers to upstream migration and other life-history stages posed by permanent and seasonal dams, stream crossings and culverts, inadequate gravel quantity, insufficient riparian stability, inadequate water quality, and seasonally unsuitable water quantity due to artificial breaching of the barrier beach for flood-control purposes.

6.2.2.2 Guerneville HSA

The Guerneville HSA occupies the southwest end of the Russian River basin in Sonoma County and has an area of 159.8 square miles. It extends from the mouth of the river at the Pacific Ocean upstream to Healdsburg and east to the outskirts of Sebastopol. Major tributaries include Green Valley, Fife, Hulbert, Dutchbill, and Willow creeks.

The lower reaches of the near-coast streams within the basin contain marsh-like environments, which are subject to daily tidal influence. Most of the subbasin is privately owned, but it also contains Armstrong Woods State Park, consisting of about 1.26 square miles in the Fife Creek watershed and 0.57 square miles in the Willow Creek watershed. No watershed plans have been adopted for these watersheds, although considerable resource assessment work has been completed and community watershed groups have been organized in both.

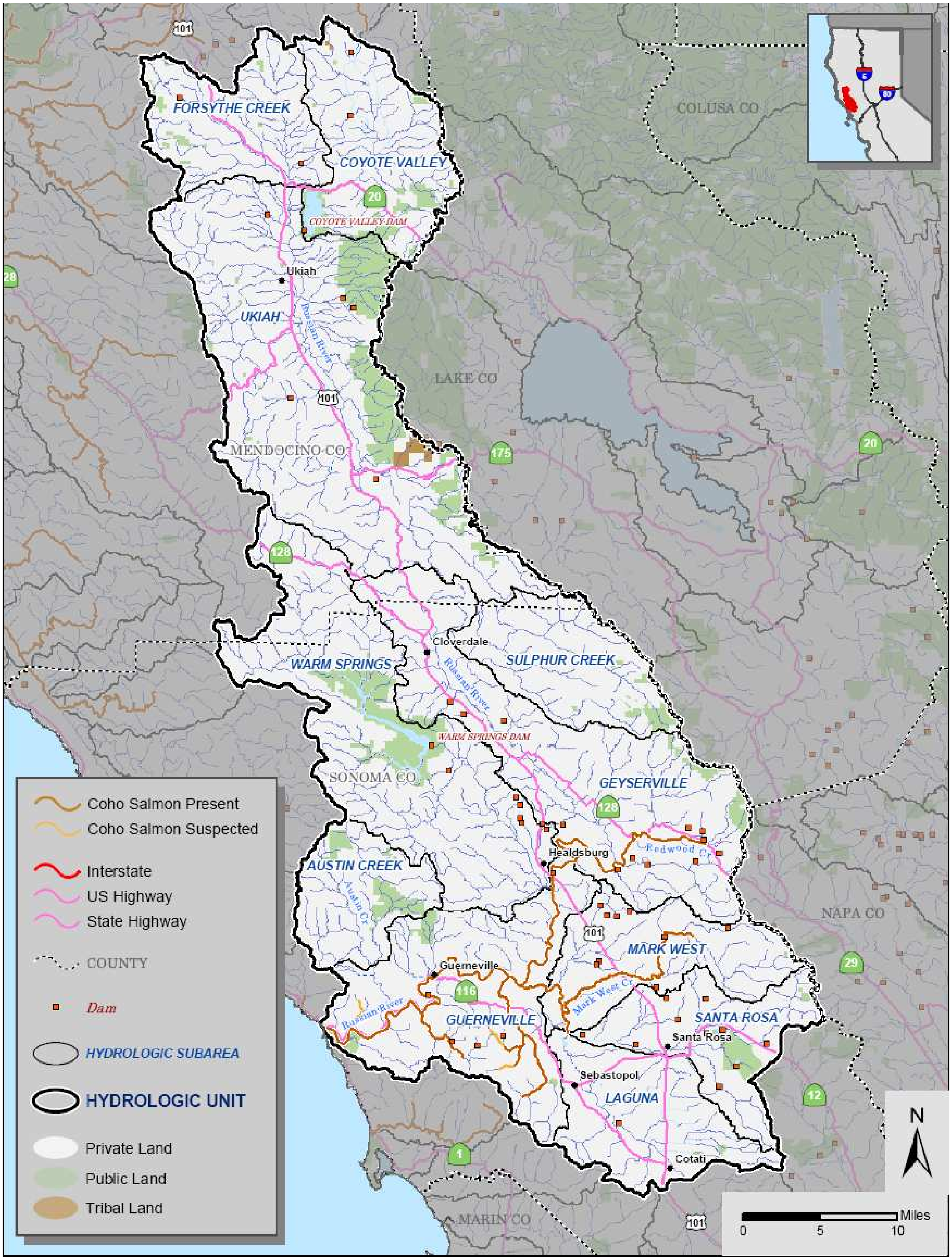
During recent surveys (2000 to 2002), coho salmon were found only in three Russian River tributaries: Green Valley, Dutchbill, and Mark West creeks. Coho salmon were found in each of the last ten years, except 2001. They were found in Dutch Bill Creek in 2002 but not in 2001, and in Mark West Creek in 2001 but not in 2002.

6.2.2.3 Austin Creek HSA

The Austin Creek HSA consists of the Austin Creek watershed and includes the major watersheds of Big Austin, East Austin, and Ward creeks. It drains an area of 62.3 square miles.

FIGURE 6-17: Mendocino Coast Hydrologic Unit (South)

FIGURE 6-18: Russian River Hydrologic Unit



Numerous perennial and intermittent streams feed both the mainstem of Austin Creek and the larger tributary systems.

Many of the headwater areas are geologically unstable, and the basin has the highest average annual rainfall of any area within the Russian River region. Major land uses in the Austin Creek subbasin include timber production, gravel mining and rural development. The watershed is primarily privately owned, except for portions under DPR ownership. Parts of the watershed are now protected from development as a part of Armstrong Woods State Park and Austin Creek State Recreation Areas, together covering 8.9 square miles. During recent surveys (2000 to 2002), coho salmon were not found in Austin Creek or any of its tributaries.

6.2.2.4 Warm Springs HSA

The Warm Springs HSA runs along the western edge of the Russian River basin in Sonoma County and contains the Dry Creek watershed and Lake Sonoma. This subbasin is named after Warm Springs Dam, constructed in 1982, which impounds Lake Sonoma. The subbasin drains an area of 218 square miles. Approximately 130 square miles of the watershed are above the lake and completely inaccessible to anadromous species. Major tributary watersheds within the Dry Creek watershed below the dam include Pena and Mill creeks, as well as numerous perennial and intermittent tributaries. Cherry, Warm Springs, and Gallaway creeks are major tributary watersheds above the dam.

Warm Springs Hatchery, operated by the Department, was built as mitigation for lost habitat and fish runs on Dry Creek above the dam. Ownership within the subbasin is primarily private, although USACE owns Lake Sonoma. The Dry Creek watershed has been the site of intense agricultural development since the turn of the twentieth century. Conifer forest dominates the upper HSA, but there are zones of grassland and oak-woodland in the lower watersheds and flood plain areas. Primary land uses today are vineyard cultivation, scattered rural development and grazing, and recreation within the boundaries of Lake Sonoma. Some timber is still harvested within the basin, and is often followed by conversion of uplands to agricultural use.

During recent surveys (2000 to 2002), coho salmon were not found in Dry Creek or any of its tributaries, although coho salmon were detected inconsistently in some tributaries during the 1990s.

6.2.2.5 Mark West Creek HSA

The Mark West HSA contains Mark West Creek and its tributaries. Mark West Creek traverses Sonoma County in a general east-west direction, meets the Laguna de Santa Rosa, and flows into the Russian River at Mirabel Park, about eight miles east of Guerneville. The subbasin covers an area of 86.3 square miles, and includes the major tributary watersheds of Windsor, Humbug, and Porter creeks. Mark West Creek and its tributaries drain a basin of approximately 40 square miles.

Cultivated fields and housing developments border most of the stream in the middle section. Where the Mark West Creek subbasin meets the Russian River, vegetation is dominated by typical redwood forest. Oaks, bay, redwood, Douglas-fir, maples, madrone, and manzanita characterize the vegetation near the headwaters. Riparian vegetation is composed of willows, oaks, bay, alder, maples, blackberry, and a limited number of redwoods. During recent surveys (2000 to 2002), coho salmon were found in Mark West Creek only in 2001, although they were detected in 1993 and 1994.

6.2.2.6 Santa Rosa Creek HSA

The Santa Rosa Creek HSA is located in the southeastern portion of the Russian River watershed, and contains Santa Rosa Creek and its major tributaries, Matanzas Creek and the North and South Forks of Santa Rosa Creek. It covers an area of 77.4 square miles. Santa Rosa Creek is a tributary to Laguna de Santa Rosa, which flows into Mark West Creek.

The upper watershed consists of mixed evergreen forest grading to oak woodland. The primary land use today is urban development, although livestock grazing and vineyard development also exist. The Santa Rosa Creek watershed is primarily in private landownership, with some portions owned by the City of Santa Rosa and the Sonoma County Regional Parks Department.

The City of Santa Rosa, located at the intersection of Highway 101 and Highway 12, is the most urbanized and densely populated community within the Russian River basin. The creek is channelized for about seven miles from the Santa Rosa City Hall downstream to Laguna de Santa Rosa. The discharge from the Santa Rosa Wastewater Treatment Facility is released into the Russian River via Santa Rosa Creek and Laguna de Santa Rosa.

The Santa Rosa Plain contains a large number of confined animal operations, including almost 100 dairies. Conversion of pasture and orchards to vineyards has increased significantly in the past decade. The upper basin, incorporated into Hood Mountain Regional Park and the McCormick Sanctuary, is now protected from further development.

During recent surveys (2000 to 2002), coho salmon were not found in Santa Rosa Creek, although they had been detected in 1993 and 1994.

6.2.2.7 Forsythe Creek HSA

The Forsythe Creek HSA, in the northwestern portion of the Russian River watershed in Mendocino County, contains the Forsythe Creek watershed and the West Fork drainage of the Russian River. The Forsythe Creek subbasin drains 84.3 square miles. The Forsythe Creek watershed and its tributaries drain a basin of approximately 47.7 square miles. Major tributaries within Forsythe watershed are Mill, Jack Smith, and Eldridge creeks. Many artificial and several natural lakes occur throughout the basin. The West Fork has its headwaters in a mountain forest but predominantly flows through hills of rangeland and pastureland for sheep and cattle, with scattered oak trees. Major tributaries include Mariposa, Corral, Fisher, and Salt Hollow creeks.

The streams flow predominantly through oak-, bay-, and maple-covered rangelands with second-growth redwoods in the upper headwaters of the drainage. Much of the central basin area is cultivated as vineyards or used for livestock grazing. Timber harvest is also a predominant land use with scattered rural homesteads. The majority of the Forsythe Creek subbasin is privately owned, with much of the watershed managed for timber production and livestock for the past century. During recent surveys (2000 to 2002), coho salmon were not found in any of the creeks or their tributaries in this HSA.

6.2.2.8 Geyserville HSA

The Geyserville HSA drains 207.8 square miles, and includes the Alexander Valley reach of the Russian River, the Maacama Creek watershed, and many smaller tributaries.

The watershed is dominated by oak grasslands except in the headwaters, where vegetation consists mostly of gray pine and oaks. Riparian vegetation generally has abundant alders and willows. Major land uses within the Maacama watershed are vineyard cultivation, cattle grazing, and urban development. The Briggs Creek watershed and its tributaries occupy the northeastern side of the upper subbasin, draining approximately 12.3 square miles. The mixed hardwood forests here are in excellent condition in this pristine sub-watershed. Much of the upper Maacama watershed remains in large parcels and is now under protection from further development under Sonoma County Open Space easements.

Coho salmon were detected in Maacama and Redwood creeks in 1993 and 1994. In addition, the Department collected juvenile coho salmon from the Maacama Creek watershed (Redwood Creek) in 2001 for the coho salmon broodstock program.

6.2.3 BODEGA AND MARIN COASTAL HYDROLOGIC UNITS

The Bodega and Marin Coastal HUs (Figure 6-19) consist of nine HSAs, four of which have documented historical coho salmon presence to Salmon Creek, Walker Creek, Lagunitas Creek, and Bolinas. Together, they drain an area of about 265 square miles. In this typical coastal region of California, the climate is highly variable, with basin-wide average rainfall of over 30 inches per year.

Approximately 95% of the Salmon Creek and Walker Creek watersheds are in private ownership, whereas about 50% of Lagunitas Creek basin and only 5% of the Redwood Creek watershed in the Bolinas HSA are privately owned. Land uses include protected open space; buffer lands for domestic drinking water; recreation, natural resource protection and management areas; organic farming, and moderately dense residential development.

Three major reservoirs form barriers to coho salmon distribution in the HUs: Soulajule Reservoir on Arroyo Sausal in the Walker Creek watershed, and the reservoirs formed behind Nicasio Dam on Nicasio Creek and Peters Dam on Lagunitas Creek, both in the Lagunitas Creek watershed. There are no fish hatcheries or fish facilities currently operated in the HUs, although the Department operated a trapping facility on Nicasio Creek during the 1960s to move coho salmon above Nicasio Reservoir.

Watersheds within the HUs have a variety of water quality impairments, including excess sediment, high temperature, low DO, and excessive nutrients. Chronic erosion and sedimentation is the primary water quality challenge throughout the HU. Tomales Bay is listed on the CWA §303(d) list as an impaired water body for high concentrations of bacteria, nutrients, pathogens, metals (mercury), and sediment. Walker, Lagunitas, and Olema creeks have been listed as impaired for sedimentation, nutrients, and fecal coliform bacteria.

Current knowledge indicates that the primary problems facing coho salmon in the HUs are the permanent loss of access to spawning and rearing habitat above Peters Dam on Lagunitas Creek and above Nicasio Dam on Nicasio Creek, fish passage barriers at road crossings, high fine sediment loads, low summer streamflow, high summer water temperature, a shortage of cover in the form of LWD, and loss of riparian vegetation. The Lagunitas and Bolinas HSAs have recent documented occurrences of coho salmon, while the Salmon and Walker creek HSAs historically supported the species.

6.2.3.1 Salmon Creek HSA

The Salmon Creek HSA is located in Sonoma County and consists of two watersheds, Salmon and Scotty creeks. Salmon Creek drains 34.5 square miles into a tidal estuary located just north of Bodega Harbor along the Sonoma coast. The six major tributaries to Salmon Creek are Finley, Coleman Valley, Tannery, Fay, Nolan, and Thurston creeks. Scotty Creek is a small drainage that flows into the Pacific Ocean just north of the Salmon Creek estuary.

Salmon Creek is characterized by a deeply incised channel and highly active bank erosion due to steep topography and livestock grazing. Instream flow data for the Salmon Creek watershed are lacking. Water temperatures in parts of the Salmon Creek watershed during the summer rearing season are mostly acceptable due the basin's close proximity to the coast. During recent surveys (2000 to 2002), no coho salmon were found in any of the creeks of this HSA.

6.2.3.2 Walker Creek HSA

The Walker Creek HSA consists of the 76 square-mile Walker Creek drainage. It is located primarily in northwestern Marin County, except for a small portion in Sonoma County. Walker Creek is the second largest tributary to Tomales Bay, draining into the northern end of the bay. The four main tributaries to Walker Creek are Keys, Chileno, Salmon and Arroyo Sausal creeks. Lagunitas Creek and Walker Creek provide 75% of the freshwater into Tomales Bay. Since 1979, releases from Soulajule Reservoir have maintained perennial flow in Walker Creek. Prior to 1985, flow in Walker Creek was intermittent in some reaches, although it is reported that in the early 1900s, Walker Creek was a perennial stream (Haible 1976).

Soulajule Reservoir sits high in the watershed on Arroyo Sausal Creek, which flows directly into Walker Creek. The reservoir was constructed in 1968 and is currently managed by Marin Municipal Water District (MMWD). This reservoir is far enough upstream to allow for salmonid access to a majority of the historic habitat.

The Walker Creek watershed has been listed as impaired for sediment, high nutrients, and high fecal coliform bacteria on the CWA §303(d) List by the San Francisco RWCB. During recent surveys (2000 to 2002), no coho salmon were found in Walker Creek or any of its tributaries.

6.2.3.3 Lagunitas Creek HSA

The Lagunitas HSA consists of the 103-square-mile Lagunitas Creek basin. This is the largest watershed in Marin County, draining a large portion of the central part of West Marin. Flowing from its headwaters on the north slope of Mt. Tamalpais, it traverses northwesterly 25 miles through four reservoirs to the southern end of Tomales Bay.

Lagunitas Dam (built in 1872), Alpine Dam (built in 1918), Bon Tempe Dam (built in 1948), and Peters Dam (built in 1954), which provide water for domestic use to central and west Marin communities, are all located on Lagunitas Creek. A fifth dam in the basin is Seeger Dam (Nicasio Dam), built in 1961, which forms Nicasio Reservoir on Nicasio Creek one mile upstream from its confluence with Lagunitas Creek. The four major tributaries to Lagunitas Creek are San Geronimo, Devil's Gulch, Olema, and Nicasio creeks. San Geronimo Creek flows through San Geronimo Valley and into Lagunitas Creek one-quarter mile downstream of Peters Dam. Devil's Gulch flows through a steep, narrow canyon into Lagunitas in Samuel P. Taylor State Park. Olema Creek flows along Highway 1, joining Lagunitas just downstream of Pt. Reyes Station.

Sub-watersheds that provide spawning habitat include Cheda and McIsaac creeks, which flow directly into Lagunitas Creek, and Woodacre, Larsen, and Arroyo Road creeks, which flow into San Geronimo Creek. During recent surveys (1997 to 2002), coho salmon were found consistently in Lagunitas Creek, as well as in Olema Creek, Devil's Gulch, and San Geronimo Creek and its tributaries, but only in one or two years in two other smaller tributaries to Lagunitas Creek.

6.2.3.4 Bolinas HSA

Coho salmon have been identified in three watersheds in the Bolinas HAS; Redwood, Pine Gulch and Easkoot creeks.

Redwood Creek drains an 8.9-square-mile watershed from the west peak of Mt. Tamalpais to its mouth at Muir Beach. Approximately seven miles of Redwood Creek provide accessible habitat for anadromous salmonids and this basin is considered one of the most productive and restorable basins for anadromous salmonid habitat in Marin County. It is largely undeveloped and its resources are protected as State and Federal parklands. Major watersheds include Fern, Bootjack, Rattlesnake, Spike Buck, Kent Canyon, and Green Gulch creeks. During recent surveys (2000 to 2002), coho salmon were found consistently in Redwood Creek.

Pine Gulch Creek, a 7.6-square-mile watershed in coastal Marin County, is the primary freshwater source to Bolinas Lagoon. Seventy percent of the water draining into Pine Gulch Creek flows off of Inverness Ridge, providing perennial flow. Currently, the watershed supports a native self-sustaining population of steelhead trout, and up until the 1970s, a native population of coho salmon. Although the Department and the NPS considered coho salmon extirpated, 538 juveniles were found in August 2001, and data suggest they originated from more than one redd. Known factors that may limit coho salmon in Pine Gulch Creek are sedimentation/erosion, lack of pool shelter, and water quantity. Because of the lack of published information, Pine Gulch Creek is not discussed in detail in the watershed summary. During recent surveys (2000 to 2002), coho salmon were found in Pine Gulch Creek only in 2002.

Easkoot Creek, a small perennial tributary with a 1.7-square-mile watershed, flows into Bolinas Lagoon at Stinson Beach. Easkoot Creek is accessible to anadromous fish in its lower reaches, for a short distance upstream of Highway 1 in the town of Stinson Beach. Lower Easkoot Creek has been highly modified and provides relatively limited potential habitat; however, juvenile coho salmon were observed there in 2002. During recent surveys (2000 to 2002), coho salmon were found in Easkoot Creek only in 2002.

6.2.4 SAN FRANCISCO BAY HYDROLOGIC UNITS

San Francisco Bay encompasses San Pablo, Suisun, Central, and South bays and covers an area of about 400 square miles (Figure 6-20). It extends for approximately 85 miles from the east end of Chips Island in Suisun Bay westward and southward to the mouth of Coyote Creek near the City of San Jose. Most of the bay's shoreline has a flat slope, which causes the intertidal zone to be relatively large. San Francisco Bay is surrounded by about 130 square miles of tidal flats and marshes. The watershed of San Francisco Bay drains an area of approximately 3,475 square miles (Leidy 1984).

San Francisco Bay Area watersheds are largely urbanized, with some areas in agriculture, grazing, and parkland. Most San Francisco Bay watersheds are currently listed as impaired for sediment, nutrients, and pathogens under CWA § 303(d). Many creeks have intermittent flow during the dry season and can be completely dry for one or more months. Many creeks contain obstructions to salmonid migration in the form of grade-control structures, road crossings, flood-control channels, permanent and seasonal dams, and seasonally dry sections. Summer and fall water temperatures in Bay Area creeks tend to be relatively high.

Several creeks and rivers of the San Francisco Bay historically supported coho salmon runs, including Alameda, San Pablo, Walnut, San Anselmo, Corte Madera, and Mill Valley (Arroyo Corte Madera Del Presidio) creeks (Leidy, 1984). No coho salmon have been observed in waters draining to San Francisco Bay since 1981.

Historically, coho salmon occurred in the San Rafael HSA in the Corte Madera Creek and Arroyo Corte Madera Del Presidio (Mill Valley) drainages (Fry 1936; Hallock and Fry 1967). The last record of coho salmon in this HSA was on September 18, 1981 when Leidy (1984) reported collecting two juveniles from Corte Madera Creek and two from Old Mill Creek (tributary to Arroyo Corte Madera Del Presidio). NOAA Fisheries has identified both Corte Madera Creek and Arroyo Corte Madera Del Presidio as critical habitat for coho salmon. Rich (1995) reported that existing habitat in the Arroyo Corte Madera Del Presidio watershed is not suitable for coho salmon.

6.2.5 SAN MATEO HYDROLOGIC UNIT

The San Mateo HU (Figure 6-21) is near the southern end of the coho salmon range and has been significantly impacted by water diversion, urbanization, road building, riparian development, land-use practices, and fire suppression. This HU includes the San Gregorio Creek, Pescadero Creek, and Año Nuevo (Gazos Creek) HSAs. Four other HSAs, San Francisco Coastal, Half Moon Bay, Pacifica, and Tunitas Creek also fall in the San Mateo HU; however, none of these has any known current or historical information that they are or were coho salmon-bearing streams, and they are not discussed further in this report.

Streams in this HU originate in the Santa Cruz Mountains and flow west or southwest to the Pacific Ocean. They are generally well shaded and summer water temperatures seldom exceed the high 60s°F, although temperatures may be higher in the lagoons and the lower stream reaches. Coho salmon distribution is generally limited to the relatively high-order, low-gradient streams and reaches. The San Gregorio subbasin is entirely within San Mateo County and covers approximately 61 square miles. Most of the watersheds for Pescadero and Gazos creeks are within San Mateo County, with a small part of the headwaters located in Santa Cruz County. The Pescadero Creek watershed is approximately 100 square miles while the Gazos Creek watershed is approximately 20 square miles.

San Gregorio, Pescadero, and Gazos creeks all have estuaries whose mouths are frequently blocked by sandbars, forming lagoons. The alteration of the lagoons, in conjunction with increased sediment loads from land-use activities, lower stream flows due to water diversions, and other watershed changes have reduced and degraded rearing habitat for juvenile coho salmon and created a poor freshwater-saltwater transition zone for smolts.

There are few definitive data on historical coho salmon abundance in this HU. Most brood-year lineages appear to be extirpated or very weak in all three watersheds, although surveys found coho salmon in the Año Nuevo HSA in 2002. Erosion and landslides are significant natural factors shaping habitat in this HU. Reduced flow and water depth during dry months and periods of drought may impede migration of adult and juvenile coho salmon between storms, and limit the distribution of rearing juveniles. Recorded water rights, unregistered riparian diversions, and wells affecting underflow contribute to reduced flow. The use of wells to extract flow from mapped and unmapped groundwater flow is a significant and growing issue in this HU.

Effective maintenance and restoration of stream flow and LWD are key challenges to coho salmon recovery in an increasingly urban setting. Comprehensive water storage and distribution is required to provide the habitat necessary for coho salmon recovery.

6.2.5.1 San Gregorio Creek HSA

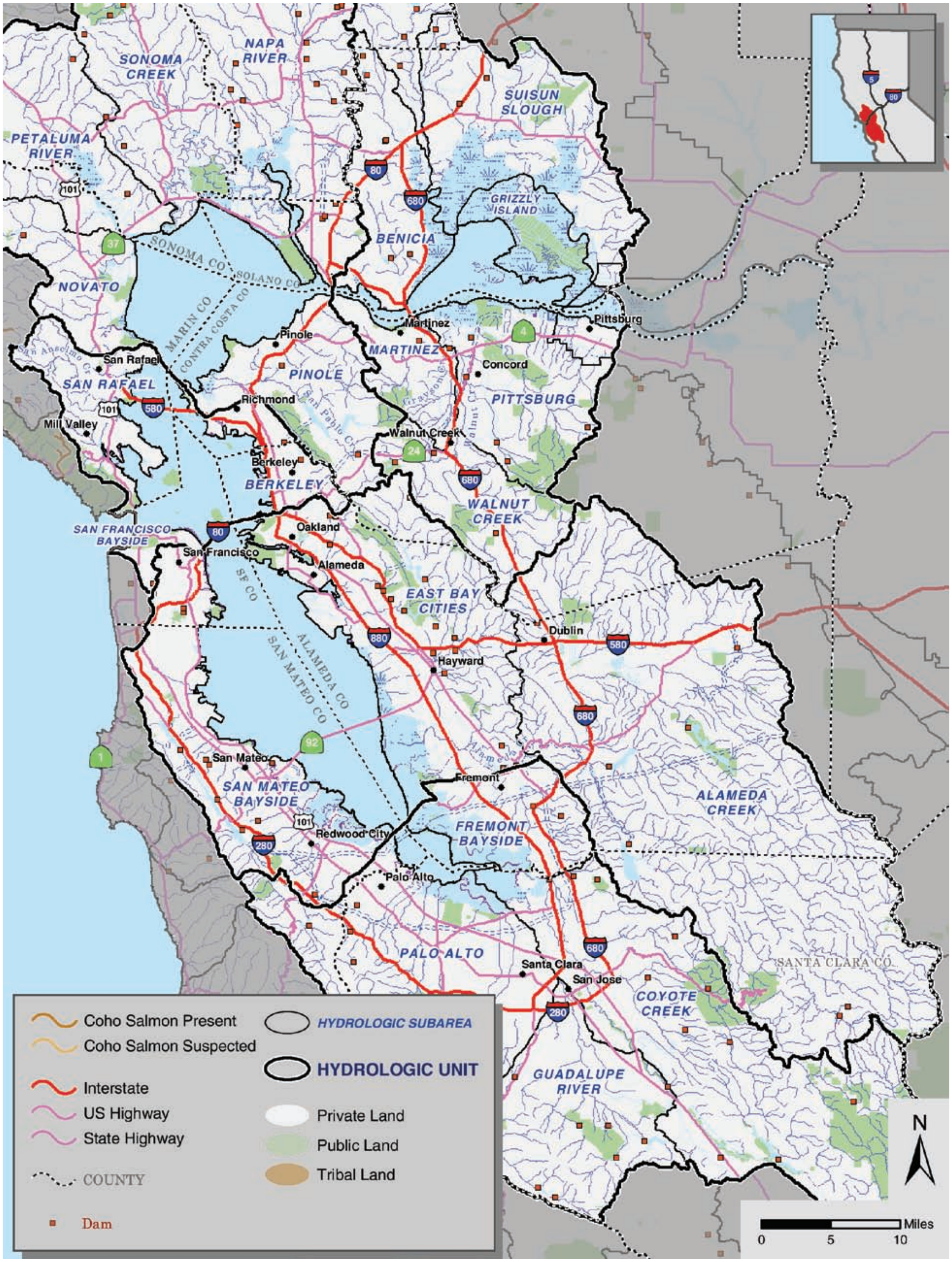
The San Gregorio watershed is located approximately 11 miles south of Half Moon Bay in San Mateo County and covers approximately 61 square miles. The mainstem of San Gregorio Creek is 11.8 miles in length, and has about 33 miles of perennial tributaries. The mainstem of San Gregorio Creek, in combination with its tributaries of La Honda, Alpine, Harrington, El Corte de Madera and Bogess creeks, contains approximately 33 miles of potentially usable rearing habitat.

Most of the San Gregorio watershed is in private ownership. Land use includes agriculture, developments (residential, minor commercial, and a road infrastructure), cattle grazing, timber harvest, and recreational trails. Because of the large private ownership and development potential, water diversions and low base flows are an important issue in this HSA. In 1993, water rights in the San Gregorio watershed were adjudicated and a minimum stream bypass flow was established. However, the prescribed bypass flows are too low to assure viable coho salmon populations.

Pescadero Creek is located approximately 16 miles south of Half Moon Bay in San Mateo County. The watershed area has an area of approximately 100 square miles. The mainstem of Pescadero Creek is approximately 26 miles in length, with an additional 44 miles of perennial tributaries. Approximately 21 miles of mainstem Pescadero Creek and Peters, Slate, Oil and Butano creeks are potential coho salmon rearing habitat. Approximately 30% of the watershed is in public ownership (DPR and the County of San Mateo) and 70% is in private ownership. Land use includes agriculture, timber harvest, grazing, development (e.g., residential, commercial, road infrastructure) and recreation.

FIGURE 6-19: Bodega and Marin Coastal Hydrologic Units

FIGURE 6-20: San Francisco Bay Hydrologic Units



6.2.5.2 Año Nuevo (Gazos Creek) HSA

Gazos Creek is located approximately 26 miles south of Half Moon Bay in the southern part of San Mateo County. The watershed is approximately 20 square miles. There is just one year of stream flow data for Gazos Creek and the data have not been completely summarized. The mainstem of Gazos Creek is approximately 6.7 miles in length and has an additional 9.2 miles of perennial tributaries, the most significant of which are Old Womans Creek and two unnamed headwater tributaries.

Approximately six miles of Gazos Creek and one half mile of Old Womans Creek are potential coho salmon rearing habitat. DPR owns the headwater section of Gazos Creek and a small in holding of Gazos Creek at the confluence of Old Womans Creek. The remainder of the watershed is privately owned or owned by land-trusts. Land uses include agriculture, timber harvest, developments (residential and a road infrastructure), and recreation. During recent surveys (2000 to 2002), coho salmon were found inconsistently in Gazos Creek. Gazos Creek also had inconsistent presence of coho salmon during the 1990s.

6.2.6 BIG BASIN HYDROLOGIC UNIT

The Big Basin Hydrologic HU (Figure 6-22) is the southern end of the coho salmon range and has been significantly impacted by water diversion, urbanization, road building, riparian encroachment, timber harvest, fire suppression, and other land use practices. This HU includes the following watersheds where coho salmon are or have been historically present: Waddell Creek (20 square miles), Scott Creek (27 square miles), San Vicente Creek (11 square miles), San Lorenzo River (138 square miles), Soquel Creek (23 square miles), and Aptos Creek (25 square miles). All are located entirely within Santa Cruz County. Streams in this HU originate in the Santa Cruz Mountains and flow west or southwest to the Pacific Ocean. They are generally well shaded and summer water temperatures seldom exceed the high 60s (°F); however, some streams or stream sections are too warm for coho salmon rearing.

Because rain and run-off are extremely rare in this HU during summer and fall months and watershed areas are relatively small, stream flows during summer and fall are a critical issue for the survival of coho salmon. Most channel-forming flows and flows necessary for migration of adult coho salmon occur from December to April. These flows breach the sandbars that are common at the mouth of most local streams. Reduced flow and depth due to water diversions may impede migration of adult and juvenile coho salmon between storms, and the range of rearing juveniles is severely limited by water depth during dry months and drought. Reduction of surface flow by pumping of underflow is particularly problematic, because the structures and their effects are relatively difficult to identify and because de-watering is often related to the cumulative effects of many structures and diversions. There are recorded water rights within the Big Basin HU, in addition to unregistered riparian diversions and wells affecting underflow. The use of wells to extract flow from mapped and un-mapped subterranean streams is a significant and growing issue in this HU.

The Monterey Bay Salmon and Trout Project, a cooperative salmonid rearing project under permit from the Department, operates the Kingfisher Flat Fish Hatchery, located on Big Creek (tributary to Scott Creek). Coho salmon production at the Kingfisher Flat Fish Hatchery, utilizing Scott Creek and San Lorenzo River fish, began in the winter of 1986/87. Hatchery operations have been sporadic since then, dependent on the availability of returning broodstock. The hatchery now operates under the principles of a conservation hatchery. There are few definitive data on historical coho salmon abundance in this HU. Coho salmon distribution is generally limited to the relatively high-order, low-gradient streams and stream sections. Most brood-year lineages appear to be extirpated or weak in most watersheds, although Waddell and Scott creeks appear to have one or two relatively strong brood-year lineages, respectively. Significant problems for coho salmon in the Big Basin HU include low stream flow, high sediment loads, and lack of LWD.

6.2.6.1 Davenport HSA

This HSA is comprised of the watersheds of Waddell, Scott, and San Vicente creeks. Together, they cover an area of about 150 square miles (Waddell and Scott creeks are located a few miles north of the town of Davenport in the northern part of Santa Cruz County). San Vicente Creek flows through Davenport. The mainstem of Waddell Creek is approximately 4.8 miles in length and has several perennial tributaries, the most significant of which are east and west branches of Waddell and Henry creeks. All 4.8 miles of the mainstem and six miles of the tributaries are potentially usable rearing habitat. Approximately 90% of the watershed is in Big Basin Redwoods State Park, with the remainder in private holdings. Land uses include recreation, minor residential development and road infrastructure, timber harvest, and agriculture.

The mainstem of Scott Creek is 11 miles in length with an additional 29 miles of perennial tributaries, the most significant of which are Little, Big and Mill creeks and Bettencourt Gulch. Approximately eight miles of the mainstem and 5.6 miles of the tributaries are considered potentially suitable rearing habitat. DPR has small in-holdings in the headwaters; however, the majority of Scott Creek watershed is privately owned. Land use in the watershed includes timber harvest, agriculture, residential development and a road infrastructure, equestrian trails and cattle grazing. Water use is variable and includes storage reservoirs in the headwaters of Big and Mill creeks, wells and surface diversions for domestic uses throughout the watershed, and wells and surface diversions for agricultural purposes in the lowermost portion of the watershed.

The mainstem of San Vicente Creek is approximately 9.3 miles in length and has an additional 11.3 miles in perennial tributaries, the most significant of which is Mill Creek. However, only 2.5 miles of the mainstem and less than one-quarter mile of the tributaries are estimated to be potentially usable coho salmon rearing habitat. At stream mile 3.4, the creek discharges from a mining tunnel. This prevents anadromous salmonids from ascending the upper portion of the watershed. Water diversion dams located at stream miles 0.5 and 0.75 on Mill Creek prohibit fish from utilizing the upper four miles of this tributary. San Vicente Creek does not have a lagoon; instead, the creek flows through a bedrock tunnel before discharging directly onto a beach and into the Pacific Ocean.

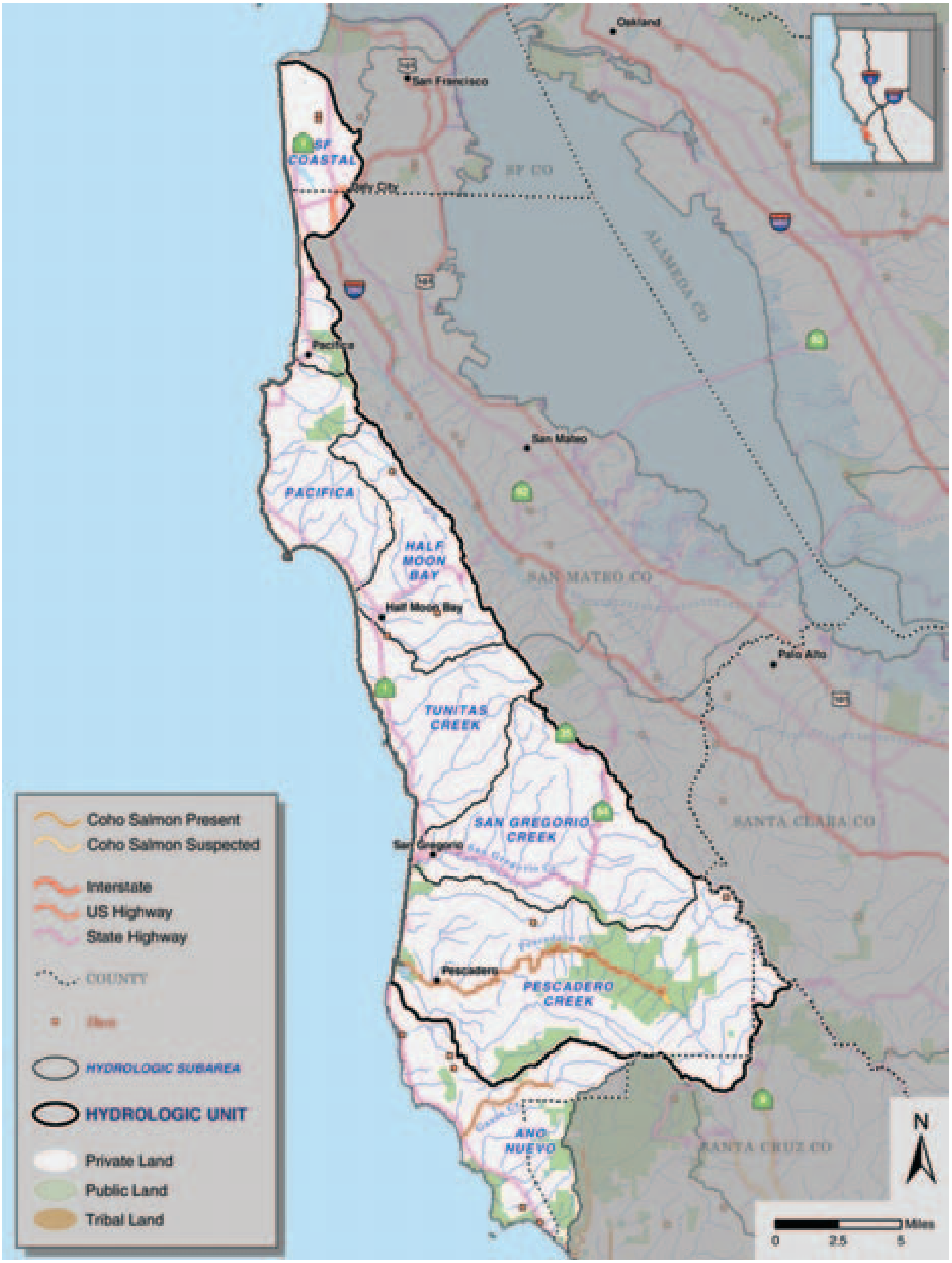
There are few definitive data on historical coho salmon abundance in this HSA due to limited field sampling. However, it is clear that coho salmon have been extirpated from many tributaries and all brood-year lineages have too few individuals to be self-sustaining. During recent surveys (2000 to 2002), coho salmon were found consistently in Scott Creek and some of its tributaries, but less consistently in Waddell Creek.

6.2.6.2 San Lorenzo River HSA

The San Lorenzo River originates in the Santa Cruz Mountains, and flows in a southerly direction before entering the Pacific Ocean in the City of Santa Cruz. The watershed encompasses an area of 138 square miles. The San Lorenzo River is approximately 26.3 miles in length and has several additional miles of perennial tributaries, the most significant of which are Boulder, Newell, Zayante, Fall, Kings, Bean, Carbonera, and Branciforte creeks. Approximately six miles of mainstem and 20.8 miles of tributary streams are considered potential coho salmon rearing habitat.

The majority of the watershed is privately owned. Land use in the watershed includes residential and commercial development, an extensive road infrastructure, timber harvest, agriculture, limited cattle grazing, recreation, equestrian facilities, and quarry operations. The San

FIGURE 6-21: San Mateo Hydrologic Unit



6 RECOVERY UNITS AND WATERSHEDS

FIGURE 6-22: Big Basin Hydrologic Unit

Lorenzo River watershed provides water to the communities of San Lorenzo Valley and Santa Cruz, thus stream flows are a critical issue in this watershed. During recent surveys (2000 to 2002), no coho salmon were found in the San Lorenzo River or any of its tributaries.

6.2.6.3 Aptos-Soquel HSA

This HSA is comprised of the watersheds of Soquel and Aptos creeks. Together, they cover an area of about 48 square miles. Soquel Creek is located approximately 2.5 miles south of the City of Santa Cruz in Santa Cruz County. Its mainstem is approximately 19 miles in length and has an additional 28 miles of perennial tributaries, the most significant of which are the West Branch Soquel Creek, and Hinckley, Hester, Bates, and Moores creeks. Approximately nine miles of the mainstem and tributaries are considered potentially usable coho salmon rearing habitat.

The Soquel Demonstration State Forest is approximately 4.2 square miles and essentially all other property in the watershed is privately owned. Land uses include residential and commercial development, an extensive road infrastructure, timber harvest, agriculture, recreation, quarry operations, limited cattle grazing, and equestrian activities. The City of Capitola actively manages the lagoon by building the sandbar and using a concrete flume. Because of extensive private ownership and water diversions, the resulting low summer and fall streamflows are a significant issue in the Soquel Creek watershed. In the 1970s, water rights in the Soquel watershed were adjudicated by court decree. The adjudication established relative priorities among diverters in the watershed, but did not specifically consider instream flow needs for fish protection and did not call for the appointment of a watermaster.

Aptos Creek is located approximately 8.5 miles south of the city of Santa Cruz in Santa Cruz County and enters the Pacific Ocean at Seacliff State Beach in the town of Aptos. Its mainstem is approximately 11.5 miles in length, but a 16-foot-high waterfall located at approximately stream mile 9.4 precludes anadromous salmonids from utilizing the headwaters. There are eight additional miles of perennial tributaries, the most significant of which are Bridge and Valencia creeks.

About 8.5 miles of Aptos Creek mainstem and approximately five miles of tributaries are considered potential coho salmon rearing habitat. To facilitate beach access, DPR manipulates the mouth of Aptos Creek each summer so that it discharges directly to the ocean. Most of Aptos Creek is owned by DPR (i.e., Nisene Marks State Park) or is privately owned; however, a small portion is owned by Santa Cruz County. Bridge Creek lies entirely within the State Park and Valencia Creek is entirely in private ownership. Land uses include residential and commercial development, a road infrastructure, recreation, agriculture, equestrian stables, and timber harvest. During recent surveys (2000 to 2002), no coho salmon were found in Aptos or Soquel creeks.

6.3 WATERSHED PRIORITIZATION

The Recovery Strategy incorporates a three-tiered process to prioritize watersheds for coho salmon recovery. This approach:

a. Identifies for maintenance and recovery those watersheds supporting key coho salmon populations in California and identifies those populations that are currently at risk of extinction;

b. Provides a ranking system for guiding recovery planning actions among watersheds; and

c. Identifies those watersheds with barriers to migration that could be corrected with ease, relative to other solutions.

This process was developed from a review of data available for coho salmon and their watersheds throughout California, as well as CRT discussions. Maps developed to guide recovery actions are provided below (Figures 6-23 through 6-30). Appendix F describes how these maps were developed and defines terms used in the following discussion. The maps, and criteria used to develop them, should be considered general guidelines for watershed recovery planning and restoration actions rather than absolute.[1]

6.3.1 GENERAL PRINCIPLES

In HSAs considered refugia for coho salmon, the Recovery Strategy will include actions that preserve, protect, and enhance these key populations and their habitats. These HSAs, identified in Figures 6-23 and 6-24 (Consistent presence of coho salmon in the SONCC and CCC Coho ESUs, respectively), are top priorities for Department resources and other resources available for habitat restoration.

Each population of coho salmon potentially represents unique genetic and life history attributes. Some populations of coho salmon are at greater risk of extinction than others, particularly those in the central coast of California. Identifying these populations will enable resource managers and others to guide actions to avoid extinction and begin recovery. HSAs in which populations of coho salmon are at high risk of extinction, identified in Figures 6-25 and 6-26 (Risk of extinction in watersheds of the SONCC and CCC Coho ESUs, respectively), will receive special consideration for maintenance and recovery actions.

Ranking of HSAs relative to their potential for coho salmon recovery is intended to guide recovery strategy actions that may improve habitat within these watersheds. This ranking incorporated information on coho salmon populations, HSA condition, and risks to coho salmon within these HSAs. HSAs scoring higher in this ranking should be given priority in the expenditure of resources available for restoration, other considerations being equal. HSA rankings for maintenance and recovery actions are presented in Figures 6-27 and 6-28 (Restoration and management potential in the SONCC and CCC Coho ESUs, respectively).

Recovery strategy actions in HSAs with barriers to migration will include providing passage for both juvenile and adult coho salmon. The distribution of barriers is illustrated in Figures 6-29 and 6-30 (disconnected habitat in the SONCC and CCC Coho ESUs, respectively). HSAs with quality habitats and few barriers should be viewed as cost-effective opportunities to provide increased habitat, relative to other recovery strategy actions.

The databases used to generate the maps and support this prioritization should be updated periodically, perhaps at three- to five-year intervals. This would allow review and modification, if warranted, of the HSA rankings.

Finally, the prioritization criteria proposed is for recovery of coho salmon, as per CESA and FGC, and may or may not apply to other salmonid species such as Chinook salmon, steelhead, and coastal cutthroat trout.

[1] Some situations may override or alter recommended priorities. Examples include, but are not limited to, willing landowners, high cost shares, unique funding opportunities or partnerships, multi-species projects, etc. Cost effectiveness must be considered regardless of priorities.

6.3.2 PRIORITIZATION PROCESS

The three steps followed to prioritize the watersheds are described in this section.

6.3.2.1 Identify Refugia Watersheds (Figures 6-23 and 6-24) and Risk of Extinction (Figures 6-25 and 6-26)

Rationale: Those HSAs in the SONCC Coho ESU with consistent presence of greater than 50% should be considered refugia watersheds. HSAs in the CCC Coho ESU having consistent presence of greater than 10% should also be considered refugia watersheds. However, even these watersheds have problems that could reduce productivity and these problems should be addressed.

Risk of extinction to coho salmon is ranked on watershed risks and coho salmon population parameters, since population abundance and genetic data are not available range-wide. The ranking combines risk (human density, water diversions, road density) and population parameters (consistent presence of coho salmon, isolation index for coho salmon populations, and run length of coho salmon populations). Those HSAs in which risk of extinction is high should be given equal priority as refugia watersheds.

Anticipated Actions:

a. On public lands, consider full maintenance and recovery of instream and riparian areas.
b. On private lands, provide incentives for riparian maintenance and recovery strategy activities that maintain and enhance coho salmon habitat.
c. Identify any problems within these watersheds and recommend actions (for example; restoring estuarine habitats in Eureka Plain, Redwood Creek and Smith River).
d. Prioritize biological refugia watersheds in the application of California coho salmon range-wide recommendations.

6.3.2.2 Identify Restoration Potential (Figures 6-27 and 6-28)

Rationale: HSAs with high scores for recovery strategy actions are known to support populations of coho salmon and have potential habitat that has been compromised. Coho salmon populations in HSAs ranking high (4-5) in the combined population, risk and habitat potential categories should have potential to respond when restoration actions are taken.

Anticipated Actions:

a. Determine if near-term (< 9 years) actions are adequate to maintain these populations at their current level.
b. Determine if near-term and long-term actions will allow for expansion of these populations in all brood years.
c. If identified recovery strategy actions satisfy categories (a) and (b) above, use the prioritization scheme to guide watershed restoration and other identified recovery strategy actions. If identified recovery strategy actions do not satisfy categories (a) and (b) above, then recommendations must be upgraded.
d. Develop recommendations specific enough to direct restoration actions.
e. Work with existing watershed groups in priority HSAs and with willing landowners on watershed assessments to develop specific actions to restore coho salmon habitat.

6.3.2.3 Identify Disconnected Habitats (Figures 6-29 and 6-30)

Rationale: Eliminating barriers to migration is among the most effective restoration actions that can be taken. Barriers to migration limit the distribution of coho salmon and limit recovery potential. Removing barriers, including but not limited to those created by Federal, State, county or private road culverts, rail crossings, tide gates and small impoundments are high priorities. Addressing levees for flood control, access over larger impoundments, or other hydraulic or thermal barriers may present greater challenges, but must also be considered important components of disconnected habitats.

Anticipated Actions:

a. Identify and map the specific locations of barriers and score barriers using two criteria: 1) the amount of coho salmon habitat made accessible by their removal and 2) the relative ease or cost of their removal (culverts, tide gates and small impoundments = 3, levees and large impoundments = 2, thermal and hydraulic barriers, and other barriers requiring site-specific evaluation = 1).
b. Where appropriate, implement existing recommendations that are specific enough to direct barrier elimination.
c. Develop additional, needed recommendations for barrier elimination.

FIGURE 6-23: Consistent presence of coho salmon in the SONCC Coho ESU

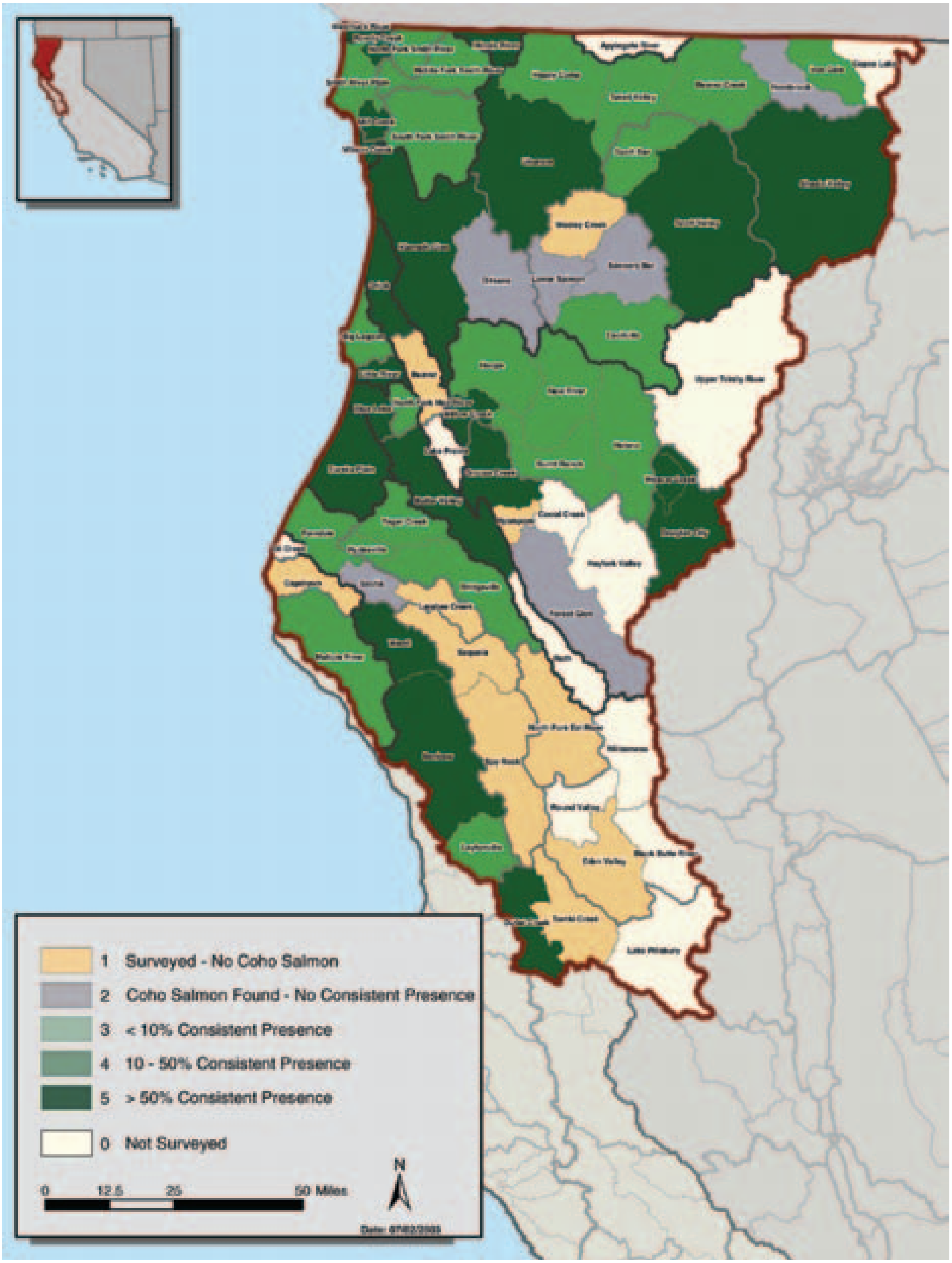


FIGURE 6-24: Consistent presence of coho salmon in the CCC Coho ESU

FIGURE 6-25: Risk of extinction in watersheds in the SONCC Coho ESU

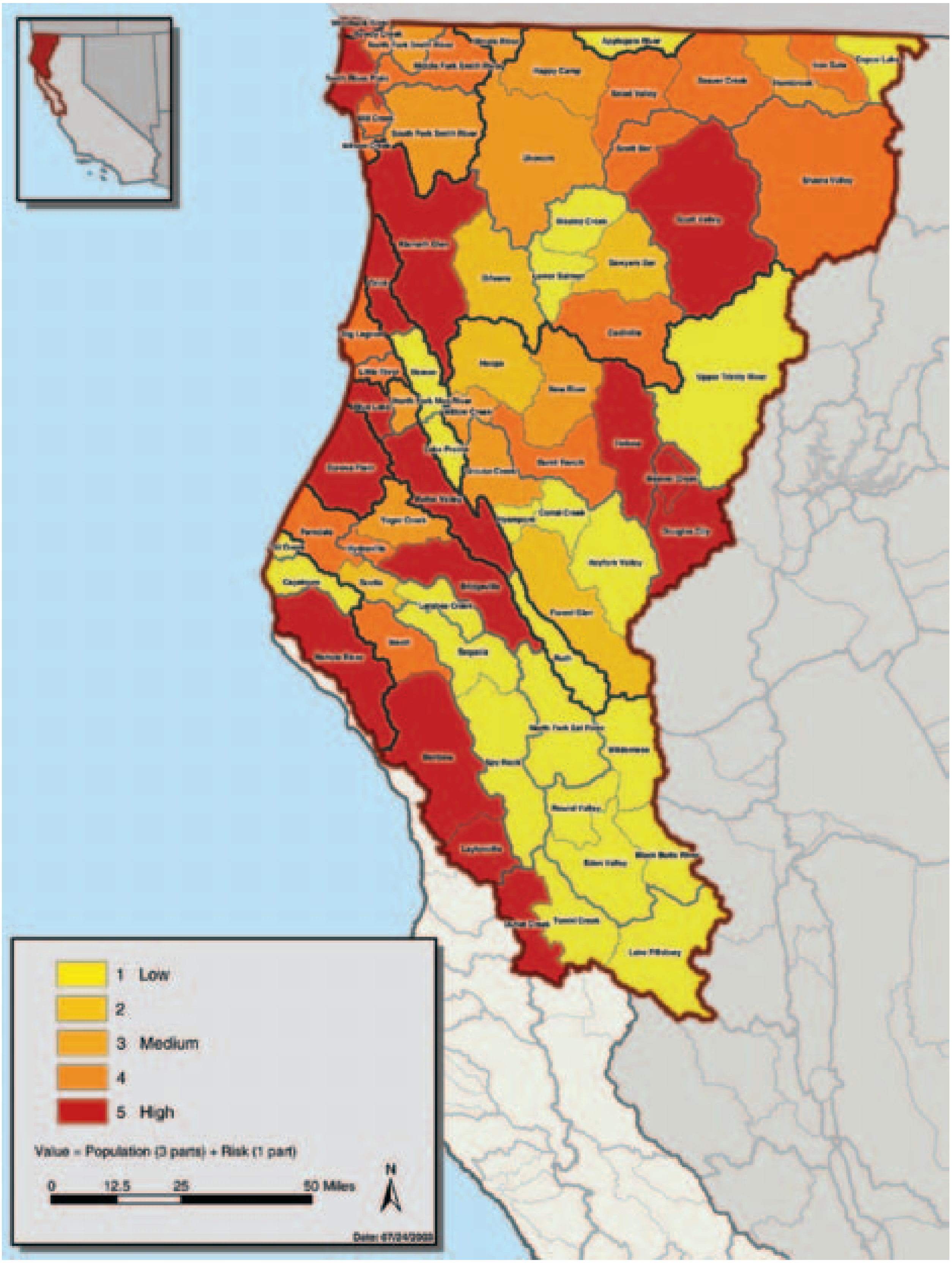


FIGURE 6-26: Risk of extinction in watersheds in the CCC Coho ESU

FIGURE 6-27: Restoration and management potential in the SONCC Coho ESU

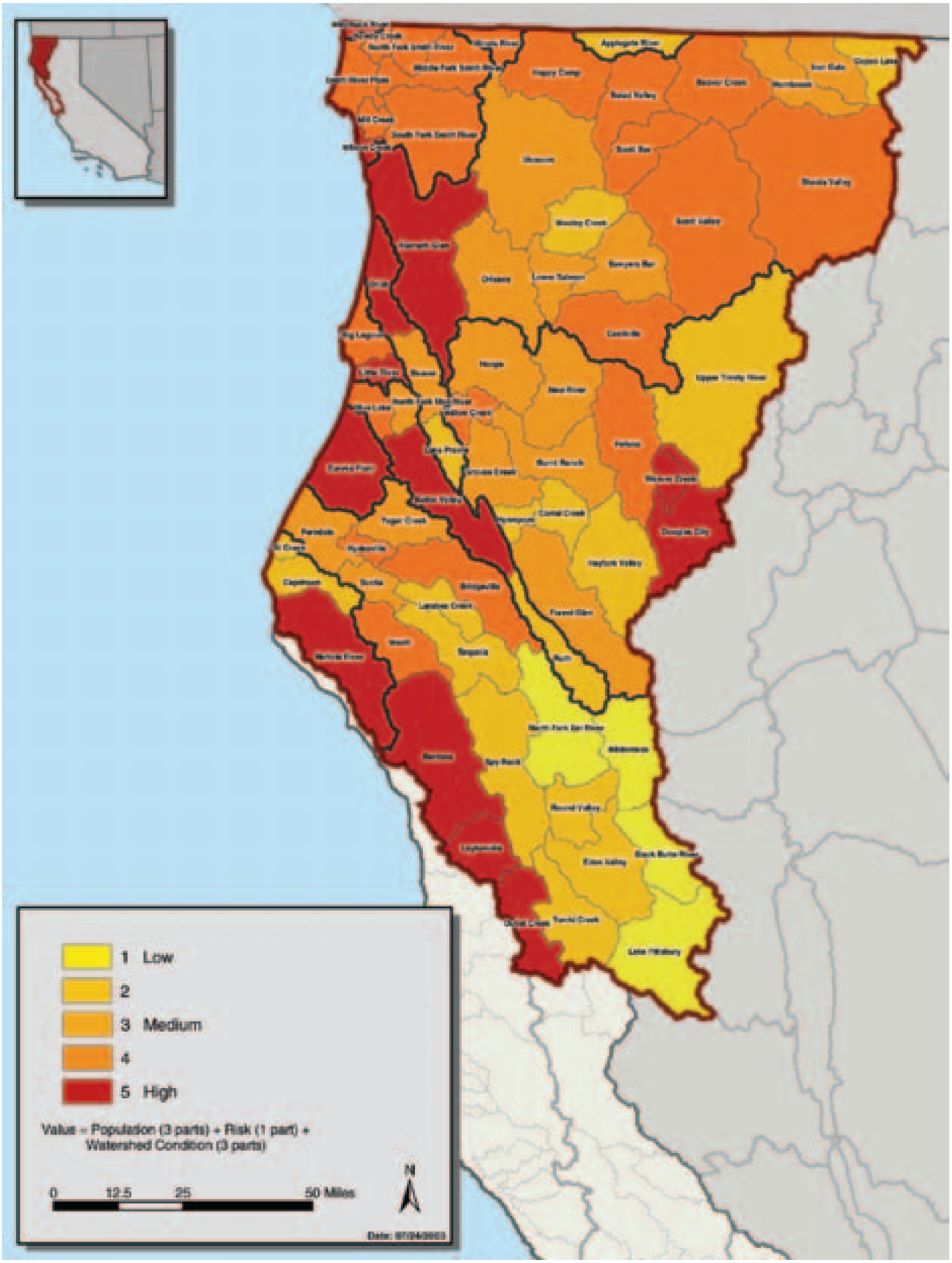


FIGURE 6-28: Restoration and management potential in the CCC Coho ESU

FIGURE 6-29: Disconnected habitat in the SONCC Coho ESU

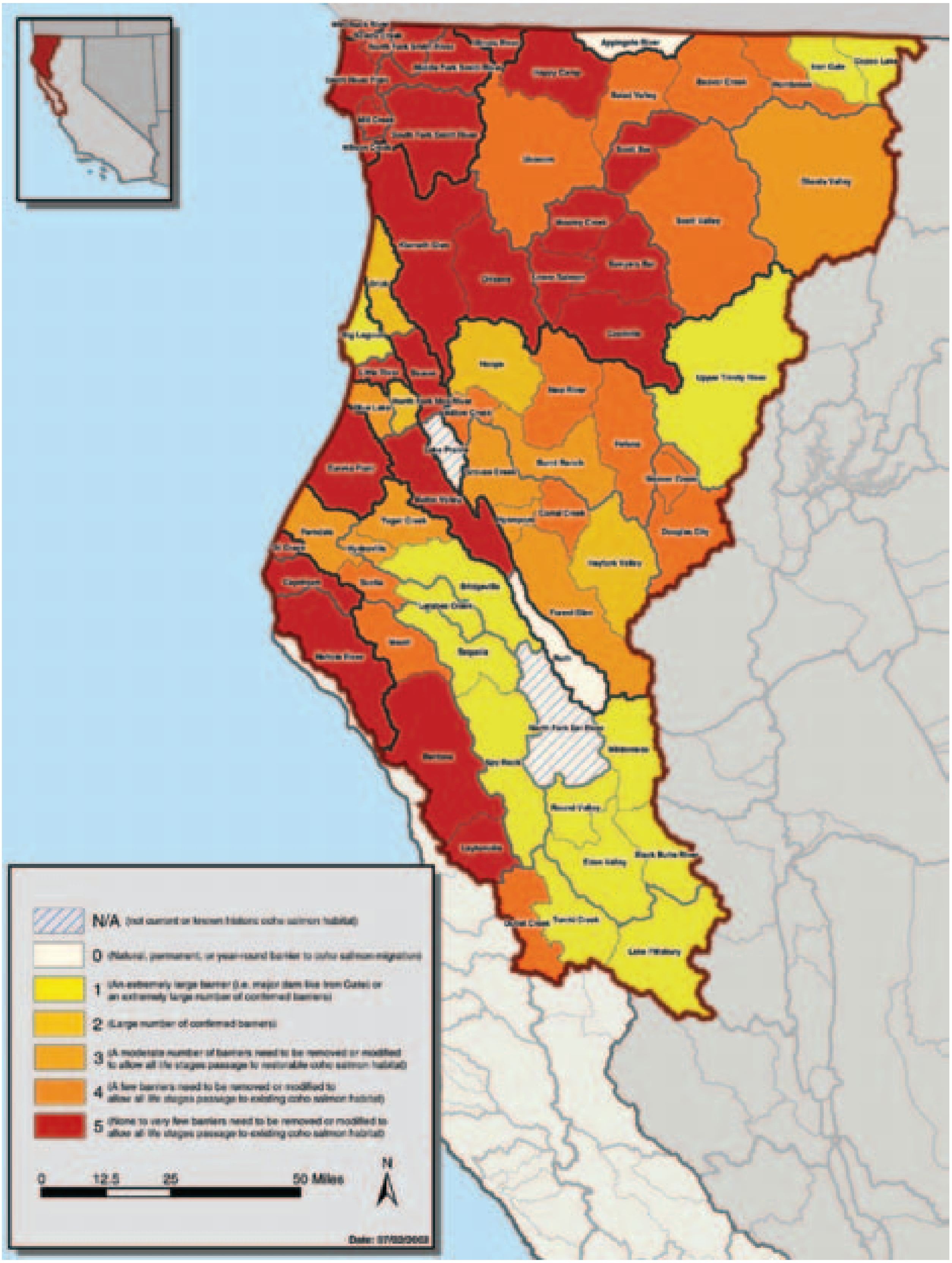
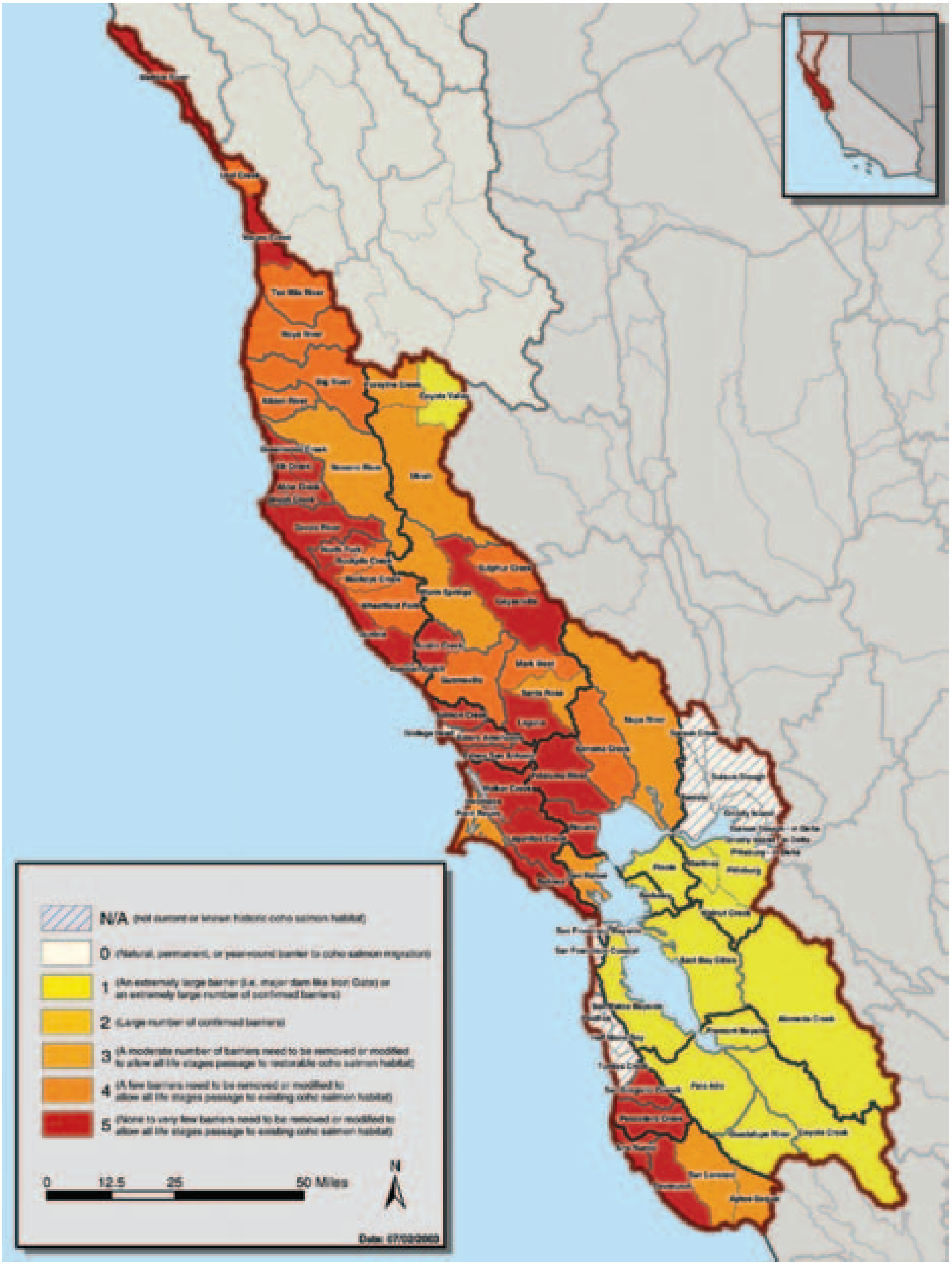


FIGURE 6-30: Disconnected habitat in the CCC Coho ESU



7 Range-wide Recommendations

Many of the potential recovery actions to address the threats and issues discussed in Chapter 3 have application across most, if not all, of the range of coho salmon in California. These issues do not necessarily threaten or impact coho salmon everywhere or to the same degree across the range. The CRT developed the following recommendations with the exception of numbers RW-LW-07, RW-LW-08, RW-IN-18, and RW-EN-24, which were developed by the Department. In a few cases, the Department has modified recommendations that were developed by the CRT. The Timber Management Recommendations (section 7.24) are a hybrid of various alternatives crafted by a subgroup of the CRT. In February 2004, the Commission approved the Timber Management Recommendations for inclusion in this Recovery Strategy. An implementation schedule, which includes identified action entities and timelines, is provided for these recommendations in Table 9-1.

Recommendation numbers presented below were used during CRT discussions and are not sequential. They are presented here only as unique identifiers for reference to individual recommendations and to maintain a permanent record of the CRT process.

7.1 STREAMFLOW

RW-I-B-01	Encourage the use of passive diversion devices designed to allow diversion of water only when minimum flow requirements are met or exceeded. Identify and develop adequate passive diversion structure designs.
RW-I-C-01	Encourage cooperative effort to plan water supply development and growth that are not harmful to coho salmon habitat. Work in coordination with the California Department of Housing and Community Development, Association of Bay Area Governments, counties, cities, water districts, and others. Provide funding and education to accomplish this.
RW-I-D-01	Encourage elimination of unnecessary and wasteful use of water from coho salmon habitat, through education components of this strategy. Encourage water conservation for existing uses.
RW-I-D-02	Improve coordination between agencies to avoid and minimize the adverse effects of future or reopened permits and licenses for water diversions on coho salmon. Promote consistency and pool limited resources to implement a regional interagency task force for regional project review (water rights, 1600, CESA). Include staff that represent the Department, SWRCB, RWQCB, NOAA Fisheries and, where applicable, other agencies. Where feasible, use programmatic, cost-efficient approaches and incentives to working with landowners to permit off-channel storage ponds. For the CCC Coho ESU, the SWRCB shall consider the June 23, 2002 Draft Guidelines developed by NOAA Fisheries and the Department in the water rights proceedings for

streams with coho salmon including season of diversion and off-stream storage, and maintenance of the natural hydrograph, where appropriate. Encourage NOAA Fisheries and the Department to work with SWRCB to modify the guidelines to be appropriate to the SONCC Coho ESU as needed.

RW-I-D-03 Provide conservation incentives to minimize negative effects of water drafting for roads and fire suppression, including, but not limited to:

a. Streamline permitting for actions that result in an improvement of instream flows;

b. Support multiple uses of water storage systems (e.g., USFS, CDF, counties, landowners); and

c. Cost-share funding where low-flow, trickle recharge water storage is used to avoid adversely affecting streamflow or coho salmon habitat.

RW-I-D-04 Evaluate the rate and volume of water drafting for dust control in streams or tributaries and where appropriate, minimize water withdrawals that could impact coho salmon. When feasible, use alternatives to water as a dust palliative (including EPA-certified compounds) that are consistent with maintaining or improving water quality.

RW-I-D-05 Explore ways to improve implementation of the Department's Lake or Stream Alteration Notification and Agreement process to protect coho salmon from the adverse affects of projects that would alter the bed, banks, channel, or natural flow streams.

RW-I-D-06 Pursue funding for the assessment, cataloging, and compliance monitoring of water diversions within the range of coho salmon. Upgrade the existing water rights information system so that water allocations can be readily quantified by watershed.

RW-I-D-08 Support a comprehensive streamflow evaluation program to determine instream flow needs for coho salmon in priority watersheds.

7.2 WATER RIGHTS

RW-II-A-01 Review authorized diversions that have no provisions to protect coho salmon. Review should be conducted in order of priority for streams with coho salmon habitat.

RW-II-A-02 Identify unauthorized diversions.

RW-II-A-04 Where flows are a limiting factor in priority coho salmon habitat, petition the SWRCB to add streams to the Declaration of Fully Appropriated Streams.

RW-II-A-05 Inventory water use and water availability in streams with coho salmon habitat. Ensure that water availability analyses on priority coho salmon habitat accurately reflect existing water use and availability. Require streamflow gauging devices on priority coho salmon streams when approving water development projects. Continue to require riparian and pre-1914 water users to file annual statements of diversion and use.

RW-II-B-01 Pursue opportunities to acquire or lease water, or acquire water rights from willing sellers for coho salmon recovery purposes. Develop incentives for water right holders to dedicate instream flows for the protection of coho salmon (Water Code §1707).

RW-II-B-02 Evaluate the cumulative effects to coho salmon from the creation of new riparian water rights associated with land subdivisions and rezonings. Where cumulative impacts on flows will be detrimental to coho salmon, consider mitigations or conditions that would protect coho salmon or avoid adverse effects to coho salmon. Conditions could include requirements that would not allow riparian water rights for new parcels at the time subdivision approvals are made.

RW-II-B-03 Within the range and distribution of coho salmon, diversion screens should be constructed, repaired, upgraded, reconstructed, and maintained in accordance with Department/NOAA Fisheries Screening Criteria.

7.3 FISH PASSAGE

RW-III-A-01 Continue and complete assessments and prioritizations for correction of fish passage barriers.

RW-III-A-02 Develop and maintain a database of barriers to fish passage.

RW-III-C-01 Encourage funding authorities to allocate adequate resources to construct new crossings and upgrade existing crossings (bridges, culvert and fills, other crossings) within the range of coho salmon to accommodate 100-year flows and associated bedload and debris. Priority for upgrading should be based upon the potential impact to coho salmon habitat.

RW-III-C-02 Evaluate NOAA Fisheries standards for passage at summer dams, and if necessary, develop additional policies and guidelines for passage at summer dams. Implement appropriate recommendations resulting from this process.

RW-III-C-04 Encourage the Federal Emergency Management Agency (FEMA) to fund upgrades to flood-damaged facilities to meet the requirements of the ESA.

RW-III-C-06 Encourage funding authorities to allocate adequate budgets to Federal, State, and local agencies for fish passage projects. This includes, but is not limited to, funding for road maintenance programs and capital project activities.

7.4 POLLUTANTS

RW-V-B-01 Improve water quality by reducing or minimizing point and non-point sources of nutrient input (i.e. sewage treatment plant discharge, septic system discharge, storm drain runoff, and agricultural runoff). Support efforts by cities and rural communities to complete system upgrades to achieve CWA compliance.

RW-V-E-01 Continue outreach, education, and enforcement related to hazardous materials spills, illegal dumping, and household hazardous waste and hazardous materials spills in creeks. Provide education on the CalTIP program.

RW-V-E-03	Continue to fund and support the CalTIP program. Provide additional training for Wardens to identify water pollution problems and promote coordination with other responsible agencies. Coordinate water rights training for resource agency personnel.

7.5 SEDIMENTS

RW-VI-A-02	Identify and prioritize specific sediment source locations for treatment that may deliver sediment to coho salmon streams. Encourage the use of protocols, such as the California Stream Habitat Restoration Manual Guidelines. Work with others to educate and provide technical assistance to landowners to implement upgrades.
RW-VI-B-01	Encourage agencies and landowners to restore natural drainage patterns and minimize hydrologic connectivity of roads, where feasible. Encourage funding agencies to provide annual funding for implementation of the program.
RW-VI-B-02	Continue to fund and provide technical support to local government and private landowner actions to reduce identified sediment input from upslope sources. Basin-wide assessments should prioritize remediation activities, which would include slope stabilization and minimizing sediment production.
RW-VI-D-01	Encourage Federal, State, and county agencies and private landowners to reduce impacts to coho salmon habitat from public and private road systems. Continue road and/or watershed assessments to identify and prioritize sources and risks of road-related sediment delivery to watercourses. Support activities to: a. Reduce road densities where necessary and appropriate; b. Upgrade roads and road-maintenance practices to eliminate or reduce the potential for concentrating run-off to streams during rainfall events. Employ best available technology when appropriate; c. Encourage measures to reduce sediment delivery from unpaved roads; d. Decrease potential for streamflow to become diverted at road crossings during high flow events, resulting in flow along the road that returns to the channel at undesirable locations; e. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; f. Minimize alteration of natural hill slope drainage patterns; and g. Encourage funding authorities to allocate adequate budgets to Federal, State, and local agencies and private landowners for road maintenance activities, capital project activities, and dedicated funding to pay for fish passage projects.

7.6 WATER TEMPERATURE

RW-X-B-01	Identify and implement actions to maintain and restore water temperatures to meet habitat requirements for coho salmon in specific streams.

RW-X-B-02	Offer funding and permit incentives to restore stream habitat where lack of LWD, riparian cover, simplified stream morphology and other conditions have been determined to be limiting factors to coho salmon habitat.

7.7 LARGE WOODY DEBRIS

RW-XII-B-01a	Identify those riparian vegetation communities that provide good opportunities for conifer LWD recruitment to coho salmon habitat. Communicate the importance of these riparian communities to appropriate agencies, restoration funding groups, and landowners, and work to maintain them in a healthy condition. Address and identify possible solutions to potential conflicts between flood management activities and maintenance of riparian vegetation and large woody debris.
RW-XII-B-01b	Prioritize riparian vegetation communities for the purposes of restoring conifer LWD recruitment.
RW-XII-B-02	Funding authorities should provide funding and technical support for riparian restoration.
RW-LW-07	Encourage management practices that promote conifer recruitment to provide short-term and long-term restoration of LWD and stream shade.
RW-LW-08	Encourage Federal, State, and county agencies and private landowners to protect instream LWD to the greatest extent practicable without endangering public safety, life or property.

7.8 STREAM COMPLEXITY

RW-XIII-C-01	Modify channel or flood control maintenance manuals for consistency with habitat requirements and protection for coho salmon.
RW-XIII-C-02	Where appropriate and feasible, work with all parties, including landowners, to reconfigure levees and channelized streams to benefit coho salmon.

7.9 REFUGIA

RW-XV-A-01	Identify key coho salmon refugia and inform land managers and other agencies of their locations and characteristics.
RW-XV-A-02	Identify core coho salmon populations, inform land managers and other agencies of their locations, and implement measures to maintain those populations.
RW-XV-B-01	Maintain or re-establish geographic distribution of coho salmon by continuing to allocate substantial improvement efforts towards identified key refugia with substantial coho salmon populations and/or otherwise suitable conditions.

7.10 HABITAT FRAGMENTATION

RW-XVI-B-01	Restore habitat connectivity between coho salmon populations in coastal and low-gradient inland streams to promote the long-term viability of coho salmon.
RW-XVI-B-02	Reduce habitat fragmentation by restoring fish passage between high quality habitat channels to allow for gene flow between breeding populations within targeted coho salmon watersheds.

7.11 COMPETITION

RW-XVIII-A-01	Develop a rapid-response eradication plan that can be implemented when invasive non-native species that negatively affect coho salmon are newly detected.
RW-XVIII-A-02	Develop management guidelines to mitigate the impacts of non-native fish species on coho salmon.
RW-XVIII-A-03	Encourage removal of non-native fish species from stock ponds where these fish pose a threat to coho salmon.

7.12 HATCHERY OPERATIONS, GENETICS, AND RELOCATION

RW-XX-B-01	Promote recovery actions that maintain the local genetic diversity of coho salmon populations to maximize fitness and long-term viability of coho salmon populations.
RW-III-C-03	Evaluate the desirability and feasibility of relocating stranded juvenile coho salmon to nearby underutilized high quality habitat. Develop a policy addressing this issue, and implement recommendations arising from the evaluation.
RW-XXI-A-01	Adopt draft policy for recovery hatcheries (Appendix G).
RW-XXI-A-02	Adopt draft guidelines for recovery hatcheries (Appendix H).

7.13 RIPARIAN VEGETATION

RW-XXII-A-02	Where necessary, provide riparian protection from livestock while providing off-stream watering.
RW-XXII-A-04	Encourage restoration of LWD and shade by improvement of existing riparian zones through planting, release of conifers or other appropriate native species, and control of blackberries and other competitors. The Department and others should provide incentives to landowners, such as technical support.
RW-XXII-A-05	Inventory and evaluate on a site-specific basis the adequacy of stream buffer zones and riparian and wetland habitat on public and private lands. This review should be coordinated between all agencies with regulatory jurisdiction.
RW-XXII-A-06	Develop and implement initiatives, including funding where appropriate, to improve stream buffers that have been determined to be inadequate.

7.14 ESTUARIES

RW-XXIII-E-01 Restore estuarine habitat and the associated wetlands and sloughs by providing fully functioning habitat. Fully functioning habitat includes:

a. Restoration of historic estuarine areas to maximize available estuarine habitats and tidal prisms;
b. Free passage for adult and juvenile coho salmon to all estuarine areas;
c. Adequate instream structure (cover and complexity);
d. Adequate riparian habitat;
e. Eradication of invasive exotic flora and fauna;
f. Protection of habitat quality by providing suitable water quality and quantity input to estuaries;
g. Protection and restoration of coho salmon prey habitat; and
h. Minimizing artificial breaching and associated potential negative impacts.

7.15 LAND USE

RW-XXV-A-01 Continue providing subvention funds to counties for Williamson Act contracts to help preserve a rural landscape for more effective recovery of coho salmon.

RW-XXV-B-03 Where necessary, revise General Plans, Local Coastal Plans, and/or Community Development Plans to direct development away from riparian habitats on coho salmon streams or tributaries. Establish incentives and standards to protect riparian and wetland areas on private lands, based on flexible subdivision design and other cooperative land development mechanisms.

RW-XXV-B-04 Encourage continued economically sustainable management of forest and agricultural lands in the range of coho salmon to reduce the potential for conversion to residential or commercial development.

RW-XXV-B-05 Evaluate range-wide the adequacy of riparian buffers and development setbacks where needed for protecting riparian and wetland habitat on county, city, and private lands adjacent to coho salmon streams.

RW-XXV-B-07 Develop and implement county, city, and landowner initiatives to expand inadequate stream buffers and protect riparian and wetland habitat for coho salmon recovery.

RW-XXV-C-01 Acquire conservation easements or land in fee title from willing landowners to protect coho salmon habitat.

7.16 PUBLIC OUTREACH

RW-XXVIII-A-01 Develop and provide informative programs for Registered Professional Foresters, Licensed Timber Operators, and other natural resource professionals regarding coho salmon and their habitat.

RW-XXVIII-A-03 The Department and the Commission should set up a periodic recognition program for watershed groups and stakeholders that are helping to implement the coho salmon recovery strategy.

RW-XXVIII-B-01 Support local governments, interested parties, and property owners in the development of incentives for landowners who participate in activities that exceed legal requirements or timelines to protect and/or restore coho salmon habitat and watershed processes.

RW-XXVIII-B-03 Encourage local governments to incorporate protection of coho salmon in flood management activities consistent with Department, RWQCB, NOAA Fisheries, and USACE requirements.

RW-XXVIII-B-04 Provide information to staff of counties and incorporated areas about the importance and requirements to develop and implement performance standards in Stormwater Management Plans.

RW-XXXIII-A-23 Provide educational materials, outreach and training for issues such as sport fishing (inadvertent incidental take), poaching (direct take) and habitat destruction (LWD removal, riparian destruction, illegal stream crossings, pollution, illegal water withdrawal, etc.).

RW-XXVIII-C-01 Educate and train restoration specialists and watershed restoration groups on the coho salmon recovery strategy.

7.17 INTEGRATION WITH OTHER PLANS AND PROGRAMS

RW-XXX-A-01 The California Board of Forestry should continue to support the Threatened and Impaired Watersheds Rules.

RW-XXX-A-02 Recommend that CDF amend FPRs to require that Registered Professional Foresters certify in timber harvesting plans that they have followed the California Licensed Foresters Association Guide to Determining the Need for Input from a Licensed Geologist during THP Preparation.

RW-XXX-A-03 Recommend that CDF use statistical analysis of land failure and sediment yield to strengthen protection in geologically unstable areas.

RW-XXX-A-04 Conduct implementation and effectiveness monitoring for Nonindustrial Timber Management Plans.

RW-XXX-B-01 As feasible, prepare and implement TMDL plans on a schedule that gives priority to key coho salmon watersheds.

RW-XXX-B-02 Request that RWQCBs' TMDL process quantify and allocate increased sediment loads that might result from restoration activities.

RW-XXX-B-05 Ensure that TMDL standards provide protection for coho salmon.

RW-XXX-B-06	Conduct outreach to State agencies and local governments to encourage their participation in the TMDL process to ensure the standards provide protection of coho salmon.
RW-XXX-D-01	Implement Fire Safe Councils' recommendations promoting the reduction of fuel near residences, while addressing impacts to other listed species, to reduce human-caused fires spreading into the forest and causing harm to coho salmon habitat.
RW-XXX-D-03	Encourage agencies and stakeholders to work together on a long-term basis to develop a process to incorporate coho salmon recovery considerations in fire reduction and fuel management strategies.
RW-XXX-D-04	Establish fire regimes to promote watershed function and health and to reduce the risk and impact of extensive, high severity fire on coho salmon and habitat.
RW-XXX-D-05	Identify areas within coho salmon range that are susceptible to extensive, high severity fires.
RW-XXX-D-06	Identify State of perturbation (=disturbance regime) in watersheds within coho salmon range to determine potential, deleterious shifts from ecological functioning regimes.
RW-XXX-D-07	Restore aquatic habitat structure and life history complexity of coho salmon populations in areas susceptible to extensive, high severity fires.
RW-XXX-E-01	Continue to implement FishNet 4C and Five County Salmon Restoration goals, including adopting and implementing written Operations and Maintenance Guidelines, training staff on guidelines, addressing fish passage and road sedimentation issues, developing riparian protections, promoting alternatives to conventional bank stabilization, and developing land use policies favorable for coho salmon.
RW-XXX-E-02	Incorporate the FishNet 4C and Five County adopted Roads Operations and Maintenance Guidelines within incidental take authorizations under CESA and as part of the coho salmon recovery strategy.
RW-XXX-F-01	Encourage NOAA Fisheries to work with USACE to reduce the impacts to coho salmon of USACE projects.
RW-XXX-J-01	After delisting is achieved, review the Recovery Strategy to determine how to continue implementation of appropriate elements of the Recovery Strategy, pursuant to and consistent with other applicable local, State, and Federal law and voluntary measures, to achieve restoration of Tribal, recreational, and commercial fisheries and avoid relisting of the species.
RW-IN-18	Encourage USFS implementation of the Aquatic Conservation Strategy as outlined in the Northwest Forest Plan, and specific Standards and Guidelines identified in the Land and Resource Management Plan for each National Forest in the range of California coho salmon.

7.18 PERMITTING

RW-XXXI-A-01 Federal, State, local governments and other interested parties should cooperate to develop regulatory assurance mechanisms to encourage land managers, local governments, and landowners to implement coho salmon habitat restoration and/or enhancement projects.

RW-XXXI-A-02 Coordinate with the SWRCB and appropriate RWCBs to implement water quality monitoring and streamline permitting of coho salmon habitat enhancement and/or restoration projects (RWQCB 401, USACE 404, NOAA Fisheries, and USFWS permitting).

RW-XXXI-A-03 Encourage State, Federal, and local governmental agencies to work with stakeholders in identifying ways to remove regulatory barriers (e.g., permitting and environmental review) to expedite activities that will contribute to the recovery of coho salmon. Examples of ideas to consider may be:

a. The creation of local permit assistance centers;

b. Seeking categorical exemptions from CEQA; and

c. Seeking a certified regulatory program under CEQA for certain activities.

RW-XXXI-A-04 Encourage the Department, NOAA Fisheries, USFWS, and USACE to coordinate and develop programmatic incidental take authorizations (e.g., 404 permits, section 7 consultations, 4(d) rules) for activities that will contribute to the recovery of coho salmon, including but not limited to the Department's Fisheries Restoration Grants Program.

RW-XXXI-A-05 Support the Department in seeking new funding to pay for environmental review and permitting of voluntary projects that will contribute to the recovery of coho salmon.

RW-XXXI-A-06 Develop and issue management memoranda of understanding under §2081(a) to participants as an incentive for voluntary activities that will contribute to the recovery of coho salmon.

RW-XXXI-A-07 Consider whether the Task Force on Removing Barriers to Restoration (Resources Agency) recommendation suggesting counties adopt ordinances to exempt restoration and/or enhancement projects from indemnification requirements is appropriate and/or desirable in the context of coho salmon recovery.

RW-XXXI-A-09 Instream restoration (structures, crossings, road decommissioning, etc.) should be allowed to begin the same time as THP activities (that require similar 1600 agreements). This would allow for an extra month in the beginning of the restoration season.

RW-XXXI-A-10 Amend grading ordinances to exempt restoration and/or enhancement activities approved by the Department fishery grants program within certain categories (specified by the county or others).

RW-XXXI-A-11 Support adequate staffing and funding for the Department restoration program to complete contracts in a timely manner (including review, site visits, etc.).

RW-XXXI-A-12 Seek a small restoration projects categorical exemption.

RW-XXXI-A-13 Create a new CEQA Categorical Exemption for barrier removals that meet the Department and NOAA Fisheries natural stream simulation criteria for passage.

RW-XXXI-B-02 Encourage State, Federal, and local governmental agencies to place greater emphasis on coordinating:

a. The permitting process (including environmental review) while ensuring protection of coho salmon and their habitat; and

b. Implementation of programs affecting coho salmon.

RW-XXXI-B-06 Where mitigation for otherwise lawful activities would mitigate for authorized take of coho salmon and contribute to recovery of coho salmon, encourage the Department to streamline the incidental take permitting process by developing guidelines for allowable take and for the issuance of incidental take permits under §2081(b).

RW-XXXI-B-07 To minimize and reduce the effects of water diversions, direct the Department to work with the SWRCB, present supportive evidence, and actively participate in making recommendations needed to implement provisions of the FGC. This may include:

a. Identifying and implementing actions to improve coordination between the agencies and others to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and their habitat including spawning gravel and natural hydrograph, and avoidance of adverse impacts caused by water diversion;

b. Funding of assessment and geographic information system (GIS) mapping of water diversions and determination and monitoring of FGC §1600 program compliance related to water diversions; and

c. Evaluating requests for on-stream dams on coho salmon streams above migratory reaches for the effects on the natural hydrograph and the effects on the supply of spawning gravel for recruitment downstream.

7.19 WATERSHED PLANNING

RW-XXXII-B-02 Provide adequate funding to the agencies to coordinate and support preparation of comprehensive watershed assessments and restoration plans that:

a. Include a professional fisheries scientist;

b. Assess streamflow, water diversions, water quality, sediment sources, fish barriers, riparian corridors, instream habitat, estuarine habitat, and land use, as necessary; and

c. Identify, prioritize, and implement site-specific restoration projects to benefit coho salmon.

RW-XXXII-B-03 Review existing, approved watershed management or restoration plans within the range of coho salmon and implement actions consistent with priority recommendations of the coho salmon recovery strategy.

7.20 ENFORCEMENT OF EXISTING LAWS

RW-XXX-C-01 Request that the Coastal Commission require landowners to fund restoration of impacted coho salmon habitat resulting from project construction without proper review and approvals.

RW-XXXIII-A-01 Support enforcement of existing laws, codes, regulations, and ordinances that address the protection of coho salmon and their habitat. Habitat includes but is not limited to water (quality and quantity), pools, riffles, instream LWD, riparian vegetation and estuaries. Existing laws, codes, regulations, and ordinances include, but are not limited to FGC §§1600, 5650, 5900 through 6100 (with an emphasis on 5901, 5937, and 6100), PRC §§ 10000-10005, CESA, and the ESA. The term "enforcement" includes, but is not limited to, education, issuing warnings, issuing citations, developing cases for referral to district attorneys offices and/or the Office of the Attorney General.

RW-XXXIII-A-02 Provide adequate budgetary funding and positions for agencies with enforcement authority to enforce laws and codes relevant to coho salmon protection.

RW-XXXIII-A-03 Review diversions and use of water in priority coho salmon streams to determine which permits and/or licenses need modification for the protection of coho salmon. Where necessary, formally request that the terms of water rights permits/licenses be modified for protection of coho salmon. This will require field studies to evaluate impacts and develop supportive evidence and formal hearings to consider proposed changes. This program must be adequately funded to be implemented.

RW-XXXIII-A-04 Agencies with the primary authority for fish and water should lead enforcement efforts and coordinate with all local, State and Federal agencies with regulatory authority affecting coho salmon.

RW-XXXIII-A-05 Request that enforcement to prevent unauthorized diversion and use of water and water permit processing a high priority. Enforcement of existing codes including Water Code §§1052 Trespass and 1831 *et seq.*, Cease and Desist. Adequate funding should be provided for enforcement and permit processing staff.

RW-XXXIII-A-06 Support continued funding for the California District Attorneys' Association's Environmental Circuit Prosecutors program and/or Environmental Project for applicable district attorney offices in the range of coho salmon.

RW-XXXIII-A-07 Dedicate fines from violations affecting coho salmon or coho salmon habitat to coho salmon recovery and restoration activities consistent with the Department's Coho Salmon Recovery Strategy, including but not limited to education and outreach. Emphasis should be placed on keeping fine money in watersheds where the violation occurred to address existing coho salmon restoration plans and projects. This recommendation applies to fines that are not otherwise mandated by law to be directed to other purposes.

RW-XXXIII-A-08 Examine penalty schedules and, if necessary, explore ways to adjust penalty schedules to reflect the impact of violations to coho salmon, taking into account other penalties that may be enforced in association with the same activity.

RW-XXXIII-A-10 Develop an outreach/information and education program that targets agency personnel, judges, district attorneys, the Attorney General's Office, municipalities, and other affected or interested parties concerning the status of coho salmon and the value and importance of coho salmon resources and coho salmon recovery. Provide educational materials, outreach and training for issues such as sport fishing (inadvertent incidental take), poaching (directed take) and habitat destruction (LWD removal, riparian destruction, illegal stream crossings, pollution, illegal water withdrawal, etc.).

RW-XXXIII-A-11 Discourage illegal dumping, poaching, and other illegal activities by promoting "neighborhood watch" programs for streams and/or watersheds.

RW-XXXIII-A-14 Support funding for increased enforcement of existing laws against dumping of toxic substances.

RW-XXXIII-A-18 Require adequate review, as staffing allows, of all applications for proposed projects that may impact coho salmon

RW-XXXIII-A-27 Establish environmental task forces made up of State, local, and Federal enforcement agencies that operate in the range of coho salmon.

RW-XXXIII-A-28 Increase funding for the Department's CalTIP program.

RW-XXXIII-A-29 Seek programmatic incidental take authority with respect to screen design and installation that conforms to Department/NOAA Fisheries screening criteria.

RW-EN-24 Encourage Federal, State, and county agencies and private landowners to protect instream LWD to the greatest extent practicable without endangering public safety, life or property.

7.21 IMPLEMENTATION

RW-XXXIV-A-01 Provide funding and incentives for projects that exceed requirements of existing law and/or expedite timelines required by law. All commitments of State and local agencies are subject to availability of funding. Funding and incentives provided by State fishery restoration accounts should be prioritized as follows:

a. Projects that exceed requirements of existing law and/or expedite timelines required by current law;
b. Projects that were installed in accordance with laws and standards in effect at the time the work was done;
c. Projects that contain elements of a. and b. above; and
d. Projects that do not meet elements of a. and b. above, but which are not a part of new development or under enforcement actions.

Projects that are mitigation for new development or activities under enforcement actions are not fundable.

RW-XXXIV-A-02 Support continued and increased funding for the California Conservation Corps to implement coho salmon restoration projects throughout the entire range of California coho salmon.

7.22 INSTREAM GRAVEL EXTRACTION

RW-XXXV-A-01 Within known or historic coho salmon habitat, permits for instream gravel extraction should require:

a. A total yearly extraction volume proportionally based on the long term mean average recruitment of gravel into the mining reach;

b. An extraction strategy that will promote species recovery by retaining sufficient gravel to preserve and restore the alluvial structure necessary for forming and maintaining critical physical habitat in, up- and downstream of the mined reach; and

c. A monitoring plan capable of demonstrating that the extraction strategy is successful.

These conditions may not be necessary if it can be determined that the extraction volume and method protect coho salmon and their habitat (including, but not limited to, protection of habitat attributes such as water quality, riparian vegetation, and the geomorphic features that control local hydraulics and safeguard the physical processes that create and maintain habitat).

7.23 ASSESSMENT, MONITORING, AND RESEARCH

RW-XXIX-B-03 Support research necessary to better understand crucial uncertainties regarding coho salmon ecology. Four important issues area:

a. Genetic relatedness and health;

b. Potential of local adaptive differences to environmental factors;

c. Identifying specific refugia, including non-natal rearing areas; and

d. Stream nutrient enrichment and cycling needs for coho salmon.

RW-XXIX-C-01 Evaluate and prioritize coho salmon issues and questions in need of research.

RW-XXIX-C-01a Develop and maintain a coho salmon species and recovery data/information system for compiling, analyzing, and distributing information on the status and trend of coho salmon and the status of coho salmon recovery.

RW-XXIX-D-04 The Department, NOAA-Fisheries, CDF, California Geological Survey (CGS), in cooperation with the landowners and representatives of the CRT, should develop a comprehensive system to gather, evaluate and manage monitoring information associated with the elements set forth in the Assessment, Monitoring, and Research section of the Recovery Strategy.

RW-XXIX-E-01 Coho salmon restoration activities should consistently use field tested implementation, effectiveness, and validation monitoring protocols.

RW-XXIX-F-01 Support immediately needed assessments necessary to better understand population and life-history uncertainties, such as:

a. Relative abundance;

b. Spawning sites/success;

c. Estuary use;

d. Barriers to juveniles;

e. Over-wintering growth and survival; and

f. Ocean condition effects on coho salmon populations.

RW-XXIX-G-01 Coho salmon recovery shall be guided by the strategic, long-term monitoring program being developed as a California coastal salmonid assessment and monitoring program.

RW-XXIX-G-02 Assessment and prioritization of actions within a watershed should precede implementation of comprehensive restoration plans in a subbasin or basin to ascertain the most crucial factors for coho salmon and habitat. This should not preclude prompt implementation of specific, obvious beneficial projects or measures already recommended in the Recovery Strategy.

RW-XXIX-H-01 Support the expenditure of restoration dollars, including Fisheries Grant Restoration funding, to research, monitor, and evaluate the effectiveness of restoration. This may require amending the PRC to allow research as an eligible project type.

RW-XXX-C-02 The Recovery Team recognizes that the Department has authority to collect data on navigable waterways. In addition, the CRT recommends the Department develop a data collection and sharing policy that:

a. Requires permission of private landowners for access across private lands to collect data where such access is desired;

b. Disclosure of data collected from private lands in a form or by a means that protects landowner privacy (i.e., disclosure of data at stream-reach level or other appropriate scale that protects landowner privacy, but also shows the relationship to the nearest tributary confluences);

c. Disclosed data must be quality assured and quality controlled;

d. Disclosure should include metadata files indicating who collected the data, and how and for what purposes the data were collected;

e. If requested, disclosed data should be in electronic form if it already exists in that form.

f. Data requests should be responded to in a timely manner, recognizing limitations of staff and budgets can affect processing requests.

7.24 TIMBER MANAGEMENT

ALT-C-01 CRT recommends government commitment of adequate financial, material, and personnel support for the life of the Recovery Strategy for on-the-ground recovery actions, identified in the Recovery Strategy. Possible funding mechanisms may include:

a. Legislation specifically identifying funding for recovery;

b. Cost-share programs with private landowners, stakeholder groups and local governments; and

c. Endowment and/or grant programs cooperatively with private sources.

ALT-C-02 The Department should provide technical expertise to support appropriate cooperatively undertaken recovery actions, which may include:

a. Technical advisors to assist in the development of restoration proposals;

b. Technical expertise to assist in the implementation of recovery activities on-the-ground; and

c. Technical expertise to assist in training and education on coho restoration projects.

ALT-C-03 The Department should develop and implement a program to design and implement a coho salmon recovery plan for individual CALWATER Planning Watersheds. The program should promote and enable cooperative working relationships between agencies, landowners and residents. This program should include:

a. Federal and State funding to assist landowners in performing watershed analysis in a manner usable by the Department;

b. A systematic evaluation at the watershed level to identify key limiting factors for the recovery of coho salmon;

c. Identification of site-specific sources and locations of the key limiting factors;

d. Identification of restoration projects for watershed transportation systems, fish passage, slope stabilization measures, erosion control measures and drainage structures;

e. Identification of beneficial management practices to protect existing values; and

f. Use of these plans and the data that support them as the principle reference document, which would save landowners and/or project proponents additional costs associated with repetitive analysis and paperwork for each project.

ALT-C-04 The Department should develop an information repository system for individual Planning Watersheds that utilizes and builds upon existing information, adding new information as it becomes available, while ensuring adequate confidentiality for information specifically pertaining to an individual's private property.

ALT-C-05 The Department should promote and support programmatic approaches to address key limiting factors in each CALWATER Planning Watershed with a watershed plan. Include these components:

a. Where appropriate and where costs to landowners are offset by monetary assistance, technical assistance or regulatory incentives, encourage landowners to develop and implement Road Management Plans that contribute to the restoration of coho salmon habitat;

b. Where appropriate and where the costs to landowners are offset by incentives, encourage the use of a licensed engineer to assist in the design and construction of watercourse crossings;

c. Continuing education and training (classroom and field) to ensure watercourse crossings are appropriately designed, constructed and maintained;

d. Cooperative habitat restoration projects that extend across ownerships to address habitat restoration efforts in a coordinated and cost effective manner; and

e. State funding to assist landowners to implement coordinated watershed riparian vegetation improvement programs that:

   i. Identify areas within the riparian zone where planting of riparian vegetation, including conifers, to improve coho salmon habitat is appropriate and

   ii. Promote vegetation modification (e.g., thinning, removal of undesired competitive vegetation) to accelerate riparian vegetation recovery and enhancement for coho salmon habitat.

ALT-C-06 The Department should set up a long term monitoring system that measures the implementation and effectiveness of FPR in effect at the time of the monitoring. The monitoring shall measure the effectiveness of the rules for maintenance and recovery of coho salmon habitat.

ALT-C-07 Encourage CDF and California Geological Survey in concert with the Board of Forestry (through the Monitoring Study Group) to develop a monitoring program to evaluate whether mitigation measures implemented by Registered Professional Foresters as part of THPs are effectively reducing the risk of mass soil movement associated with harvesting operations, including road and landing construction. Any monitoring system should be designed to compare harvested areas to non-harvested areas so it can be determined whether harvesting, road and landing construction activities increase the likelihood of mass soil movement. The THP work completion report and the Monitoring Study Group's Hillslope Monitoring Program, as well as periodic air photo flights and photo interpretation, could provide the basis for monitoring and evaluation.

ALT-C-08 CDF document voluntary efforts taken by forest landowners beneficial to coho salmon that:

a. Provide mitigation measures that exceed FPRs requirements; and/or

b. Are identified in specific CALWATER Watershed Recovery Plans.

ALT-C-09 The Department should develop a system to evaluate implementation and effectiveness of voluntary efforts to recover coho salmon populations.

ALT-C-10 The Department should develop, with appropriate peer review, a long-term consolidation and analysis of resource assessments and monitoring data.

ALT-C-11 The Department should collaborate with CDF and appropriate industry groups to provide watercourse training and roads assessment watershed academy.

ALT-C-12 Acquire conservation easements or land in fee title from willing landowners to protect coho salmon habitat.

ALT-C-13 The Department should seek funding for staff to improve effectiveness of the Department timberland conservation program.

ALT-C-14 Continue participation in full review of THPs and participation and other timberland conservation activities associated with managing timberlands.

ALT-C-15 In watersheds with coho salmon, the Department will prepare a "coho salmon biological assessment" when acting as a Lead or Responsible agency under the California Environmental Quality Act (CEQA) for timberland conservation activities, including but not limited to the review of timber harvesting plans. A "coho salmon biological assessment" is an assessment by the Department of project effects, if any, on coho salmon. The biological assessment will include conclusions by the Department regarding potential for the project to "jeopardize" the long-term survival of or "take" coho salmon. It will also include the Department's assessment of the significance of project impacts for purposes of "mandatory findings of significance" under 14 CCR §15065 (a), (b), and (c).

ALT-C-16 In conjunction with CDF, qualified landowners representatives and experts, and qualified independent scientists with appropriate expertise, and consistent with the availability of staff, the Department will monitor for five years (or more if necessary to develop an adequate sampling regime) the implementation of the FPR in effect at the time to determine whether these rules are consistent with the long-term survival of coho salmon.

ALT-C-17 If results of monitoring, based on substantial evidence as the term is defined by 14 CCR §15384, conclude that the implementation of the FPR s are not providing adequate protection for the long-term survival of coho salmon, the Department in cooperation with CDF and interested stakeholders will develop recommendations to ensure adequate protection for the long-term survival of coho salmon.

ALT-B-19 Recommend that a "proof of concept" pilot program be developed and implemented to test a mathematical or scientific method of cumulative effects analysis as was suggested in the 2001 report, "A Scientific Basis for the Prediction of Cumulative Watershed Effects" (otherwise known as the "Dunne Report"), by the U.C. Committee on Cumulative Watershed Effects. The pilot program would be developed and implemented by a panel of experts such as those at U.C. in cooperation with the Department, CDF, and SWRCB.

ALT-B-20 Recommend that CDF and the Board of Forestry work with the Department and other interested agencies and stakeholders to establish a procedure for THPs to document and evaluate the implementation and effectiveness of coho-related mitigation measures prior to the official completion inspection by CDF and other agencies.

8 Watershed Recommendations

Range-wide recommendations for recovering coho salmon in California are presented in Chapter 7. While some issues and risks facing coho salmon are constant across the entire range, others are unique to an ESU. Additionally, issues and risks for coho salmon populations and their associated habitat (both current and historic) vary substantially by recovery unit watersheds. Accordingly, the Recovery Strategy emphasizes recovery recommendations and activities at various hydrologic levels.

To aid the Department in the development of the Recovery Strategy, the CRT identified issues and developed recommendations, the vast majority of which are included in the Recovery Strategy. Several recommendations were developed after the last CRT meeting, and therefore, the CRT did not have the opportunity to review these recommendations. In a few cases, the Department has modified some of the recommendations that were developed by the CRT. Implementation schedules for the SONCC and CCC Coho ESUs are provided in Chapter 9, with additional implementation for the SSPP in Chapter 10.

The recommendations were developed for two geographic levels, the HU, which generally corresponds to major watersheds or sub-regions within the range of coho salmon, and within each HU by HSA, which generally corresponds to major tributary watersheds. In a few cases recommendations are presented for the HA, a unit intermediate in scale between the HU and the HSA. In some cases where adjacent HUs have similar characteristics and issues they are presented in a combined section (e.g., Bodega and Marin Coastal HUs, and the multiple HUs tributary to San Francisco Bay).

Recommendation numbers presented below were used during CRT discussions. They are presented here only as unique identifiers for reference to individual recommendations and to maintain a permanent record of the CRT process.

8.1 SOUTHERN OREGON/NORTHERN CALIFORNIA COASTS ESU

Recommendations for the SONCC Coho ESU in California are presented in this section.

8.1.1 ROGUE RIVER AND WINCHUCK RIVER HYDROLOGIC UNITS

8.1.1.1 Illinois River HSA

RO-IR-01	Develop a long-term plan to promote retention of LWD.
RO-IR-02	Support continued control of sediment.
RO-IR-03	Monitor impacts of suction dredge activities for deleterious affects on coho salmon, taking corrective measures when needed.
RO-IR-04	Develop a cooperative management strategy with Oregon Department Fish and Wildlife to improve downstream habitat conditions.

8.1.1.2 Winchuck River Hydrologic Unit/Winchuck River HSA

WR-SF-01 Develop a short-term plan to increase LWD until natural recruitment can be restored.

WR-SF-02 Develop a long-term plan to restore a mature coniferous riparian zone to South Fork Winchuck River.

WR-SF-03 Support the assessment, prioritization, and treatment of sources of sediment.

8.1.2 SMITH RIVER HYDROLOGIC UNIT

SR-HU-01 Develop and implement a program to control exotic vegetation, particularly canary grass, which impedes access to and use of tributaries by coho salmon.

SR-HU-02 Assess, prioritize and treat barriers to passage and other impediments to use (including water diversion), especially those blocking access to and use of smaller tributaries, including Cedar, Clarks, Morrison, Peacock, Sultan and Little Mill creeks.

SR-HU-03 Develop and implement a plan to restore the effectiveness and use of off-channel areas, sloughs, and wetlands. Yontocket, Tillas and Tryon sloughs should be given immediate attention. Since a portion of Yontocket Slough is State property, the restoration of connectivity and functionality of this slough should be given priority.

SR-HU-04 Investigate the feasibility of restoring channelized reaches of streams to natural meander belts (e.g., Lower Rowdy and Dominie creeks) that would allow recruitment of stored spawning gravel, re-establish scour pools, recruit woody debris from banks, and ultimately restore fluvial processes that maintain coho salmon habitat.

SR-HU-05 Improve the quality and quantity of deep pools, spawning gravels, and cover by measures to:

a. Protect existing LWD recruitment potential through the retention of mature coniferous trees in the riparian zone;
b. Establish adequate streamside buffer areas that are protected from vegetation removal;
c. Increase the amount of in-channel LWD;
d. Continue to review THPs; and
e. Continue riparian management projects with ranchers.

SR-HU-06 Assess the impacts of steelhead outplanting by the Rowdy Creek Hatchery.

SR-HU-07 Adequately treat legacy sources of sediment and provide for minimization of new sediment input.

SR-HU-08 Support the use of the existing watershed coordinator to aid in implementing recommendations.

8.1.2.1 Mill Creek HSA

SR-MC-01 Assess, prioritize, and treat sediment sources (mostly legacy roads).

SR-MC-02 Develop and implement a short-term plan to add LWD and a long-term plan to promote recruitment of LWD.

SR-MC-03 Develop and implement a revegetation plan for the riparian zone that includes planting of coniferous species, along with the release of conifers from competitors, such as alders and blackberries.

8.1.2.2 Wilson Creek HSA

SR-WC-01 Work with landowners to determine the amount of LWD necessary for improved flushing, pooling and habitat conditions for coho salmon, facilitate immediate placement, and develop a plan for long-term recruitment.

SR-WC-02 Develop a plan to increase connectivity of riparian habitat through fencing and planting.

SR-WC-03 Support the assessment, prioritization, and treatment of sources of sediment.

8.1.2.3 Smith River Plain HSA

SR-PL-01P Support the assessment, prioritization, and treatment of barriers to passage.

8.1.3 KLAMATH RIVER HYDROLOGIC UNIT[1]

KR-HU-01 Facilitate development of an adaptive management plan in preparation for low-flow emergencies in cooperation with the USBR, NOAA Fisheries, the USFWS, the Department of the Interior (DOI), tribes, the SWQCB and other stakeholders.

KR-HU-03 Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage.

KR-HU-04 Develop a plan, including a feasibility analysis, for coho salmon passage over and above Iron Gate and Copco dams to restore access to historic habitat.

KR-HU-07 Analyze the feasibility and appropriateness of site-specific 2084 authorization for sport fishing for hatchery coho salmon.

KR-HU-08 Complete comprehensive flow study activities (e.g., Hardy Phase II), and use them to educate water managers on how to reduce impacts to coho salmon.

KR-HU-09 Apply protective down-ramp rates at Iron Gate Dam to minimize stranding of coho salmon fry.

KR-HU-10 Support efforts to improve quality of water entering the Klamath River mainstem from the upper Klamath River basin.

KR-HU-11 Perform cost/benefit analysis of full or partial hydroelectric project removal for the purposes of improving water quality, coho salmon passage, and sediment transport.

KR-HU-13 Ensure that uplands in key cold-water tributaries are managed in a way that preserves their cold-water thermal regime.

[1] Recommendations for Klamath River HU do not include the Salmon River HA, Shasta Valley HA, Scott River HA, or the Trinity River HU, all of which are listed below.

KR-HU-14 Investigate coho salmon non-natal rearing and refugia use in lower reaches of tributaries and mainstem confluences. Protect and enhance tributary reaches identified as providing refugia to coho salmon juveniles.

KR-HU-15 Address water quality and quantity problems in Klamath River tributaries that exacerbate mainstem water quality problems.

KR-HU-16 Assess hatchery operations in terms of coho salmon recovery in accordance with the policies and guidelines included in this recovery strategy.

KR-HU-17 Continue disease monitoring of juvenile coho salmon emigration in the Klamath River mainstem so that major disease outbreaks can be identified and their causes evaluated.

KR-HU-18 Conduct disease monitoring of migrating adult Chinook and coho salmon during fall migration.

KR-HU-19 Conduct studies in and around the Klamath River Hydroelectric Project to see if the project is contributing to habitat for the ceratomyxosis intermediate host.

KR-HU-20 Restore appropriate coarse sediment supply and transport near Iron Gate Dam. Means to achieve this could include full or partial removal of the Klamath River Project, or gravel introduction such as is done below other major dams (e.g., Trinity Dam).

KR-HU-22 Where lack of flows is a limiting factor, acquire additional water through conservation easements, purchases and/or transfers of water and water rights from willing sellers, where appropriate. Dedicate these flows to instream coho salmon needs. Water transfers would be used as an interim, emergency measure, with easements and purchases for the long-term.

KR-HU-24 Encourage water master service for all diversions by assisting with funding from the State and/or Federal government.

KR-HU-25 Promote public interest in the Klamath River Basin's coho salmon, their beneficial use and habitat requirements.

8.1.3.1 Klamath Glen HSA

KR-KG-01 Support the continuation of long-term estuary investigations to better understand the estuary's role in the survival of Klamath River basin coho salmon.

KR-KG-02 Develop a plan to restore off-channel estuarine, wetland, and slough habitat in lower Hunter and Salt creeks:

a. Determining if key properties, conservation easements, or development rights should be purchased from willing sellers; and
b. Encouraging the installation of livestock exclusion fencing to protect restored areas.

KR-KG-03 Develop a plan to maintain Blue Creek watershed tributaries as key thermal refugia and for their cool water contributions to the mainstem Klamath River. The plan should emphasize that:

a. Sediments from upslope activities do not impact the refugia;

b. Upslope stabilization and restoration activities (including road assessment and treatment) continue;

c. In-channel and riparian restoration efforts (target riparian retention efforts) continue; and

d. Feral cattle are removed.

KR-KG-04 Finalize and implement the Lower Klamath Sub-Basin Watershed Restoration Plan (Dale and Randolph 2000) to protect and restore Klamath River mainstem tributaries, even those that do not support populations of coho salmon but that provide cool water and which improve mainstem Klamath River water quality, particularly during warm summer months. Actions should:

a. Protect and/or restore riparian habitat;

b. Stabilize upslope areas to prevent sedimentation and aggradation at the mouth of tributaries; and

c. Work with Federal land managers to reduce impacts to riparian corridors and sediment loads.

KR-KG-05 Support actions to reduce sediment input from upslope sources, such as to:

a. Decommission roads and skid trails;

b. Upgrade roads and maintenance practices;

c. Ensure adequate coho salmon migration is provided for at stream/road crossings;

d. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and

e. Minimize alteration of natural hill slope drainage patterns.

KR-KG-06 Review existing inventory and assessment of barriers (Gale 2003) and prioritize barriers impeding migration of adult and juvenile coho salmon throughout the Lower Klamath River tributaries.

KR-KG-06b Investigate temporal and spatial magnitude of tributary deltas and seasonal subsurface flow reaches to determine impacts to juvenile and adult coho salmon migration and to quantify seasonal loss of lower tributary habitat. Investigation should include assessment of long-term delta size trends, annual variation in coho salmon access periodicity by tributary, quantification of seasonal habitat loss and fish stranding, and the relation of delta and subsurface flow formation to upslope erosion, river and tributary flow, mainstem bed load deposition and other causative factors.

KR-KG-06c Conduct feasibility study to re-establish adult coho salmon passage above major barriers in lower Roaches and Tully creeks and the Middle and North Forks of Ah Pah Creek.

KR-KG-07 Support treating sediment sources and improving riparian and instream habitat conditions to provide adequate and stable spawning and rearing areas for coho salmon.

KR-KG-08 Develop a plan to restore in-channel and riparian habitat in tributaries:

a. Revegetate riparian zones with native species (e.g., conifers) to stabilize stream banks and promote a long-term supply of LWD;
b. Provide adequate protection from development, grazing, etc. for riparian areas; and
c. Relocate roads out of riparian areas where feasible.

KR-KG-09 Develop a plan to provide suitable accumulations of woody cover in slow-velocity habitats for coho salmon winter rearing on a short-term basis by placing wood in needed areas until natural supplies become available.

KR-KG-10a Construct livestock exclusionary fencing and corresponding riparian restoration as necessary in Salt, lower High Prairie, lower Hunter and lower Terwer creeks. Provide funding and incentives to landowners and/or restoration groups where necessary to achieve this goal.

KR-KG-10b Develop a plan to remove feral cattle from lower Blue and Bear creeks.

KR-KG-11a Work with Humboldt County, NOAA Fisheries and existing and future gravel-mining operators to restrict gravel-mining operations to appropriate mainstem Klamath River locations. Gravel mining should not be conducted within lower Klamath River tributary watersheds until a scientifically valid and peer-reviewed geomorphic analysis is conducted to determine existing channel stability, causes of excess aggradation, and identifies gravel mining as an appropriate restorative measure, as outlined in task RW-XXXV-A-1. (See Table 9-1).

KR-KG-12 Encourage cooperation between industrial timber land managers and the tribes to restore coho salmon habitat. Use the successful Tribal/Simpson Resource Company program as an example.

KR-KG-13 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;
b. Management to promote conifer recruitment;
c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and
d. Incentives to landowners, such as technical support.

KR-KG-14 Provide technical and financial support to implement riparian restoration throughout alluvial reaches in lower Blue, Terwer, Hunter and Salt creeks.

KR-KG-15 Investigate straying and impacts of exotic fish (e.g., bass and bullhead) populations in an abandoned mill pond in lower Richardson Creek to coho salmon in the adjoining Klamath River estuary.

KR-KG-17 Continue funding and technical support for the California Conservation Corps Del Norte Center to continue their collaborative participation with the Yurok Tribe and Simpson Resource Company to implement watershed restoration throughout the lower Klamath River subbasin.

KR-KG-18 Support continued implementation of the Coho Salmon Regional Abundance Inventory throughout the lower Klamath River subbasin.

KR-KG-19 Develop a plan to restore the historic flood plain on Hoppaw Creek, in cooperation with landowners and Caltrans.

8.1.3.2 Orleans HSA

KR-OR-01 Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon that provide cool water and which improve mainstem Klamath River water quality and which provide thermal refugia for coho salmon, particularly during warm summer months. The plan should:

a. Include improved land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources;

b. Request that the SWRCB review existing water appropriations for compliance;

c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and

d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.

KR-OR-02 Support activities to maintain connectivity (i.e., flow) between mainstem habitat and tributary habitat in Slate and Red Cap creeks.

KR-OR-03 Develop a plan to protect and enhance spawning and rearing habitats in Boise and Camp creeks.

KR-OR-04 Develop a plan to protect and enhance Bluff and Red Cap Creek watersheds, which are classified as *Key Watersheds* in the Northwest Forest Plan, and are biological refugia for coho salmon. Key watersheds serve as biological refugia for maintaining and recovering habitat for stocks of anadromous fish at risk, such as coho salmon.

KR-OR-05 Re-establish natural fire regimes consistent with the Northwest Forest Plan to reduce the risk and impact of large, severe fire on coho salmon.

KR-OR-06 Support efforts to provide livestock exclusion fencing where feasible and appropriate, while providing off-site watering.

KR-OR-07 Support actions to reduce sediment input from upslope sources, including measures to:

a. Decommission roads and skid trails;

b. Upgrade roads and maintenance practices;

c. Ensure adequate coho salmon migration is provided for at stream/road crossings;

d. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and

e. Minimize alteration of natural hill slope drainage patterns.

8.1.3.3 Ukonom HSA

KR-UK-01 Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should:

a. Include improved land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources;
b. Request that the SWRCB review existing water appropriations for compliance;
c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and
d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.

KR-UK-02 Support actions to reduce sediment input from upslope sources, including measures to:

a. Decommission roads and skid trails;
b. Upgrade roads and maintenance practices;
c. Ensure adequate coho salmon migration is provided for at stream/road crossings;
d. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and
e. Minimize alteration of natural hill slope drainage patterns.

KR-UK-03 Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage. Implement highest priority barrier repairs as identified in the Caltrans inventory. USFS and the Karuk Tribe have identified culverts on Highway 96 at Stanshaw, Sandy Bar, and Coon creeks as needing treatment.

KR-UK-04 Develop a plan to ensure continued yields of high quality water and the maintenance the ecological function of tributary riparian systems, including measures to:

a. Conduct riparian revegetation and stream-bank restoration;
b. Encourage, where feasible, the relocation of roads out of riparian areas and off of unstable land features (e.g., active landslides, granitic terrain, toe zones, wet-seepy areas);
c. Increase the number of conifers and deciduous trees, where appropriate, for more stable stream banks, stream shading, and eventual recruitment of LWD; and
d. Revegetate flood plain areas using native species.

KR-UK-05	Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Management to promote conifer recruitment; c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and d. Incentives to landowners, such as technical support.
KR-UK-06	Re-establish natural fire regimes consistent with the Northwest Forest Plan to reduce the risk and impact of large, severe fire on coho salmon.
KR-UK-07	Where necessary, provide riparian protection from livestock through exclusion fencing while providing off-site watering.
KR-UK-08	Encourage installation of screens on diversions to Department-NOAA Fisheries standards. Provide funding incentives to landowners where necessary to achieve this goal.
KR-UK-09	Improve water diversion and delivery system efficiency.
KR-UK-10	Continue restoration and monitoring of Siskon Mine to prevent further degradation of the riparian resource.
KR-UK-11	Request that the SWRCB to investigate diversions and use of water on Stanshaw Creek.

8.1.3.4 Happy Camp HSA

KR-HC-01	Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should: a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources; b. Request that the SWRCB review existing water appropriations for compliance; c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.
KR-HC-02	Support actions to reduce sediment input from upslope sources, including measures to: a. Decommission roads and skid trails; b. Upgrade roads and maintenance practices; c. Ensure adequate coho salmon migration is provided for at stream/road crossings; d. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and e. Minimize alteration of natural hill slope drainage patterns.

KR-HC-03 Develop a plan to improve coho salmon passage at stream and road crossings, including measures to:

a. Replace culverts on both the USFS and Caltrans roads with structures allowing coho salmon passage. The USFS and Karuk Tribe have identified culverts under Highway 96 at Cade, Portuguese, and Fort Goff creeks as needing treatment;

b. Prioritize and upgrade crossings to accommodate 100-year storm flows and associated bedload and debris; and

c. Encourage the USFS, County and State agencies to provide adequate budgets basin-wide for road maintenance and upgrades.

KR-HC-04 Develop a plan to ensure continued yields of high quality water and maintenance the ecological function of tributary riparian systems, including measures to:

a. Conduct riparian revegetation and stream-bank restoration;

b. Encourage, where feasible, the relocation of roads out of riparian areas and off of unstable land features (e.g., active landslides, granitic terrain, toe zones, wet-seepy areas);

c. Increase the number of conifers and deciduous trees, where appropriate, for more stable stream banks, stream shading, and eventual recruitment of LWD; and

d. Revegetate flood plain areas using native species.

KR-HC-05 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;

b. Management to promote conifer recruitment;

c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and

d. Incentives to landowners, such as technical support.

KR-HC-06 Re-establish natural fire regimes consistent with the Northwest Forest Plan to reduce the risk and impact of large, severe fire on coho salmon.

KR-HC-07 Where necessary, provide riparian protection from livestock through exclusion fencing while providing off-site watering.

KR-HC-08 Encourage installation of screens on diversions to Department-NOAA Fisheries standards. Provide funding incentives to landowners where necessary to achieve this goal.

KR-HC-09 Increase water diversion and delivery system efficiency where feasible and appropriate. Provide funding and incentives to landowners where necessary to meet this goal.

KR-HC-10 Encourage the NCRWQCB to continue monitoring Grey Eagle Mine and tailings as a follow-up to remediation that has already been done. Encourage EPA Region 9 to consider coho salmon when dealing with both emergency and remedial actions.

8.1.3.5 Seiad Valley HSA

KR-SV-01 Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should:

a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources;

b. Request that the SWRCB review existing water appropriations for compliance;

c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and

d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.

KR-SV-02 Support actions to reduce sediment input from upslope sources:

a. Decommission roads and skid trails;

b. Upgrade roads and maintenance practices;

c. Ensure adequate coho salmon migration is provided for at stream/road crossings;

d. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and

e. Minimize alteration of natural hill slope drainage patterns.

KR-SV-03 Support efforts to improve coho salmon passage at stream and road crossings, including measures to:

a. Replace culverts on both the USFS and Caltrans roads with structures allowing coho salmon passage;

b. Treat coho salmon passage problems associated with the USFS roads;

c. Prioritize and upgrade crossings to accommodate 100-year storm flows and associated bedload and debris; and

d. Encourage the USFS, County, and State agencies to provide adequate budgets basin-wide for road maintenance and upgrades.

KR-SV-04 Develop a plan to ensure continued yields of high quality water and to maintain the ecological function of tributary riparian systems, including measures to:

a. Conduct riparian revegetation and stream-bank restoration;

b. Encourage the relocation of roads out of riparian areas and off of unstable land features (e.g., active landslides, granitic terrain, toe zones, wet-seepy areas);

c. Increase the number of conifers and deciduous trees, where appropriate, for more stable stream banks, stream shading, and eventual recruitment of LWD; and

d. Revegetate flood plain areas using native species.

KR-SV-05 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;

b. Management to promote conifer recruitment;

c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and

d. Incentives to landowners, such as technical support.

KR-SV-06 Manage roadless areas within the Seiad Valley HSA to be consistent with land use allocations under the Northwest Forest Plan to reduce the risk of large, severe fires by re-establishing the natural fire regimes.

KR-SV-07 Where necessary, provide riparian protection from livestock through exclusion fencing while providing off-site watering.

KR-SV-08 Encourage installation of screens on diversions to Department-NOAA Fisheries standards. Provide funding incentives to landowners where necessary to achieve this goal.

KR-SV-09 Study the likely benefits to instream flow of increasing the efficiency of water diversions and delivery systems where feasible and appropriate. Provide funding and incentives to landowners where necessary to meet actions that are given a high priority.

KR-SV-10 Identify illegal water diverters; request that the SWRCB take appropriate action and review and/or modify water use based on the needs of coho salmon and authorized diverters.

KR-SV-11 Look for opportunities to acquire water rights for instream flow from willing participants who possess valid water rights.

KR-SV-12 Assess potential coho salmon passage problem associated with private water diversion at the mouth of Middle Creek (tributary to Horse Creek). If problem exists, design and implement remediation project.

8.1.3.6 Beaver Creek HSA

KR-BC-01 Re-establish natural fire regimes consistent with the Northwest Forest Plan to reduce the risk and impact of large, severe fire on coho salmon.

KR-BC-02 Encourage landowners to manage fuels to prevent large, severe fires and to evaluate the application of the Watershed Evaluation Mitigation Addendum.

KR-BC-03 Assess fine sediment production and delivery from the USFS road adjacent to the West Fork of Beaver Creek and implement appropriate remediation.

KR-BC-04 Hydrologically disconnect the USFS Beaver Creek road, north of West Beaver Creek.

KR-BC-05 Support actions to reduce sediment from upslope sources:

a. Decommission roads and skid trails;

b. Upgrade roads and maintenance practices;

c. Ensure adequate coho salmon migration is provided for at stream/road crossings;

d. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams;

e. Minimize alteration of natural hill slope drainage patterns; and

f. Encourage the relocation of roads out of riparian areas and off of unstable land features (e.g., active landslides, granitic terrain, toe zones, wet-seepy areas).

KR-BC-06 Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should:

a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources;

b. Request that the SWRCB review existing water appropriations for compliance;

c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and

d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.

KR-BC-07 Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months.

KR-BC-08 Improve coho salmon passage at stream and road crossings, by measures to:

a. Replace culverts on both the USFS and Caltrans roads with structures allowing coho salmon passage;

b. Treat coho salmon passage problems associated with the USFS roads;

c. Prioritize and upgrade crossings to accommodate 100-year storm flows and associated bedload and debris; and

d. Encourage the USFS, County, and State agencies to provide adequate budgets basin-wide for road maintenance and upgrades.

KR-BC-09 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;

b. Management to promote conifer recruitment; and

c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors.

KR-BC-10 Provide technical support as an incentive to landowners for ongoing efforts of restoring LWD and shade to the watershed.

KR-BC-11 Where necessary, provide riparian protection from livestock while providing off-site watering.

8.1.3.7 Hornbrook HSA

KR-HB-01 Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should:

a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources;

b. Request that the SWRCB review existing water appropriations for compliance;

c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and

d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.

KR-HB-02 Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months.

KR-HB-03 Improve coho salmon passage at stream and road crossings, including measures to:

a. Replace culverts on both the USFS and Caltrans roads with structures allowing coho salmon passage;

b. Treat coho salmon passage problems associated with the USFS roads; and

c. Encourage the USFS, County, and State agencies to provide adequate budgets basin-wide for road maintenance and upgrades.

KR-HB-05 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;

b. Management to promote conifer recruitment;

c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and

d. Incentives to landowners, including technical support.

KR-HB-09 Study the likely benefits to instream flow of increasing the efficiency of water diversions and delivery systems where feasible and appropriate. Provide funding and incentives to landowners where necessary to meet actions that are given a high priority.

KR-HB-10 Identify water diverters; request that the SWRCB review and/or modify water use based on the needs of coho salmon and authorized diverters.

KR-HB-11 Look for opportunities to acquire water rights for instream flow from willing participants who possess valid water rights.

8.1.3.8 Iron Gate HSA

KR-IG-01 Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should:

a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources;

b. Request that the SWRCB review existing water appropriations for compliance;

c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and

d. Provide measures that reduce hydrologic connectivity between streams and roads, where feasible.

KR-IG-02 Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months.

KR-IG-03 Improve coho salmon passage at stream and road crossings, including measures to:

a. Prioritize and upgrade crossings to accommodate 100-year storm flows and associated bedload and debris;

b. Treat coho salmon passage problems associated with the USFS roads; and

c. Encourage the USFS, County, and State agencies to provide adequate budgets basin-wide for road maintenance and upgrades.

KR-IG-05 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;

b. Management to promote conifer recruitment;

c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and

d. Incentives to landowners, including technical support.

KR-IG-09 Study the likely benefits to instream flow of increasing the efficiency of water diversions and delivery systems where feasible and appropriate. Provide funding and incentives to landowners where necessary to meet actions that are given a high priority.

KR-IG-10 Identify water diverters; request that the SWRCB review and/or modify water use based on the needs of coho salmon and authorized diverters.

KR-IG-11 Look for opportunities to acquire water rights for instream flow from willing participants who possess valid water rights.

8.1.4 SALMON RIVER HYDROLOGIC AREA

SA-HA-01 With the goal of reducing sediment and providing coho salmon passage at all life history stages where roads affect coho salmon habitat:

a. Implement Forest Roads Analysis, private and county roads assessment recommendations;

b. Complete road sediment source inventory on all roads within the Salmon River HSA; and

c. Correct identified passage barriers on all roads.

SA-HA-02 Foster the multi-agency task force to identify and prioritize barrier to fish passage and implement corrective treatments. This task force would include at a minimum, representatives from Salmon River Restoration Council, Karuk Tribe, the USFS, NOAA Fisheries, the USFWS, and the Department.

SA-HA-03 Educate landowners, restoration specialists, and watershed restoration groups to reduce the impacts of private roads on coho salmon.

SA-HA-04 Encourage collaborative efforts among agencies and stakeholders to control or remove invasive exotics using integrated pest management techniques.

SA-HA-05 Reduce the risk of large, severe fires through fuels management around residential structures, homes, and escape routes. Implement Salmon River Fire Safe Council recommendations promoting the reduction of fuel near residences to reduce human-caused fires spreading into the forest and causing harm to coho salmon habitat.

SA-HA-06 Re-establish fire regimes consistent with Northwest Forest Plan objectives to reduce the risk and impact of large, severe fire on coho salmon.

SA-HA-09 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade, primarily in tributaries and key refugia areas, through:

a. LWD placement;

b. Management to promote conifer recruitment;

d. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and

e. Incentives to landowners, such as technical support.

SA-HA-10 Develop a plan to prioritize and remediate mine tailings.

8.1.4.1 Lower Salmon River HSA

SA-LS-01 Restore and maintain habitat connectivity between the Salmon River and Nordheimer Creek where low flow or sediment aggradation has been known to restrict coho salmon passage.

SA-LS-02 Support ongoing maintenance and operations for the Nordheimer Creek Fish Ladder.

8.1.4.2 Sawyers Bar HSA

SA-SB-01 Reduce current and future sediment inputs to Specimen Creek, North Russian and South Russian creeks by the following actions:

a. Upgrade, improve, maintain, and/or storm proof (out sloping roads, reducing hydrologic connectivity) roads;

b. Stabilize slopes where feasible;

c. Reduce or avoid alteration of natural hill slope drainage patterns; and

d. Upgrade stream/road crossings and ensure coho salmon passage.

SA-SB-02 Conduct riparian revegetation and stream-bank stabilization along entire North Fork by the following actions:

a. Control vegetation removal in the streamside zone;

b. Increase the number of conifers and deciduous trees to provide stable stream shading and which will eventually become a source for LWD; and

c. Revegetate flood plain areas using native species.

8.1.5 SHASTA VALLEY AND SCOTT RIVER HYDROLOGIC AREAS

SS-HA-01 Reduce the risk of large, severe fires through fuels management (especially in the Scott) around residential structures and homes. Implement Fire Safe Council recommendations promoting the reduction of fuel near residences to reduce human-caused fires spreading into the forest and causing harm to coho salmon habitat.

SS-HA-02 Support actions to reduce human-caused sediment input from upslope sources identified through public and private inventories. Prioritize remediation activities, which would include slope stabilization, minimizing sediment production, and eliminating coho salmon passage barriers.

SS-HA-03 Encourage Federal, State, and county agencies and private landowners to reduce impacts to coho salmon habitat from public and private road systems. Continue road and/or watershed assessments to identify and prioritize sources and risks of road-related sediment delivery to watercourses. Support activities to:

a. Reduce road densities where necessary and appropriate;

b. Upgrade roads and road maintenance practices to eliminate or reduce the potential for concentrating run-off to streams during rainfall events. Employ best available technology when appropriate;

c. Decrease potential for stream flow to become diverted at road crossings during high flow events resulting in flow along the road that returns to the channel at undesirable locations;

d. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams;

e. Minimize alteration of natural hill slope drainage patterns; and

f. Encourage funding authorities to allocate adequate budgets to Federal, State, and local agencies and private landowners for road maintenance activities, capital project activities, and dedicated funding to pay for coho salmon passage projects.

SS-HA-04	Encourage funding authorities to allocate adequate resources to prioritize and upgrade crossings to provide coho salmon passage within the range of coho salmon to pass 100-year flows and the expected debris loads (e.g., LWD that might be mobilized).
SS-HA-05	Identify barriers to passage and prioritize them for removal, through collaborative efforts with other agencies' needs.
SS-HA-06	Design and implement a reclamation plan to remediate effects of historical mining (i.e., tailings near Callahan) with the goal of enhancing the production and survival of coho salmon. Identify locations, costs, and restoration potential of intensively mined areas. (Carry out the same kind of planning for Trinity River and Indian Creek.)
SS-HA-07	Improve water quality by reducing or minimizing both domestic and municipal sources of nutrient input (i.e., sewage treatment plant discharge and storm drain runoff). Support efforts by cities and rural communities to complete system upgrades to achieve CWA compliance.
SS-HA-08	Minimize impacts of cattle grazing on watercourses through exclusionary fencing as necessary and appropriate (i.e., providing off-site watering, preventing overgrazing, etc.).
SS-HA-09	Support cooperative State and local efforts to redirect Big Mill Creek into its historic channel under State Route 3, thereby restoring adult and juvenile coho salmon access to approximately 1.25 miles of quality spawning and rearing habitat.
SS-HA-10	Assess the potential benefits and technical feasibility of increasing stream flows in the Scott River for fish and wildlife within the Klamath National Forest. This should be dealt with during the verification described in SSRT water management recommendations.
SS-HA-11	Request the USBR to study the potential benefits of adjusting Iron Gate flows to better meet the needs of adult and juvenile life stages to enhance Scott/Shasta coho salmon production, consistent with the flow needs of the Klamath and Trinity rivers.
SS-HA-18	Support ongoing watershed planning and complete comprehensive, peer-reviewed watershed restoration plans for the Shasta and Scott rivers that include identification and prioritization of all restorative needs in each basin. When restoration funds are limited, implementation should occur on the highest priority issues most likely to effectively address coho salmon needs within each basin.
SS-HA-24	Investigate incentive-based alternatives with willing participants for preserving water quality, quantity and coho salmon habitat in the Big Springs area in the Shasta River.
SS-HA-25	Maintain and revegetate, where appropriate, riparian trees in headwaters and along creeks that provide shade habitat essential for coho salmon.
SS-HA-26	Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement; and

b. Management to promote conifer recruitment.

8.1.6 TRINITY RIVER HYDROLOGIC UNIT

TR-HU-01 Implement the Trinity River Record of Decision (ROD), which would provide:

a. Variable annual instream flows for the Trinity River from the Trinity River Dam (TRD) based on forecasted hydrology for the Trinity River Basin as of April 1st of each year, ranging from 369,000 acre-feet (af) in critically dry years to 815,000 af in extremely wet years;

b. Physical channel rehabilitation, including the removal of riparian berms and the establishment of side-channel habitat;

c. Sediment management, including the supplementation of spawning gravels below the TRD and reduction in fine sediments which degrade coho salmon habitat;

d. Watershed restoration efforts, addressing negative impacts which have resulted from land use practices in the basin; and

e. Infrastructure improvements or modifications, including rebuilding or fortifying bridges and addressing other structures affected by the peak instream flows provided by the ROD.

TR-HU-02 Recommend to the NCRWQCB that the TMDL process consider alterations in the sediment load allocations and targets due to implementation of the ROD.

TR-HU-06 Recommend that the USBR implement the Trinity River TMDL instream flushing flows without affecting ROD allocations.

TR-HU-07 Encourage the NCRWQCB to establish TMDL implementation plans for the Main Stem and South Fork using the upslope indicators and targets established in the Mainstem Load Allocation.

TR-HU-08 Support development of a County grading ordinance based on exemption, certification, and permitting criteria.

TR-HU-09 Encourage Trinity County to implement the Five Counties *Water Quality and Stream Habitat Protection Manual for County Road Maintenance* in Northwestern California Watersheds.

TR-HU-10 Support continued State and Federal funding for the implementation of sediment reduction programs for private lands and the implementation of DIRT-prioritized sediment source sites treatment funding on County roads.

TR-HU-11 Encourage Trinity County to establish incentives and standards for private riparian and wetlands area protection based on flexible subdivision design; road, curb and gutter requirements; minimum lot size and density; clustering and other techniques.

TR-HU-12 Encourage Trinity County to establish riparian setbacks for grading activities on private lands, based on the Department's 1994 recommendations to District I counties.

TR-HU-13 Evaluate the impacts of non-native fish species on coho salmon and develop management guidelines to reduce impacts.

TR-HU-14 Encourage Trinity County to develop or amend existing County Conservation, Open Space and Land Use Elements and Community plans to focus development away from riparian habitats, wetland habitats, or steep slopes. Consider all species habitats, wildland-urban fire hazard and other land uses factors in making allocations.

TR-HU-15 Analyze the feasibility and appropriateness of site-specific §2084 authorization for sport fishing for hatchery coho salmon.

8.1.6.1 Douglas City HSA

TR-DC-01 Evaluate water diversions on Reading, Indian, and Browns creeks. Restore coho salmon passage and encourage instillation of screens to Department-NOAA Fisheries standards. Provide incentives to landowners when necessary to reach this goal.

TR-DC-02 Increase riparian function in lower Reading, Indian, and Browns creeks with conservation easements or landowner incentives that reduce agricultural and grazing impacts.

TR-DC-03 Implement sediment reduction plans consistent with County plans and policies.

8.1.6.2 Grouse Creek HSA

TR-GC-01 Support continued implementation of habitat restoration, including measures to stabilize upslope areas, enhance riparian zones, storm proof, stabilize, and/or decommission roads, and replace culverts.

8.1.6.3 Hyampom HSA

TR-HY-01 Request that the USFS develop a management plan for Big Slide to reduce human contributions to mobilization of sediments, including evaluating relocation of the county road that crosses Big Slide.

TR-HY-02 Request that the USFS reduce fuel loading in stands that could be susceptible to large, severe fire. Where appropriate, this management should include actions to accelerate the growth of conifers for LWD recruitment, develop mature shade canopy in the riparian zone, and to provide for other multiple use goals.

TR-HY-03 Continued implementation of habitat restoration, including measures to stabilize upslope areas, enhance riparian zones, storm proof, stabilize, and/or decommission roads, and replace culverts.

8.1.6.4 Hayfork HSA

TR-HA-01 Encourage agricultural/residential water conservation programs through incentive programs.

TR-HA-02 Recommend that Trinity County amend its Critical Water Resources Overlay zone to address new riparian water rights development resulting from parcel subdivision. The amendment should include expanding the overlay zoning to additional watersheds where summer surface flows are limiting factors for residents and for coho salmon fisheries habitat.

TR-HA-03	Support continued implementation of riparian improvements through restoration activities, land use planning, and conservation easements.
TR-HA-04	Support efforts to provide livestock exclusion fencing where feasible and appropriate, while providing off-site watering.
TR-HA-05	Continue to implement habitat restoration, including measures to stabilize upslope areas, enhance riparian zones, storm proof, stabilize, and/or decommission roads, and replace culverts.

8.1.7 MAD RIVER HYDROLOGIC UNIT

MR-HU-01 Work with landowners and other entities to reduce coho salmon tributary stream temperature through the development of mature coniferous overstory within the riparian zone by continuing:

a. Planting programs in stream corridors barren of mature conifers;

b. THP review; and

c. Riparian management projects with cattle ranchers.

MR-HU-02 Recommend that the SWRCB make a high priority in this HU of the:

a. Review of authorized diversions that have no provisions to protect coho salmon; and

b. Identification of unauthorized diversions and enforcement actions to stop them.

MR-HU-03 Work with landowners and other entities to improve the quality and quantity of deep pools, spawning gravels, and cover by measures to:

a. Protect existing LWD recruitment potential through the retention of mature coniferous trees in the riparian zone;

b. Establish adequate streamside buffer areas;

c. Increase the amount of in-channel LWD;

d. Continue to review THPs; and

e. Continue riparian management projects with ranchers.

MR-HU-04 Conduct pre-project geological surveys where needed. Develop permit conditions to limit activities within unstable areas and identify mitigation measures for restoration and enhancement.

MR-HU-05 Adopt measures to protect riparian vegetation for all development over which they have jurisdiction.

MR-HU-07 Assess barriers to passage, prioritize barriers for removal, and develop a plan to treat the barriers, with Warren Creek given a high priority for treatment.

MR-HU-08 Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage. This is a known problem at Cañon Creek, Dry Creek, and North Fork Mad River.

MR-HU-09 Consider the mouths of Cañon Creek, Dry Creek, and North Fork Mad River as locations to:

a. Identify causes of loss of connectivity;
b. Evaluate management techniques;
c. Implement the identified strategy; and
d. Address permitting complexity for identified implementation measures.

MR-HU-10 Continue stream management activities with landowners in Lower Lindsay Creek.

MR-HU-11 Develop programs to control exotic vegetation, especially canary grass.

MR-HU-12 Evaluate the impact of the Mad River Hatchery steelhead production on coho salmon.

MR-HU-13 Encourage Federal, State, and county agencies and private landowners to reduce impacts to coho salmon habitat from public and private road systems.

MR-HU-14 Continue road and watershed assessments to identify and prioritize sources and risks of road-related sediment delivery to watercourses.

MR-HU-15 Reduce road densities where necessary and appropriate.

MR-HU-16 Decrease potential for stream flow to become diverted at road crossings during high flow events, resulting in flow along the road that returns to the channel at undesirable locations.

MR-HU-17 Stabilize slopes along roadways to minimize or prevent erosion and to minimize future risk of eroded material entering streams.

MR-HU-18 Minimize alteration of natural hill slope drainage patterns to decrease erosion and sediment input into the streams.

MR-HU-19 Encourage funding authorities to allocate adequate budgets to Federal, State, and local agencies and private landowners for road maintenance activities, capital project activities, and dedicated funding to pay for coho salmon passage projects.

MR-HU-20 Encourage CHERT to incorporate coho salmon friendly measures.

8.1.7.1 Blue Lake HSA and North Fork Mad HSA

MR-BL-01 Encourage landowners, municipalities, and Tribal interests to work together to develop a watershed restoration plan.

MR-BL-02 Encourage agencies and land managers to work with qualified watershed groups. Develop and support well informed watershed communities with regards to coho salmon habitat issues. Ensure that there are adequate incentives for landowners who participate in activities to protect and/or restore coho salmon habitat and watershed processes. Implement an outreach program regarding issues of parity and obligations of stakeholder groups.

8.1.7.2 Butler Valley HSA

MR-BV-01 Reduce temperature impacts through establishment of adequate streamside buffer areas that are protected from vegetation removal; with emphasis on maintaining a significant number of large conifers within the riparian zone.

MR-BV-02 Reduce input of fine and coarse sediments into streams through priority road related sediment reduction assessment and implementation, and reducing management activities within unstable areas.

MR-BV-03 Establish access for both adult and juvenile coho salmon to suitable habitat by upgrading prioritization of culverts identified as passage barriers on both private and public lands.

8.1.8 REDWOOD CREEK HYDROLOGIC UNIT

RC-HU-01 Work with Redwood National and State parks, private landowners, and interested parties to improve coho salmon habitat conditions of the estuary while protecting Highway 101 and the Town of Orick. These plans should aim toward restoring the historic form and function of the estuary/lagoon and slough channels, riparian forests, and adjacent wetlands. This includes providing for:

a. Unconfined channels;
b. Restoration of riparian vegetation, tree cover, wetlands, and off-channel and rearing habitat;
c. Increased sediment transport, pool depth, and LWD;
d. Work to restore natural drainage patterns from adjacent wetlands; and
e. Improving the conditions of sloughs and tributaries to the estuary (Strawberry, Dorrance and Sand Cache creeks).

RC-HU-02 Work with USACE, Redwood National and State parks, and Humboldt County Planning Department to modify levee maintenance manuals to be consistent with habitat requirements of coho salmon while maintaining flood control.

RC-HU-03 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;
b. Management to promote conifer recruitment;
c. Improvement of existing riparian zones through plantings, release of small, suppressed conifers, and control of alders, blackberries, and other competitors (RW-XXII-A-04); and
d. Incentives to landowners, such as funding and technical support.

RC-HU-04 Encourage completion of assessments of sediment sources and upgrade deficient assessments; then encourage implementation of the recommendations contained in the assessment, paying particular attention to road assessment and implementation of road improvement projects; and the incorporation of measures to preclude sediment delivery to stream systems in near stream land use planning (especially on slopes greater than 35%).

RC-HU-05 Develop and implement measures to reduce water temperatures, improve the quality and quantity of deep pools, spawning gravels, and cover by protecting existing LWD recruitment potential through retention of mature trees in the riparian zone, establishing adequate near stream buffer areas protected from vegetation removal, and increasing the amount of in-channel LWD. Root wads should be left on LWD.

RC-HU-06 Coordinate a long-term, concerted effort between landowners, interested parties, and responsible agencies to determine the current population size and trends of coho salmon of Redwood Creek.

RC-HU-07 Conduct pre-project geological surveys where needed.

RC-HU-08 Continue to review and improve THPs with regard to protection of coho salmon and their habitat.

8.1.9 TRINIDAD HYDROLOGIC UNIT

TP-HU-01 Support the assessment, prioritization, and treatment of sediment sources, particularly roads, which have not been assessed and acknowledge progress that has been made in addressing sediment sources.

TP-HU-02 Work with Humboldt County and landowners to maintain flood plain capacity and prevent future encroachment on the flood plain.

8.1.9.1 Big Lagoon HSA

TP-BL-01 Continue to work with private landowners to develop riparian buffers with an adequate conifer component and canopy closure to reduce temperatures, increase LWD, and provide sediment filtration.

TP-BL-02 Develop a plan to restore the historic flood plain on Mill Creek (a.k.a. Pitcher Creek), in cooperation with landowners.

8.1.9.2 Little River HSA

TP-LR-01 Develop a plan to improve the functioning of the lower river estuary. Re-establish conifers and a functional flood plain and riparian zone on the lower river channel. Re-establish more complex instream habitat. The plan should include the release of conifers, exclusion fencing where necessary, and riparian planting.

TP-LR-02 Work with landowners to minimize the impacts of agricultural activities on the estuary.

TP-LR-04 Work with Humboldt County and landowners to maintain current flood plain capacity and prevent future encroachment on the flood plain.

8.1.10 EUREKA PLAIN HYDROLOGICAL UNIT

EP-HU-02 Support implementation of Humboldt County's provisions to protect Stream Management Areas and evaluate their effectiveness; recommend revisions as necessary.

EP-HU-03 Work with agencies and landowners, to re-establish estuarine function.

EP-HU-04 Acknowledge the Arcata City Sewage Treatment Project and encourage implementation of similar projects elsewhere, where possible.

EP-HU-05 Assess sources of sediment input, prioritize and implement remediation projects.

EP-HU-06a Review recent habitat surveys and identify gaps in data; conduct habitat surveys in areas identified as lacking data.

EP-HU-06b Identify and prioritize rearing habitat reaches for protection.

EP-HU-06c Improve quality and quantity of deep pools and spawning gravels.

EP-HU-06d In cooperation with willing landowners, restore and maintain historical tidal areas, backwater channels and salt marsh.

EP-HU-06e Maintain, protect and restore channel conditions important to all life stages of coho salmon (e.g., spawning gravels, pool depth, rearing gravels, food) as it relates to bed load.

EP-HU-06f Identify reaches where naturally functioning channel and flood plain conditions exist. Maintain and restore a functioning flood plain and natural channel processes where practicable.

EP-HU-06g Identify impacted reaches where a functioning flood plain could be re-established:

a. Prioritize areas that are not naturally functioning for restoration potential; and
b. Develop site specific project objectives to protect and restore naturally functioning channel and flood plain conditions where feasible.

EP-HU-06h Conduct hydrologic analysis for all Humboldt Bay tributaries.

EP-HU-06i Establish access for both adult and juvenile coho salmon to suitable habitat where practicable.

EP-HU-06j Upgrade all county culverts already identified as passage barriers and prioritized for repair.

EP-HU-06k Conduct an inventory and prioritize for treatment migration barriers other than county culverts (private roads, tide gates) including Rocky and Washington gulches.

EP-HU-06m Conduct LWD survey, identify location and areas for potential recruitment and/or placement of LWD structures:

a. Map areas where large conifer riparian habitat exists;
b. Increase the canopy by planting appropriate conifer and hardwood species composition along the stream where the canopy is not at acceptable levels. In many cases, planting will need to be coordinated to follow bank stabilization or upslope erosion control projects;
c. Protect existing LWD structure;
d. Increase the amount of large wood debris in rearing reaches;
e. Provide additional LWD for rearing habitat;

f. Ensure retention of mature trees in the riparian corridor;

g. Establish adequate streamside buffer areas that are protected from vegetation removal; and

h. Protect and maintain habitat associated with instream LWD.

EP-HU-06n Maintain functional riparian habitat. Conduct assessment of historic and present riparian conditions.

EP-HU-06o Develop site specific riparian restoration plans:

a. Restore degraded riparian habitat; and

b. Establish a monitoring program to evaluate success of restoration projects.

EP-HU-06p Maintain and/or attain turbidity and suspended sediment levels beneficial to coho salmon during all life stages. Establish a coordinated turbidity monitoring plan.

EP-HU-06q Reduce input of fine sediments into the stream system by the following actions:

a. Conduct comprehensive road inventory;

b. Carry out priority road related sediment reduction;

c. Implement priorities for road-related sediment reduction projects identified in existing road inventories projects;

d. Identify areas still needing road/erosion inventories;

e. Identify ongoing road maintenance needs;

f. Identify landslide hazard areas such as steep unstable slopes, stream crossings,(other than those identified in the road inventory) and inner gorge area;

g. Conduct pre-project geological surveys and/or reducing management activities within these areas, especially road construction, grading, intensive timber harvests; and

h. Identify and treat bank erosion sites.

EP-HU-06r Assess and establish temperatures beneficial to coho salmon during all life stages by:

a. Evaluating temperature ranges in all tributaries;

b. Reviewing existing temperature data;

c. Identifying data gaps and establish watershed-wide temperature monitoring program; and

d. Determining if temperatures are a concern for coho salmon.

EP-HU-06t Prevent point and non-point source pollution (i.e. septic systems, livestock, household chemicals, petrol-chemicals, herbicides, fertilizer and other pollutants) by actions to:

a. Where necessary, limit direct livestock access to stream, and runoff impacts from livestock pens; and

b. Identify any pollutants that are potentially affecting coho salmon, identify priorities for pollution reduction and strategy to be pursued.

EP-HU-06v Determine and maintain adequate flows for migrating juvenile and adult coho salmon. Develop an inventory of current water rights, and conduct a field survey of water withdrawals in main-stem and tributaries.

EP-HU-06w Maintain open space lands (e.g., agriculture, forestland) for water retention and limit addition of impervious surfaces in the watershed.

EP-HU-06x Identify socioeconomic impacts of watershed management and future possible solutions.

EP-HU-06y Facilitate and sustain a well informed watershed community with regards to coho habitat issues.

EP-HU-06z Ensure that there are adequate incentives for landowners who choose to protect and/or restore watershed processes.

EP-HU-28 Support and encourage urban stream day-lighting efforts in Arcata and Eureka to reconnect and restore coho salmon habitat.

8.1.11 EEL RIVER HYDROLOGIC UNIT

ER-HU-01 Support the existing watershed cooperative working groups and the formation of new groups where necessary.

ER-HU-02 Acknowledge that the pike minnow is a problem and support efforts to control it.

ER-HU-03 Continue ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD through:

a. LWD placement;

b. Management to promote conifer recruitment; and

c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and incentives to landowners, such as technical support.

ER-HU-05 Recommend that the SWRCB make a high priority the identification of unauthorized diversions and enforcement actions to stop them in the Eel River HU.

ER-HU-07 Encourage the CHERT to incorporate coho salmon friendly measures.

ER-HU-08 Develop a plan to restore an adequate migration corridor in the mainstem Eel River.

ER-HU-09 Assess and prioritize sediment sources, including roads.

ER-HU-10 Treat prioritized sediment sources, including roads.

ER-HU-11 Identify coho salmon rearing impacts from Van Arsdale outplanting site.

ER-HU-12 In cooperation with agencies and landowners, plan to re-establish estuarine function, restore and maintain historical tidal areas, backwater channels and salt marsh.

ER-HU-13 Request that Caltrans assess, prioritize, and treat culverts that are barriers to passage on Highway 101. Identify barriers to passage and prioritize them for removal, through collaborative efforts with other agencies.

8.1.11.1 Ferndale HSA

ER-FE-01 Encourage the Salt River Local Implementation Plan to incorporate coho salmon-friendly measures, in cooperation with the agencies. For the Salt River Local Implementation Plan to be effective, assessment prioritization and treatment of sediment sources in the watershed must be completed.

ER-FE-02 Support the acquisition of conservation easements as an incentive for landowners to conserve and enhance habitat.

8.1.11.2 Van Duzen River HSA

ER-VD-01 Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage. The plan should

a. Evaluate management techniques;

b. Implement the identified strategy; and

c. Address permitting complexity for identifying implementation measures.

ER-VD-02 Implement the plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage.

ER-VD-03 Recommend that the CHERT incorporate coho salmon-friendly measures.

ER-VD-04 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement; and

b. Improvement of existing riparian zones through plantings, release and recruitment of conifers, and control of alders, blackberries, and other competitors.

ER-VD-05 Assess and prioritize excess sediment sources including roads.

ER-VD-06 Treat excess sediment sources including roads.

8.1.11.3 Scotia HSA

ER-SC-02 Evaluate the benefits to coho salmon of removing the barrier on Bridge Creek.

8.1.11.4 South Fork Eel River HA

ER-SF-01 Explore opportunities to acquire conservation easements with conditions that provide for benefits to coho salmon.

8.1.11.5 Weott HSA

ER-WE-01 Support the DPR's efforts to complete the storm proofing of Bull Creek watershed.

ER-WE-02 Support the DPR and private property owners planting of trees and implement other habitat enhancement as necessary in the Bull and Salmon Creek watersheds.

ER-WE-03	Request that Caltrans assess, prioritize, and treat culverts that are barriers to passage along Avenue of the Giants and Highway 101. Identify barriers to passage and prioritize them for removal, through collaborative efforts with other agencies.

8.1.11.6 Benbow HSA

ER-BE-01	Support assessment of the entire watershed.
ER-BE-04	Request that the CDF monitor Non-industrial Timber Management Plans to ensure that they are properly implemented.

8.1.11.7 Laytonville HSA

ER-LA-01	Support continued watershed restoration efforts, including measures to reduce temperatures in Ten Mile Creek.
ER-LA-02	Support efforts to prioritize and treat culverts on county roads that are barriers.
ER-LA-03	Encourage the county to coordinate with landowners on the removal of barriers on private property.
ER-LA-04	Support efforts by the county sheriff to enforce laws against dumping and the Department of Health to clean up dumped materials.
ER-LA-06	Encourage cities, counties, and Caltrans to adopt maintenance manuals that protect coho salmon habitat (e.g., standards for sidecasting of spoils and identification of spoils disposal sites).
ER-LA-07	To minimize and reduce the effects of water diversions, take actions to improve SWRCB coordination with other agencies to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and other anadromous salmonids and natural hydrograph, and avoidance of adverse impacts caused by water diversion.

8.1.11.8 Outlet Creek HSA

ER-OC-01	Prepare a technical assessment of Outlet Creek watershed, develop recommendations to restore long-term function, and prioritize implementation.
ER-OC-02	Encourage the City of Willits to become involved in planning for coho salmon recovery and to: a. Assess, prioritize, and treat barriers to passage; b. Address water quality issues; c. Modify facility maintenance practices as necessary; and d. Evaluate land use planning and revise plans as appropriate.
ER-OC-03	Encourage the NCRWQCB to upgrade the basin plan to benefit coho salmon.

8.1.12 CAPE MENDOCINO HYDROLOGIC UNIT

CM-HU-01	Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade by the placement of LWD in stream channels to improve channel structure and function
CM-HU-02	Assess and prioritize of sources of excess sediment including roads.
CM-HU-03	Treat of sources of excess sediment, including roads.
CM-HU-04	Investigate the feasibility of restoring estuarine function to maximize habitat for coho salmon.
CM-HU-05	Prioritize and upgrade all county culverts identified as passage barriers.
CM-HU-06	Conduct an inventory and prioritize for treatment migration coho salmon barriers other than county culverts.

Recommendations are presented separately for the four subbasins of the Mattole River HSA.

8.1.12.1 Southern Subbasin Mattole River HSA

CM-MS-01	Encourage elimination of unnecessary and wasteful use of water to improve stream surface flows and coho salmon habitat through outreach and education of water and conservation practices.
CM-MS-02a	Ensure protection of the high quality habitat found in the Mattole River headwaters and historic coho salmon streams.
CM-MS-02b	Protect high quality habitat found in the South Fork of Vanauken, Mill, Stanley, Thompson, Yew, and Lost Man creeks through recognition of current land management practices and encourage private landowners to continue land stewardship.
CM-MS-03	Promote a cooperative effort to establish monitoring stations at appropriate locations to monitor in-channel sediment (or turbidity) both in the lower basin and in the lower reaches of major tributaries.
CM-MS-04	Support the assessment, prioritization, and treatment of sources of excess sediment.
CM-MS-05	Study herbicide use with respect to impacts on coho salmon. Encourage lead agencies to consider herbicide application in CEQA and NEPA review.
CM-MS-06	Follow the NCRWQCB suggested best management practices (BMPs) to protect water quality from the ground application of pesticides.
CM-MS-07	Work with University of California Cooperative Extension (UCCE) specialists to monitor summer water and air temperatures and flow in cooperation with landowners using Department-accepted protocols.
CM-MS-08	Request that Mendocino County evaluate all parcels (new and existing) for their impacts to coho salmon habitat.
CM-MS-09	Request that Mendocino County investigate promoting cluster development away from streams to protect coho salmon.
CM-MS-10	Provide incentives to landowners to protect habitat and reduce water use.

CM-MS-11 Develop educational materials for landowners explaining how they can protect coho salmon.

CM-MS-12 Request that the SWRCB begin the process of declaring the southern subbasin to be fully appropriated in the spring and summer.

CM-MS-13 Request that the SWRCB make the enforcement of water rights in this watershed a priority.

CM-MS-14 Pursue opportunities to acquire fee title, easement, and water rights from willing sellers.

CM-MS-15 Encourage the planting of trees in riparian areas when appropriate and where conditions are suitable.

8.1.12.2 Western Subbasin Mattole River HSA

CM-MW-01 Assess current levels of LWD, determine amount necessary for improved flushing, pooling and habitat conditions for coho salmon, facilitate immediate placement and develop a plan for long-term recruitment.

CM-MW-02 Cooperate in establishing monitoring stations at appropriate locations (e.g., Squaw, Honeydew, and Bear creeks) to monitor in-channel sediment and track aggraded reaches in the lower basin and in the lower reaches of major tributaries.

CM-MW-03 Support the assessment, prioritization, and treatment of sources of excess sediment.

CM-MW-04 Encourage the monitoring of summer water and air temperatures using Department-accepted protocols. Continue temperature monitoring efforts in Stansberry, Mill (RM 2.8) Clear, Squaw, Woods, Honeydew Bear, North Fork Bear, South Fork Bear, Little Finley, Big Finley, and Nooning creeks, and expand efforts into other subbasin tributaries.

CM-MW-05 Develop a plan to manage near-stream buffers to reduce the effects of solar radiation and to moderate air temperatures.

CM-MW-06 Encourage the assessment, prioritization, reclamation and enhancement of riparian habitat.

CM-MW-07 Recognize and support ongoing efforts of landowners, the BLM, and others to improve habitat conditions for coho salmon.

CM-MW-08 Recommend coordinated, expedited processing of SWRCB and 1600 agreements for projects that are intended to reduce summer diversions.

CM-MW-09 Develop a public education program to raise awareness of the habitat needs of coho salmon and how the community, especially landowners, can improve coho salmon habitat.

CM-MW-10 Develop incentives for landowners and communities to reduce summer water withdrawals and enhance habitat.

CM-MW-11 Develop programs to support continued land-use patterns and discourage conversions and subdivisions.

CM-MW-12 Support a plan for mapping unstable soils and use of the information to guide land-use decisions, road design, and other activities that can increase erosion.

8.1.12.3 Northern Subbasin Mattole River HSA

CM-MN-01 Encourage tree planting and other vegetation management to improve canopy cover, especially in Conklin, Oil, Green Ridge, Devils, and Rattlesnake creeks.

CM-MN-02 Encourage cooperative efforts for treatment of stream-bank erosion sites to reduce sediment yield to streams, especially in Sulphur, Conklin, and Oil creeks and the lower reaches of the North Fork Mattole River.

CM-MN-03 Due to high incidence of unstable slopes in this subbasin, any permitting of future sub-division development proposals should be based on existing county-imposed forty acre minimum parcel sub-division ordinances.

8.1.12.4 Eastern Subbasin Mattole River HSA

CM-ME-01 Continue to conduct and implement road and erosion assessments, especially in Middle, Westlund, Gilham, Sholes, Blue Slide, and Fire creeks.

CM-ME-02 Encourage tree planting and other vegetation management to improve canopy cover, especially in Dry and Blue Slide creeks.

CM-ME-03 Encourage cooperation at stream-bank erosion sites to reduce sediment yield to streams, especially in Middle, Westlund, Gilham, North Fork Fourmile, Sholes, Harrow, Little Grindstone, Grindstone, Eubank, and McKee creeks.

8.2 CENTRAL CALIFORNIA COAST ESU

Recommendations for the CCC Coho ESU are presented in this section.

8.2.1 MENDOCINO COAST HYDROLOGIC UNIT

MC-HU-01 Encourage local jurisdictions to update general plans to include measures to protect coho salmon.

MC-HU-03 Encourage the County to limit development in the 100-year flood plain where the development would adversely affect coho salmon or their habitat.

MC-HU-04 Encourage Mendocino and Sonoma counties to adopt county grading ordinances.

MC-HU-05 Encourage the County to expand the CEQA checklist for Mendocino County to include coho salmon.

MC-HU-06 Increase stream complexity by actions to:

a. Retain current limited supply of LWD, boulders, and other structure-providing features;

b. Install new LWD, boulders, and other features immediately; and

c. Restore riparian vegetation to provide for future recruitment of LWD.

MC-HU-07 Support the assessment, prioritization, and treatment of sediment sources at an HSA level.

MC-HU-08 Determine site-specific recommendations, including incentives, to remedy high temperatures. Depending on the terrain and aspect, examples could include riparian planting to increase shade to reduce high ambient temperature and raise humidity along streams.

MC-HU-09 Map unstable soils and use that information to guide land-use decisions, road design, THPs, and other activities that can promote erosion.

MC-HU-10 Provide education and training on water diversion practices and facilitate compliance with pertinent regulations (e.g., FGC §1600 *et seq.*, CFPR 916.9, California water rights law).

MC-HU-11 Improve pool frequency and depth by actions to:

a. Continue to treat existing upslope sediment sources; and

b. Avoid or minimize land ownership fragmentation/conversion to more intensive uses.

MC-HU-12 Discourage poaching of coho salmon by measures to:

a. Cooperate with and provide incentives to landowners to maintain road and trail closures to be effective against trespass;

b. Encourage monitoring of road closures and timely repair of defective or damaged road closure systems;

c. Promote CalTIP, especially how it might apply to spawning coho salmon; and

d. Report un-permitted road use to local, State, and Federal enforcement personnel during periods when coho salmon are running.

MC-HU-13 To promote channel complexity and provide rearing habitat, investigate the desirability and feasibility of reintroduction of beavers.

MC-HU-14 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. Management to promote conifer recruitment; and

b. Incentives to landowners, such as technical support.

MC-HU-15 Maintain or improve instream flows by actions to:

a. Avoid or minimize increases in water use; and

b. Provide incentives to remove or convert direct diversions to off-stream storage and restrict the season of diversion to December through March.

MC-HU-16 The Department, the SWRCB, the RWQCB, the CDF, Caltrans, and counties, in cooperation with NOAA Fisheries, should evaluate the rate and volume of water drafting for dust control in streams or tributaries and where appropriate, minimize water withdrawals that could impact coho salmon. These agencies should consider existing regulations or other mechanisms when evaluating alternatives to water as a dust palliative (including EPA-certified compounds) that are consistent with maintaining or improving water quality.

MC-HU-17 Maintain or re-establish geographic distribution of coho salmon by continuing to allocate substantial improvement efforts towards identified biological refugia spawning coho salmon populations, and/or otherwise suitable habitat conditions accessible to coho salmon.

MC-HU-18 Coordinate with the NCRWQCB to implement water quality monitoring and streamline permitting of coho salmon habitat restoration projects (RWQCB 401, USACE 404, NOAA Fisheries, and USFWS permitting).

MC-HU-19 Encourage funding authorities to allocate adequate resources to prioritize and upgrade culverts to provide coho salmon passage within the range of coho salmon to pass 100-year flows and the expected debris loads (e.g. LWD that might be mobilized).

MC-HU-20 Decrease coarse sediment delivery by implementing actions to work with:

a. Landowners, other resource professionals, and agencies to identify areas of increased risk of mass wasting to enable avoidance or mitigation of triggering activities; and
b. Transportation system (State, county, and private road and rail) construction and maintenance personnel to identify risks and mitigation measures for mass wasting such as replacing culverts with bridges, minimizing fill volumes on culverts, and constructing critical dips at culverts.

MC-HU-21 Decrease fine sediment loads by actions to:

a. Abandon riparian road systems and/or upgrade roads and skid trails that deliver sediment to adjacent water courses;
b. Limit winter use of unsurfaced roads and recreational trails by unauthorized and impacting uses;
c. Minimize the density of road and trail crossings of water courses;
d. Encourage out-sloping roads with rolling dips as the standard, wherever feasible, for all roads, and especially unsurfaced roads; and
e. Work with landowners to identify and modify practices such as road maintenance that generate fine sediment.

MC-HU-22 Develop erosion control projects similar to the North Fork Ten Mile River erosion control plan.

8.2.1.1 Albion River HSA

MC-AR-01 Place instream structures to improve gravel retention and habitat complexity.

MC-AR-02 Provide technical assistance and incentives to landowners in developing and implementing sediment reduction plans to meet requirements of the CWA TMDL, making watersheds with an implementation schedule the highest priority.

MC-AR-03 Conduct collaborative evaluations of priorities for treatment of barriers such as Fish Passage Forum.

MC-AR-04 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;

b. Management to promote conifer recruitment;

c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and

d. Incentives to landowners, such as technical support.

MC-AR-07 Protect and enhance riparian buffer zones through conservation planning, acquisition, and easements, where necessary and with willing landowners to protect coho salmon.

MC-AR-10 Encourage coordination of large wood placement in streams as part of logging operations and road upgrades to maximize size, quality, and efficiency of effort.

MC-AR-11 Encourage, when necessary and appropriate, restricted access to unpaved roads in winter to reduce road degradation and sediment release. Where restricted access is not feasible, encourage measures such as rocking to prevent sediment from reaching streams with coho salmon.

MC-AR-12 Conduct comprehensive subbasin erosion control "storm proofing" combined with installation of LWD into streams.

MC-AR-13 Modify stream barriers to allow coho salmon passage while maintaining LWD.

8.2.1.2 Big River HSA

MC-BR-01 To minimize and reduce the effects of water diversions, take actions to improve SWRCB coordination with other agencies to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and other anadromous salmonids and natural hydrograph, and avoidance of adverse impacts caused by water diversion.

MC-BR-02 Target Big River for enhancement of instream habitat by installation of LWD.

8.2.1.3 Garcia River HSA

MC-GA-02 Re-establish connectivity of North Fork Garcia River to the mainstem.

MC-GA-05 Provide technical assistance and incentives to Garcia River landowners for developing and implementing sediment reduction plans to meet the requirements of the CWA TMDL.

MC-GA-06 Utilize as a model for erosion reduction and LWD placement the comprehensive approach practiced in the South Fork of the Garcia River.

MC-GA-07 Investigate stream nutrient enrichment and cycling needs for coho salmon.

MC-GA-08 Study the Garcia River estuary using the Garcia River Estuary Enhancement Feasibility Study, as well as new information, to consider restoring estuary functions that would benefit coho salmon.

MC-GA-09 Encourage coordination of LWD in streams as part of logging operations and road upgrades to maximize size, quality, and efficiency of effort.

MC-GA-11 Maintain the following tributaries to provide coldwater input to the Garcia River mainstem: Hathaway, North Fork, Rolling Brook, Mill Creek (lower Garcia River), South Fork, Signal, Mill Creek (upper Garcia River).

MC-GA-12 Work with landowners to plant riparian zones of Blue Waterhole, Inman Creek, and Pardaloe Creek with the goal of reducing instream temperatures and inputs into the Garcia River mainstem, and providing a long-term source of conifer LWD.

MC-GA-13 Encourage, when necessary and appropriate, restricted access to unpaved roads in winter to reduce road degradation and sediment release. Where restricted access is not feasible, encourage measures such as rocking to prevent sediment from reaching streams with coho salmon.

MC-GA-14 Protect and enhance riparian buffer zones through conservation planning, acquisition, and easements, where necessary and with willing landowners to protect coho salmon.

MC-GA-16 Excavate a geomorphically designed channel in the lower North Fork Garcia River, which currently goes subsurface in the summer months, stranding thousands of salmonids. Juvenile coho salmon should be rescued until restoration project is undertaken and completed.

MC-GA-17 Work with landowners to plant conifers in the lower mainstem Garcia River from Eureka Hill road Bridge to Windy Hollow road with the goal of reducing stream temperature, providing bank stability and long-term LWD. Note the lower mainstem is currently seeing a reemergence of steelhead spawning and rearing life history. Reductions of mainstem temperature to a suitable range for coho salmon would be a very favorable development.

MC-GA-18 Consider projects to open logjam migration barriers while maintaining LWD in the North Fork, South Fork, and Fleming Creek.

MC-GA-19 Complete the remaining 25% of erosion control sites, identified in the South Fork Garcia River by the Trout Unlimited North Coast Coho Project.

MC-GA-21 Place large woody debris in Inman Creek, South Fork Garcia River, Signal Creek, and North Fork Garcia River, where necessary and with willing landowners.

MC-GA-22 Plant redwood trees in the lower seven miles of the Garcia River mainstem between Eureka Hill road and Windy Hollow road for long term LWD and bank stability and reduction of instream temperatures (which are now close to being suitable for coho salmon).

8.2.1.4 Navarro River HSA

MC-NA-03 Investigate stream nutrient enrichment and cycling needs for coho salmon.

MC-NA-04 Supplement ongoing efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through:

a. LWD placement;

b. Management to promote conifer recruitment;

c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and

d. Incentives to landowners, such as technical support.

MC-NA-06 The SWRCB, the Department, and NOAA Fisheries should make enforcement of pertinent laws and codes concerning illegal and unpermitted dams and diversions a high priority for action. Ongoing education and incentives and assistance with water conservation are called for.

MC-NA-07 Comprehensive, subbasin wide, erosion control and LWD installation is being implemented by Mendocino Redwood Company in partnership with the Department through the North Coast Coho Project in the Little North Fork. This approach of "storm proofing" key subbasins needs to be fully implemented in the key subbasins of Flynn, Dutch Henry, John Smith, Minnie, Horse Camp and German creeks. These tributaries have been identified as high priority in the Navarro River Restoration Plan.

MC-NA-08 Provide technical assistance and incentives to Navarro River landowners for developing and implementing sediment reduction plans to meet the requirements of the CWA TMDL.

MC-NA-09 Encourage coordination of large wood placement in streams as part of logging operations and road upgrades to maximize size, quality, and efficiency of effort.

MC-NA-10 Protect and enhance riparian buffer zones through conservation planning, acquisition, and easements, where necessary and with willing landowners to protect coho salmon.

MC-NA-11 Encourage, when necessary and appropriate, restricted access to unpaved roads in winter to reduce road degradation and sediment release. Where restricted access is not feasible, encourage measures such as rocking to prevent sediment from reaching streams with coho salmon.

8.2.1.5 Noyo River HSA

MC-NO-02 Investigate the role of the Pudding Creek Dam impoundment in coho salmon migration and freshwater survival rate; repair dam as appropriate.

MC-NO-04 Request that Mendocino County implement a sediment reduction plan related to water quality.

MC-NO-05 Support funding to address barriers to passage on the California Western Railway right-of-way.

MC-NO-06 Evaluate the biological justification for the egg-taking station on the South Fork Noyo River.

8.2.1.6 Ten Mile River HSA

MC-TM-01 Complete implementation of erosion control sites identified in Hawthorne Campbell, Department, and TU North Coast Coho Project on North Fork Ten Mile. Encourage development of similar projects in other coho salmon subbasins.

MC-TM-02 Protect and enhance riparian buffer zones through conservation planning, acquisition, and easements, where necessary and with willing landowners to protect coho salmon.

MC-TM-03 Encourage, when necessary and appropriate, restricted access to unpaved roads in winter to reduce road degradation and sediment release. Where restricted access is not feasible, encourage measures such as rocking to prevent sediment from reaching streams with coho salmon.

MC-TM-05 Provide technical assistance and incentives to Ten Mile River landowners for developing and implementing sediment reduction plans to meet the requirements of the CWA TMDL.

MC-TM-06 Evaluate the biological justification for the egg-taking station on the South Fork Noyo River.

8.2.1.7 Gualala River HSA

MC-GU-02 Complete comprehensive assessment/implementation of erosion control measures in entire North Fork basin.

MC-GU-03 Enforce existing bypass flow permit conditions of the SWRCB and the Department for the North Gualala Water Company diversion on North Fork Gualala River.

MC-GU-04 Investigate expanding North Fork riparian zone through acquisition/easement from willing participants where necessary.

MC-GU-05 Encourage coordination of large wood placement in streams as part of logging operations and road upgrades to maximize size, quality, and efficiency of effort.

MC-GU-07 Consider Haupt Creek for acquisition/easement of old growth redwood sections from willing participants.

MC-GU-09 Recovery goal should be to restore conditions in all tributaries that historically contained coho salmon.

MC-GU-11 Enforce all pertinent laws relating to summer dams and diversions to provide adequate year round flows and coho salmon passage. Baseline flow (i.e., hydrograph) studies are needed.

MC-GU-12 Protect and enhance riparian buffer zones through conservation planning, acquisition, and easements, where necessary and with willing landowners to protect coho salmon.

MC-GU-13 Take a critical look at emerging conversion of timberland and oak woodlands in the Gualala River.

8.2.2 RUSSIAN RIVER HYDROLOGIC UNIT

RR-HU-02 Encourage the RWQCB to upgrade the Basin Plan to benefit salmonids (revisions have been proposed by the RWQCB).

RR-HU-03 Identify water diverters; request that SWRCB review and/or modify water use based on the needs of coho salmon and authorized diverters.

RR-HU-04 Assess, prioritize, and develop plans to treat barriers to passage in all HSAs.

RR-HU-06 Assess riparian canopy and impacts of exotic vegetation (especially *Arundo donax*), prioritize, and plan riparian habitat reclamation and enhancement programs.

RR-HU-07 Implement the Sotoyome Resource Conservation District's Fish Friendly Farming Program within Sonoma and Mendocino counties.

RR-HU-08 Implement Coho Salmon Captive Broodstock Program:

a. Continue genetic analysis of source stocks for coho salmon broodstock. Recent genetic data produced by the Bodega Marine Laboratory and the NOAA Fisheries laboratory at Santa Cruz identifies that source populations in the Russian River and Marin County are genetically distinct. Further analysis of other broodstock year classes needs to be completed by NOAA Fisheries to weigh the risks of inbreeding and outbreeding depression in the captive broodstock program. A review of stocking history may help determine how locally adapted stocks can be utilized to enhance variability and reduce risk of extirpation. This review should be completed before mating protocols are finalized and implemented. The Department has completed this review in the Russian River HU, and the review for Bodega-Marin Coastal HU is underway;

b. Stock first priority barren streams. First priority streams are streams the Department has identified with good habitat condition resulting from complete restoration or unimpaired functions include Felta and Mill creeks (tributary to Dry Creek west of Healdsburg), Freezeout, Willow and Sheephouse creeks (near Duncans Mills), and Ward Creek (tributary to Austin Creek). Identify additional streams that may be suitable for stocking as restoration occurs;

c. Develop and implement a monitoring and evaluation program to adaptively manage the coho salmon broodstock program. Coordinate and implement a monitoring and evaluation program that would meet high and medium priority monitoring objectives as outlined in the coho salmon hatchery genetic management plan;

d. Develop, implement, and evaluate experimental release protocols for the captive broodstock program;

e. Review and revise long-term hatchery program goals based on results of the monitoring and evaluation program implemented in the experimental captive broodstock program; and

f. Develop and implement a long-term monitoring program for coho salmon abundance trends in suitable index streams that have recent (within eight years) coho salmon presence or that will be supplemented with the captive broodstock program. The Department has contracted Humboldt State University to develop these protocols in coordination with NOAA Fisheries.

RR-HU-09 Review and develop preferred protocols for Pierce's Disease Control that would maintain a native riparian corridor and develop an outreach program.

RR-HU-10 Throughout the HU, advise Sonoma County to consider recommendations to offset impacts from county policies and operations, as developed by the FishNet program in their report, Effects of County Land Use Policies and Management Practices on Anadromous Salmonids and Their Habitat (Harris et al, 2001). Advise Mendocino County to consider recommendations to offset impacts from county policies and operations, as developed by the Five County effort.

RR-HU-11 Sonoma and Mendocino counties should develop grading and erosion control standards supported by a grading ordinance, to minimize sediment impacts to coho salmon habitat.

RR-HU-12 Restore coho salmon passage at county structures on all streams inhabited by coho salmon, as identified in the Russian River Fish Passage Assessment report (Taylor, March 2003). Encourage expansion of coho salmon passage inventories as needed to use a comprehensive watershed approach to coho salmon passage. Integrate coho salmon passage projects at county facilities with coho salmon passage improvements involving other landowners, throughout targeted coho salmon watersheds.

RR-HU-13 Sonoma County Public Works and Parks departments should adopt and implement the best management practices in Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance (FishNet 4C 2004) after review and approval by State regulatory agencies is completed. Mendocino County Public Works should adopt the Five County Roads manual after review and approval by State regulatory agencies is completed.

RR-HU-14 Sonoma and Mendocino County's Public Works, Water Agencies and Flood Control District's should reduce native riparian vegetation clearing and sediment removal adjacent to and in streams with coho salmon. Retain LWD within streams to the extent possible. When woody material is removed it should be stored and made available for stream enhancement projects.

RR-HU-15 Sonoma and Mendocino County planning and public works should promote alternatives to conventional bank stabilization for public and private projects, including bioengineering techniques.

RR-HU-16 Sonoma and Mendocino counties and incorporated areas should review development set-backs for adequacy in protecting critical streams inhabited by coho salmon, and revise as needed. Promote streamside conservation measures, including conservation easements, setbacks, and riparian buffers.

RR-HU-17 Sonoma and Mendocino County Public Works, Transportation Departments, Parks and Open Space Districts, should inventory, evaluate and fix problem roads which systematically contribute sediment to streams inhabited by coho salmon.

RR-HU-18 Support efforts and develop county, city, and other local programs to protect and increase instream flows for coho salmon. Sonoma and Mendocino counties should have policies to minimize impervious surfaces and promote surface water retention. The counties should participate in regional water management planning through the general plan process and in other venues as appropriate.

8.2.2.1 Russian River Mainstem

RR-MS-01 Manage summer flows in the mainstem of the Russian River to the benefit of rearing coho salmon and the estuary, while ensuring that all existing legal water uses and rights are accounted for.

RR-MS-02 Investigate the opportunity to operate the estuary as a natural system, allowing periods of closure to benefit coho salmon rearing, and appropriate timing of opening to benefit coho salmon migration/emigration.

RR-MS-03 Explore adjusting the operation of Mirabel Dam within confines of existing water rights and legal uses to improve passage of downstream migrants.

RR-MS-04 Evaluate the feasibility of bypassing large dams.

RR-MS-05 Update temperature analyses below Coyote Dam and Warm Springs Dam and review dam management.

RR-MS-06 In upper mainstem, prioritize and plan habitat restoration programs and projects.

8.2.2.2 Guerneville HSA

RR-GU-01 Encourage local agencies to implement recommendations of completed non-point source sediment assessments.

RR-GU-02 Assess, prioritize, and treat sources of excess sediment.

RR-GU-03 Supplement first priority barren streams as part of the coho salmon broodstock program. Within the Guerneville HSA, these streams include Willow, Sheephouse, Freezeout, Dutchbill and Green Valley creeks.

RR-GU-04 Acquire from willing sellers conservation easements or land in fee title in habitat essential for coho salmon.

RR-GU-06 Identify water diverters; request that SWRCB review or modify water use based on the needs of coho salmon and authorized diverters. Monitor and identify problems and prioritize needs in terms of changes to water diversion, in particular Green Valley and Dutchbill creeks, which have been identified as current or potential streams inhabited by coho salmon that go dry in some years.

8.2.2.3 Austin Creek HSA

RR-AC-01 Encourage Sonoma County to implement recommendations of completed non-point source sediment assessments.

RR-AC-02 Assess, prioritize, and treat sources of excess sediment.

RR-AC-03 Supplement first priority barren streams with the coho salmon broodstock program, such as Ward Creek. Identify additional streams that may be suitable for stocking as restoration occurs.

8.2.2.4 Warm Springs HSA

RR-WS-01	Develop plans to improve riparian vegetation in Dry Creek and its tributaries. Develop and implement riparian improvements through land-use planning, use of conservation easements, and implementation of the Sotoyome Resource Conservation District's Fish Friendly Farming Program.
RR-WS-02	Support implementation of measures to modify flows in Dry Creek to provide summer rearing habitat for coho salmon.
RR-WS-03	Supplement first priority barren streams as part of the coho salmon broodstock program, such as Mill and Felta creeks. Identify additional streams that may be suitable for stocking as restoration occurs.
RR-WS-04	Review and develop preferred protocols for Pierce's Disease Control that would maintain a native riparian corridor and develop an outreach program.
RR-WS-06	Assess, prioritize, and develop plans to treat sources of excess sediment.
RR-WS-07	Increase habitat structure and complexity in Dry Creek to enhance habitat diversity, and provide depositional areas for spawning gravels for coho salmon (i.e., place LWD or large boulder structures).

8.2.2.5 Mark West Creek HSA

RR-MW-01	Reduce habitat fragmentation and implement riparian improvements through land-use planning and use of conservation easements from willing landowners.
RR-MW-02	Develop plans to improve instream habitat conditions.
RR-MW-04	Assess, prioritize, and develop plans to treat sources of excess sediment.

8.2.2.6 Santa Rosa Creek HSA

RR-SR-01	Encourage Sonoma County and the City of Santa Rosa to reduce habitat fragmentation and implement riparian improvements through land-use planning and use of conservation easements from willing landowners.
RR-SR-02	Evaluate and develop solutions to problems caused by channelization.
RR-SR-03	Assess, prioritize, and develop plans to treat sources of excess sediment.

8.2.2.7 Forsythe Creek HSA

RR-FO-01	Improve migration and summer/overwintering habitat through riparian restoration and erosion control.
RR-FO-02	Assess, prioritize, and develop plans to treat sources of excess sediment.

8.2.2.8 Geyserville HSA

RR-GE-01	Maintain and improve riparian condition and water temperature through land use planning and conservation easements from willing landowners.
RR-GE-03	Assess, prioritize, and develop plans to treat sources of excess sediment.

8.2.3 BODEGA AND MARIN COASTAL HYDROLOGIC UNITS

BM-HU-01 Implement BMPs for road projects. Support Sonoma and Marin County Departments of Public Works, Caltrans, and other appropriate agencies to implement and maintain environmentally sound upgrades, modifications, and new construction of road projects, including culverts and stream crossings.

BM-HU-02 Continue to implement erosion control projects that were assessed and inventoried in sediment assessment plans throughout watersheds of the HU.

BM-HU-03 To avoid and minimize the adverse effects of water diversion on coho salmon, improve coordination between the SWRCB, the Department, and other agencies, to promote flows that will provide for a natural hydrograph, and to address protective conditions, such as by-pass flows, season of diversion, and off-stream storage.

BM-HU-04 Encourage local governments to incorporate protection of coho salmon in any flood management activities.

BM-HU-05 Encourage counties to implement performance standards in stormwater management plans.

BM-HU-06 On private and public lands, address issues of low flow by increasing riparian protection restoration, sediment control, and employing BMPs that encourage permeability and infiltration.

BM-HU-07 Continue outreach, education, and enforcement related to household hazardous waste and hazardous materials spills in creeks.

BM-HU-08 Encourage the cultivation and availability of locally indigenous native plants for use in restoration and bank stabilization.

BM-HU-09 Investigate opportunities for restoring historic runs in identified watersheds.

BM-HU-10 Continue to support landowners and the Marin RCD to restore riparian zones and manage livestock to increase stream protection and soil retention. Encourage sustainable land management practices and control of sediment sources in agricultural zones.

BM-HU-11 Continue to support the many active watershed groups in the HU, encouraging a focus on coho salmon restoration where appropriate.

BM-HU-12 Implement coho salmon passage improvements as identified in inventories conducted by the Salmon Protection and Watershed Network (SPAWN), Taylor and Associates, Trout Unlimited and the NPS. Expand inventories as needed for a comprehensive watershed approach for coho salmon passage.

BM-HU-13 County planning, public works, open space, and fire departments should continue to implement FishNet 4C priority goals for this region, which include:

a. Enact and enforce Marin County Streamside Conservation Area Ordinance;
b. Adopt and implement Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance (FishNet 4C 2004);

c. Systematically work to restore coho salmon passage at county facilities; and

d. Address issues of sediment from roads through restoration and education.

BM-HU-14 Monitor the effectiveness and maintenance of watershed restoration projects (e.g., Sonoma County Coastal Wetland Enhancement Plan; Walker Creek Watershed Enhancement Plan; San Geronimo Creek Watershed Sediment Source Sites Assessment and Evaluation; Lagunitas Creek Final Sediment and Riparian Management Plan; and Watershed Assessment and Erosion Prevention Planning Project for the Redwood Creek Watershed). Augment inventories as needed.

8.2.3.1 Salmon Creek HSA

BM-SA-01 Coordinate efforts of involved agencies in review of plans for timber harvest and vineyard conversion. Support appropriate entities in the development and implementation of standards and BMPs for agriculture to reduce pathogen, nutrient, and sediment loadings to creeks.

BM-SA-02 Continue to implement erosion control projects that were assessed and inventoried in sediment assessment plans, and monitor effectiveness and maintenance of past and current watershed restoration projects. Augment surveys as necessary.

BM-SA-03 Continue to fund and support landowners to restore riparian zones and manage livestock to increase stream protection and soil retention. Encourage sustainable land management practices and control sediment sources in agricultural zones.

BM-SA-04 Implement recommendations of watershed plans consistent with the coho salmon recovery strategy. Review existing, approved watershed management or restoration plans within the range of coho salmon and implement actions consistent with priority recommendations of the coho salmon recovery strategy.

BM-SA-05 Encourage the design of vineyard operations to ensure adequate protection of coho salmon habitat attributes, including riparian corridors, instream flow, and water quality.

BM-SA-06 Support a coho salmon limiting factors assessment of the Salmon Creek estuary.

8.2.3.2 Walker Creek HSA

BM-WA-01 Continue to fund and support landowners and the Marin RCD to restore riparian zones and manage livestock to increase stream protection and soil retention. Address water quality and nutrient loading issues by encouraging sustainable land management practices, controlling sediment sources, protecting riparian zones and employing BMPs that encourage permeability and infiltration.

BM-WA-02 Continue to support active watershed groups, encouraging a focus on coho salmon restoration where appropriate.

BM-WA-03 Assess the water temperature regime during the summer season for three to five years to determine the role of water temperature as a limiting factor in coho salmon production.

BM-WA-04 Support landowners and the Marin RCD in projects to improve channel conditions and restore natural channel geomorphology, including side channels and dense contiguous riparian vegetation.

BM-WA-05 Implement high priority fishery enhancement projects for the reduction of sediment delivery and the restoration of riparian corridors as listed in the Walker Creek Enhancement Plan (2001).

BM-WA-06 Look for opportunities to increase woody debris retention and recruitment.

BM-WA-07 Continue to assess the release of water from Soulajule Reservoir to develop the optimum release for coho salmon.

BM-WA-08 Support a coho salmon limiting factors assessment in Keys Estero and Tomales Bay.

8.2.3.3 Lagunitas Creek HSA

BM-LA-01 Use recommendations of existing sediment source surveys to restore habitat of coho salmon. Augment surveys as necessary. Expand inventories as needed for a comprehensive watershed approach for coho salmon passage.

BM-LA-03 Coordinate with appropriate agencies to restore coho salmon passage at barriers identified by Ross Taylor, SPAWN, and others. Complete any needed surveys of migration barriers.

BM-LA-04 Investigate opportunities for restoring historic runs of coho salmon.

BM-LA-05 Commit ongoing resources and support of stewardship in the basin to include riparian enhancement and protection, sediment source reduction, habitat typing and surveying, coho salmon surveys and counts, water conservation, outreach and education, effectiveness monitoring of projects, and planning and assessment of potential restoration projects to benefit coho salmon.

BM-LA-06 Provide incentives for septic inspection, repair, and replacement to reduce aquatic pollution.

BM-LA-07 Assess, evaluate, and implement habitat restoration actions in Nicasio Creek.

BM-LA-08 Develop a monitoring and assessment program for the estuarine reaches of Lagunitas Creek and inter-tidal reaches of Tomales Bay, looking at impacts to coho salmon rearing and emigration.

BM-LA-09 Consider restoration of Olema Marsh, Bear Valley Creek, and the mouth of Olema Creek, to benefit coho salmon. The restoration should provide rearing habitat refuge during high flows, habitat protection, and food production. Hydrologic connectivity between marshes should be restored.

BM-LA-11 Throughout the Lagunitas Creek drainage, work with private landowners to encourage biotechnical bank stabilization, riparian protections, woody debris retention, and timing of water withdrawals to help protect coho salmon.

BM-LA-12 In the San Geronimo Creek sub-watershed, continue public outreach and education for private landowners, residents, commercial, public utility and county workers regarding best management practices to control erosion, protect riparian vegetation, retain LWD, and minimize disturbance to coho salmon from pets.

BM-LA-13 In the San Geronimo Creek sub-watershed, encourage removal of non-native fish species from stock ponds where they are a threat to coho salmon.

BM-LA-14 In the San Geronimo Creek sub-watershed, Marin County should determine a policy for reviewing new development projects and impacts to the creek from new well construction. The County should consider adopting recommendations for well developments from the local coastal plan.

BM-LA-15 Encourage the NPS to continue practices to benefit coho salmon, including restoration projects, sediment control projects, locating well constructed fences out of riparian zones, repairing headcut gullies as possible, and implementing rotational grazing in locations to minimize erosion and impacts to the creek.

BM-LA-16 Encourage the County of Marin to continue to implement and coordinate the Watershed Protection Agreement Program for additional water hook-ups in Nicasio and San Geronimo creek watersheds.

BM-LA-17 Look for opportunities to restore natural channel form and function in upper watershed to protect summer flows into San Geronimo Creek.

BM-LA-18 Encourage continuation of riparian protection and sediment control projects. Focus on working with landowners to manage livestock to protect riparian areas, and to implement erosion control projects on State and Federal parkland and on private lands (e.g., Devil's Gulch).

BM-LA-21 Continue public outreach and education for private landowners, residents, commercial, public utility and county workers regarding best management practices to control erosion, protect riparian vegetation, retain LWD, and minimize disturbance to coho salmon from pets.

BM-LA-23 Determine policy for reviewing new development projects and well construction. Consider adopting recommendations for well developments from the coastal plan.

8.2.3.4 Bolinas HSA

BM-BO-01 Implement recommendations of completed sediment source surveys. Supplement surveys as necessary.

BM-BO-02 Continue to support restoration efforts on Bolinas and Big lagoons to benefit coho salmon during all life phases and seasons.

BM-BO-03 Work with landowners and appropriate agencies to manage low summer flows for coho salmon, on a watershed basis. Provide support and incentives to protect both fisheries flows and agriculture, including timing of withdrawals, construction of off-site storage facilities, water conservation practices and riparian zone protections. Conduct outreach and education for landowners on these practices.

BM-BO-04 Look for opportunities to increase LWD recruitment and retention.

BM-BO-05 Provide incentives for septic inspection, repair and replacement to improve water quality in both streams and lagoons.

BM-BO-06 Encourage the NPS to provide additional space for Stinson Beach Water District for off-stream storage to protect coho salmon in Easkoot Creek.

BM-BO-07 Identify, prioritize, and treat coho salmon passage barriers in the Redwood Creek drainage.

BM-BO-08 Identify and resolve problems related to trails in these watersheds, including location of trails and access for construction and maintenance of roads and trails.

8.2.4 SAN FRANCISCO BAY HYDROLOGIC UNITS

SF-HU-01 Habitat suitability evaluations in the San Francisco Bay Area should include coho salmon.

SF-HU-02 Where appropriate, apply range-wide recommendations to suitable streams in the San Francisco Bay.

SF-SR-01 Work to restore coho salmon habitat, especially in Arroyo Corte Madera del Presidio and Corte Madera Creek.

8.2.5 SAN MATEO HYDROLOGIC UNIT

SM-HU-02 To minimize and reduce the effects of water diversions, take actions to improve SWRCB coordination with other agencies to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and natural hydrograph, and avoidance of adverse impacts caused by water diversion.

SM-HU-03 Develop legislation that will fund county planning for environmentally sound growth and water supply. Work in coordination with the California Department of Housing and Community Development, Association of Bay Area Governments, and other government associations.

SM-HU-04 Implement FishNet 4C priority actions that protect coho salmon.

a. Continue to protect riparian zones on streams inhabited by coho salmon within the coastal zone according to local coastal plan and THP prescriptions. Evaluate the need to apply coastal zone protections to streams inhabited by coho salmon that are not in the coastal zone;
b. Develop, adopt and implement written standards for routine operations and maintenance. Train staff in BMPs;
c. Conduct coho salmon passage assessments and restore coho salmon passage to coho salmon habitat;
d. Conduct road assessments and address issues of sedimentation from county public works and parks roads and trails;
e. Promote alternatives to conventional bank stabilization for public and private projects;

f. Establish adequate spoils storage sites throughout the counties so that material from landslides and road maintenance can be stored safely away from anadromous streams. Coordinate these efforts with Caltrans; and

g. Work to increase county enforcement of permit conditions and erosion control plans on development.

SM-HU-05 Support continued economically sustainable management of forest and agricultural lands in the range of coho salmon to reduce the potential for conversion to residential or commercial development.

8.2.5.1 San Gregorio Creek HSA and Pescadero Creek HSA

SM-SG-01 Minimize take attributable to diversion of stream flow. Potential take results from three primary impacts to habitat: 1) reduced rearing habitat for juveniles, 2) reduced flows necessary for smolt emigration, and 3) reduced flows necessary for adult immigration. This recommendation would develop and support alternatives to diversion of stream flow, where the alternatives may include operation of off-stream reservoirs, development of infrastructure necessary for conjunctive use of stream flow, and use of desalinated ocean water.

SM-SG-02 Conduct a watershed assessment in San Gregorio Creek that addresses impacts to coho salmon.

SM-SG-03 Conduct a comprehensive assessment of watershed processes (e.g., hydrology, geology, fluvial-geomorphology, water quality, vegetation), instream habitat, and factors limiting coho salmon production. Use the assessment results to develop a plan for restoration of coho salmon passage, instream habitat, and upslope erosion control, for implementation by cooperating landowners/managers.

SM-SG-04 Implement BMPs designed to reduce erosion of soil and consequential sedimentation of instream habitat attributable to roads (e.g., practices described in the California Salmonid Stream Habitat Restoration Manual).

SM-SG-05 Implement BMPs designed to reduce bank erosion, water temperature, and removal of LWD by improving the form and function of the riparian forest. These BMPs include livestock exclusion fencing, reclamation and reconstruction of flood plain, and active revegetation.

SM-SG-07 Request that the SWRCB declare critical tributaries to San Gregorio and Pescadero creeks fully appropriated during summer and fall months.

8.2.5.2 Año Nuevo (Gazos Creek) HSA

SM-AN-01 Implement the projects recommended as high priority for coho salmon in the Gazos Creek watershed restoration plan.

8.2.6 BIG BASIN HYDROLOGIC UNIT

BB-HU-02 Provide education and training on coho salmon-friendly water diversion practices to facilitate compliance with pertinent regulation (e.g., FGC §1600 *et seq.*, CFPR 916.9, California Water Code, the Department – NOAA Fisheries guidelines).

BB-HU-03 Encourage funding authorities to allocate adequate resources to prioritize and upgrade culverts to provide coho salmon passage within the range of coho salmon to pass 100-year flows and the expected debris loads (e.g. LWD that might be mobilized).

BB-HU-04 Develop, facilitate, and support by-pass stream-flow requirements on all streams inhabited by coho salmon. Evaluate existing structures and apply to all future structures.

BB-HU-05 Implement the highest priority restoration projects in the watershed plans that address coho salmon habitat. Adjust ongoing efforts based on results.

BB-HU-06 Complete a broad conjunctive-use feasibility study to focus on creative ways to better manage existing surface and groundwater resources in Santa Cruz County, including all cities and water districts, to better utilize groundwater storage and increase baseflow at critical times. This would involve water sources under the control of Scotts Valley Water District, City of Santa Cruz, Soquel Water District, and San Lorenzo Water District.

BB-HU-07 Develop a lagoon management plan that addresses the needs of coho salmon.

8.2.6.1 Davenport HSA

BB-DA-01 Work with the SWRCB to develop and enforce stream flow bypass requirements for diversions from the alluvial reaches of Waddell, mainstem Scott, Big, Mill, and San Vicente creeks.

BB-DA-02 Petition the SWRCB to declare Scott and San Vicente creeks fully appropriated during summer and fall months.

BB-DA-03 Improve the form and function of riparian vegetation in alluvial reaches by implementing established BMPs designed to reduce bank erosion, temperature, and removal of LWD. These BMPs include, but are not limited to, livestock fencing where needed, reclamation or reconstruction of flood plains, and active revegetation. This recommendation applies especially to Scott Creek.

BB-DA-04 Reduce erosion from roads and resulting sedimentation of instream habitat. Implement established BMPs that account for public safety standards, including, but not limited to, assessment procedures and a suite of road reconstruction prescriptions. This recommendation applies especially to Scott Creek.

BB-DA-05 Encourage the DPR to develop a logjam management plan for Waddell Creek. Log jams should be closely examined for coho salmon passage and conservatively modified if absolutely necessary for coho salmon passage.

BB-DA-07 Develop and enforce stream flow bypass requirements for diversions from the alluvial reaches of mainstem San Vicente and Mill creeks.

8.2.6.2 San Lorenzo River HSA

BB-SL-01 Reduce soil erosion and resulting sedimentation of in-stream habitat that is attributable to roads. Implement adopted BMPs, accounting for public safety standards, including, but not limited to, assessment procedures and a suite of road reconstruction prescriptions. This recommendation applies especially to San Lorenzo River.

BB-SL-02 Develop and enforce stream flow bypass requirements for diversions from the alluvial reaches of San Lorenzo River and its tributaries, Zayante, Fall, Bear, Boulder, and Branciforte creeks.

BB-SL-03 Evaluate the Felton Diversion Dam for impacts to coho salmon.

BB-SL-04 Improve adult coho salmon passage at locations named in the San Lorenzo River Enhancement Plan, the Santa Cruz Road Crossing and Salmonid Passage Assessment (Taylor 2003) and other locations identified by the Department as being problematic. Implement the portions of these plans that are consistent with recovery strategy.

8.2.6.3 Aptos-Soquel HSA

BB-AP-01 Implement elements of the Soquel Creek Watershed Assessment and Enhancement Project Plan consistent with the recommendations of recovery strategy. Specifically focus on projects recommended as high-priority in this coho salmon-centric plan. These projects include preservation of base flow, restoration of flood plains, improvements to coho salmon passage, BMPs to reduce sedimentation of instream habitat.

BB-AP-02 Explore and promote opportunities to assure diversion of streamflow (directly or indirectly) is consistent with perpetuation of Soquel Creek coho salmon. Among others, these opportunities include amendments to the adjudication, water conservation, shallow recharge opportunities, shallow-well gauging, deep-well gauging, stream-gauging, self-monitoring of diversions, and conjunctive water management for recovery of groundwater levels.

9 Implementation

Several hundred range-wide and watershed-specific recommendations for recovering coho salmon in California are listed in Chapter 7 (Range-wide Recommendations) and Chapter 8 (Watershed Recommendations). The majority of these recommendations were developed by the CRT. The Department further subdivided and refined some recommendations to facilitate successful implementation. The implementation schedules are intended to reflect the substance and intent of the recommendations. To successfully implement these recommendations, they must be both feasible and funded. Several elements necessary for implementation are described below. Implementation schedules for the range-wide and watershed recommendations follow.

The Recovery Strategy and implementation schedule must be capable of being carried out in a scientifically, technologically, and economically reasonable manner [FGC §2111(b)]. In addition, they must be carried out in a legal manner. Therefore, all of the processes and activities within this strategy are subject to these considerations.

9.1 AVAILABILITY OF FUNDS

Implementation of the Recovery Strategy by the Department is subject to the availability of adequate funding and staffing resources. It is also subject to the availability of adequate funds of other action entities and participants to support and implement recovery strategy actions.

9.2 WATERSHED PRIORITY

Each watershed in the coho salmon range was prioritized as described in Section 6.3 and Appendix G. The resulting rankings for restoration and management potential, as depicted in Figures 6-27 and 6-28, were assigned to each HSA in the implementation schedule.

9.3 TASK LEVEL

Each recovery recommendation is assigned a Task Level, denoting its relative importance or priority for implementation. There are three task levels:

E Task Level E is the highest level. These tasks must be implemented rapidly or early in the coho salmon recovery process because they are critical to coho salmon recovery or they must precede tasks included in levels D and C.

D Task Level D includes tasks that contribute directly to the stated recovery criteria or goals or must be implemented if recovery criteria or goals are to be achieved.

C Tasks included in Task Level C contribute to stated recovery criteria or goals or will likely result in the delay of recovery if not implemented.

Task levels for recommendations were assigned by CDFG technical staff with watershed-specific expertise and with input from some CRT members. Task levels for SSPP recommendations were assigned by consensus of SSRT members based on specific knowledge of the Shasta Valley and Scott River watersheds.

9.4 TASK NUMBER

Recovery recommendations (Chapters 7 and 8) were, in many instances, refined and subdivided into multiple tasks by the Department to facilitate successful implementation. Hence, new numbers were assigned to tasks in the implementation schedules (Tables 9-1 and 9-2). Original recommendation numbers (or original identifiers) are also provided for reference.

9.5 ACTION ENTITIES

Action entities, including governments, organizations, and other parties that are either responsible for recovery actions or will be instrumental in recovery of coho salmon in California have been identified. They include, but are not limited to:

- Federal agencies
  - Bureau of Reclamation (USBR)
  - National Marine Fisheries Service (NOAA Fisheries)
  - National Park Service (NPS)
  - United States Army Corps of Engineers (USACE)
  - United States Fish and Wildlife Service (USFWS)
  - United States Forest Service (USFS)
- State agencies
  - California Conservation Corps (CCC)
  - California Department of Fish and Game (DFG)
  - California Department of Forestry and Fire Protection (CDF)
  - California Department of Parks and Recreation (DPR)
  - California Fish and Game Commission (FGC)
  - California Geological Survey (CGS)
  - Regional Water Quality Control Board (RWQCB)
  - Resources Agency
  - State Water Quality Control Board (SWQCB)
  - California Department of Transportation (Caltrans)
  - Board of Forestry and Fire Protection (BOF)
- County governments
- City governments
- Resource Conservation Districts
- Tribal governments
- Private industry (including forestry, agriculture, livestock, mining)
- Private landowners
- Conservation organization
- Watershed councils and groups
- Academic institutions

9.6 ESTIMATED TIME

Some recovery actions are already occurring (ongoing), but most actions have yet to be initiated. Some of those actions can commence immediately or within the first five years of the strategy (interim), while others require other actions to occur before they, themselves, can be undertaken (long-term). Some actions will be immediate and temporary (short-term), while others will continue indefinitely and at constant intervals (continual).

9.7 IMPLEMENTATION SCHEDULES

The Department has organized the range-wide and watershed recommendations into schedules for implementation, which include the Department's identification of watershed priority, task level, action entity(ies), and estimated time. Table 9-1 sets forth the implementation schedule for range-wide recommendations. Table 9-2 (SONCC) and Table 9-3 (CCC) set forth the implementation schedules for the watershed recommendations.

TABLE 9-1: Implementation schedule for range-wide recommendations

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
STREAMFLOW					
E	RW-SF-01	Design passive diversion devices for water diversions.	**Potential Lead:** CDFG	Interim	*RW-I-B-01b*
C	RW-SF-02	Use passive diversion devices designed to allow diversion of water only when minimum flow requirements are met or exceeded.	**Potential Lead:** Landowners	Long-term	*RW-I-B-01*
C	RW-SF-03	Plan water supply development and growth that are not harmful to coho salmon habitat.	**Potential Lead:** Department of Housing and Development, Counties and Cities, Water Districts, ABAG	Long-term	*RW-I-C-01*
C	RW-SF-04	Increase agency coordination in planning water supply development and growth that are not harmful to coho salmon habitat.	**Potential Lead:** Department of Housing and Development, Counties and Cities, Water Districts, ABAG	Long-term	*RW-I-C-01b*
C	RW-SF-05	Fund planning and education to accomplish water supply development and growth that is not harmful to coho salmon habitat.	**Potential Lead:** Department of Housing and Development, Counties and Cities, Water Districts, ABAG, CDFG, NOAA Fisheries	Long-term	*RW-I-C-01c*
C	RW-SF-06	Educate public on unnecessary and wasteful use of water from coho salmon streams.	**Potential Lead:** SWRCB, RWQCBs, DWR, CDFG	Interim/ Continual	*RW-I-D-01*
C	RW-SF-07	Create interagency task force to improve coordination and promote consistency between agencies to avoid and minimize the adverse effects of future or reopened permits and licenses for water diversions on coho salmon.	**Potential Lead:** CDFG, SWRCB, RWQCB, NOAA Fisheries	Long-term	*RW-I-D-02*
C	RW-SF-08	Encourage NOAA Fisheries and CDFG to work with SWRCB to validate and modify the guidelines *(Guidelines for Maintaining Instream Flows to Protect Fisheries Resources Downstream of Water Diversions in Mid-California Coastal Streams, 2002)* to be appropriate to the SONCC Coho ESU as needed.	**Potential Lead:** NOAA Fisheries, CDFG	Long-term	*RW-I-D-02b*
C	RW-SF-09	Use programmatic, cost-efficient approaches and incentives to work with landowners to remove or convert direct diversions to off-channel storage ponds or tanks.	**Potential Lead:** CDFG, SWRCB, RWQCB, NOAA Fisheries, Landowners	Long-term	*RW-I-D-03*
D	RW-SF-10	Restrict the season of diversion to December through March to provide sufficient flows for coho salmon while ensuring the permitted use need is met.	**Potential Lead:** SWRCB, RWQCB	Long-term	*RW-I-D-03b*
E	RW-SF-11	Evaluate the rate, location, and volume of water drafting for dust control in streams or tributaries and where appropriate, minimize water withdrawals that could impact coho salmon.	**Potential Lead:** CDF, USFS, CDFG, Landowners	Long-term/ Continual	*RW-I-D-04*
D	RW-SF-12	When feasible, use alternatives to water as a dust palliative that are consistent with maintaining or improving water quality.	**Potential Lead:** Counties, Landowners	Long-term/ Continual	*RW-I-D-04b*
C	RW-SF-13	Improve implementation of the Lake or Stream Alteration Notification and Agreement process to protect coho salmon from the adverse affects of projects that would alter the bed, banks, channel, or natural flow streams.	**Potential Lead:** CDFG	Interim/ Continual	*RW-I-D-05*
E	RW-SF-14	Pursue funding for assessing, cataloging, and monitoring water diversions within the range of coho salmon.	**Potential Lead:** Federal, Tribal, State, and Local Government; Ranching, Agricultural, Forestry, Fishing, and Conservation Stakeholders	Long-term	*RW-I-D-06*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
STREAMFLOW (continued)					
C	RW-SF-15	Assess, catalog, and monitor water diversions within the range of coho salmon.	**Potential Lead:** RWQCBs **Others:** CDFG, Counties	Long-term	*RW-I-D-06b*
C	RW-SF-16	Upgrade the existing water rights information system so that water allocations can be readily quantified by watershed.	**Potential Lead:** SWRCB	Interim/ Continual	*RW-I-D-06c*
C	RW-SF-17	Provide conservation incentives to minimize negative effects on coho salmon of water drafting for roads and fire suppression, including, but not limited to: a. Streamline permitting for actions that result in an improvement of instream flows; b. Support multiple uses of water storage systems; and c. Cost-share funding where low-flow, trickle recharge water storage is used to avoid adversely affecting streamflow or coho salmon habitat.	**Potential Lead:** Counties, CDF, USFS	Long-term/ Continual	*RW-I-D-07*
E	RW-SF-18	Establish a comprehensive streamflow evaluation program to determine instream flow needs for coho salmon in priority watersheds.	**Potential Lead:** CDFG	Long-term	*RW-I-D-08*
WATER RIGHTS					
E	RW-WR-01	Review authorized diversions that have no provisions to protect coho salmon in areas with high priority coho salmon habitat.	**Potential Lead:** SWRCB, RWQCBs	Interim/ Continual	*RW-II-A-01*
E	RW-WR-02	Identify unauthorized diversions.	**Potential Lead:** SWRCB, RWQCBs	Interim/ Continual	*RW-II-A-02*
C	RW-WR-03	Petition the SWRCB to add streams to the Declaration of Fully Appropriated Streams where flows are a limiting factor for coho salmon.	**Potential Lead:** CDFG	Interim	*RW-II-A-04*
E	RW-WR-04	Inventory water use and water availability in streams with coho salmon habitat.	**Potential Lead:** SWRCB, RWQCBs **Other:** CDFG	Long-term	*RW-II-A-05*
D	RW-WR-05	Ensure that water availability analyses on priority coho salmon habitat accurately reflect existing water use and availability.	**Potential Lead:** SWRCB, RWQCBs **Other:** CDFG	Long-term	*RW-II-A-05b*
E	RW-WR-06	Require streamflow-gauging devices on priority coho salmon streams when approving water development projects.	**Potential Lead:** Local Government, RWQCBs	Long-term	*RW-II-A-05c*
C	RW-WR-07	Continue to require riparian and pre-1914 water users to file annual statements of diversion and use.	**Potential Lead:** SWRCB	Interim/ Ongoing	*RW-II-A-05d*
D	RW-WR-08	For coho salmon recovery purposes, acquire or lease water, or acquire water rights from willing sellers.	**Potential Lead:** Wildlife Conservation Board	Interim/ Continual	*RW-II-B-01*
D	RW-WR-09	Develop incentives for water right holders to dedicate instream flows for the protection of coho salmon (Water Code §1707).	**Potential Lead:** CDFG, SWRCB	Long-term	*RW-II-B-01b*
C	RW-WR-10	For new riparian water rights created by subdivisions and rezonings, consider mitigation or conditions to protect coho salmon or avoid adverse effects where cumulative impacts on flows will be detrimental to coho salmon.	**Potential Lead:** Local Government **Other:** CDFG, NOAA Fisheries	Long-term	*RW-II-B-02*
E	RW-WR-11	Follow CDFG-NOAA Fisheries screening criteria when constructing, repairing, upgrading, reconstructing, and maintaining diversion screens within the range and distribution of coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, Counties, Landowners	Interim/ Continual	*RW-II-B-03*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
FISH PASSAGE					
E	RW-FP-01	Continue and complete assessments and prioritizations for correction of fish passage barriers.	**Potential Lead:** CDFG, NOAA Fisheries, CCC	Interim/ Ongoing	*RW-III-A-01*
C	RW-FP-02	Continue to refine, update, and maintain the Coastal Conservancy database of barriers to fish passage.	**Potential Lead:** Coastal Conservancy, Fish Passage Forum, CDFG, Counties	Interim/ Ongoing	*RW-III-A-02*
E	RW-FP-03	Encourage funding authorities to provide adequate resources to construct new crossings and upgrade existing crossings (bridges, culverts and fills, other crossings) within the range of coho salmon to accommodate100-year flows flood and associated bedload and debris. Priority for upgrading should be based upon the potential impact to coho salmon habitat.	**Potential Lead:** Federal, Tribal, State, and Local Government; Ranching, Agricultural, Forestry, Fishing, and Conservation Stakeholders	Long-term	*RW-III-C-01*
C	RW-FP-04	Allocate adequate resources to prioritize and upgrade culverts within the range of coho salmon to pass 100-year flows and associated debris loads (e.g. LWD that might be mobilized).	**Potential Lead:** CDFG, NOAA Fisheries, CDF, USFS, Caltrans, RWQCBs, Counties	Long-term	*RW-III-C-01b*
C	RW-FP-05	Evaluate NOAA Fisheries standards for passage at summer dams, and if necessary, develop additional policies and guidelines for passage at summer dams. Implement any recommendations resulting from this process.	**Potential Lead:** NOAA Fisheries, CDFG	Interim	*RW-III-C-02*
C	RW-FP-06	Fund upgrades to flood-damaged fish passage facilities to meet the requirements of Department/NOAA Fisheries fish passage criteria, and CESA.	**Potential Lead:** FEMA **Other:** CDFG, NOAA Fisheries, Counties	Ongoing/ Continual	*RW-III-C-04b*
E	RW-FP-07	Encourage funding authorities to allocate adequate budgets to Federal, State, and local agencies for identifying, designing, and implementing fish passage projects. This includes, but is not limited to, funding for road maintenance programs and capital project activities.	**Potential Lead:** Federal, Tribal, State, and Local Government; Ranching, Agricultural, Forestry, Fishing, and Conservation Stakeholders	Long-term/ Continual	*RW-III-C-06*
D	RW-FP-08	Allocate adequate budgets to Federal, State, and local agencies for identifying, designing, and implementing fish passage projects.	**Potential Lead:** NOAA Fisheries, CDFG, DWR, SWRCB	Long-term	*RW-III-C-06b*
POLLUTANTS					
D	RW-PL-01	Improve water quality by reducing or minimizing point and non-point sources of nutrient input (e.g., sewage treatment plant discharge, septic system discharge, storm drain runoff, and agricultural runoff). Support efforts by cities and rural communities to complete system upgrades to achieve CWA compliance.	**Potential Lead:** SWRCB, RWQCBs	Interim/ Continual	*RW-V-B-01*
D	RW-PL-02	Within range of coho salmon, support efforts to complete system upgrades to cities and rural communities to achieve Clean Water Act compliance.	**Potential Lead:** Local Government **Other:** Federal and State Agencies	Long-term	*RW-V-B-01b*
C	RW-PL-03	Continue outreach, education, and enforcement related to hazardous materials spills, illegal dumping, and household hazardous waste dumping in creeks.	**Potential Lead:** SWRCB, CDFG	Interim/ Ongoing	*RW-V-E-01*
C	RW-PL-04	Continue to fund and support the CalTIP program.	**Potential Lead:** CDFG	Interim/ Ongoing	*RW-V-E-03*
C	RW-PL-05	Provide additional training for wardens to identify water pollution problems and promote coordination with other responsible agencies.	**Potential Lead:** CDFG	Interim/ Continual	*RW-V-E-03b*
C	RW-PL-06	Coordinate water rights training for resource agency personnel.	**Potential Lead:** Federal and State Agencies, SWRCB	Long-term/ Continual	*RW-V-E-03c*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
SEDIMENTS					
E	RW-SD-01	Identify and prioritize specific sediment source locations for treatment that may deliver sediment to coho salmon streams.	**Potential Lead:** CGS	Long-term	*RW-VI-A-02*
C	RW-SD-02	Use protocols, such as the *California Stream Habitat Restoration Manual Guidelines* for upgrading areas of sediment delivery.	**Potential Lead:** CDFG, Landowners, Counties	Interim/ Continual	*RW-VI-A-02b*
C	RW-SD-03	Educate and provide technical assistance to landowners to upgrade areas of sediment delivery.	**Potential Lead:** CDFG, CGS	Interim/ Continual	*RW-VI-A-02c*
D	RW-SD-04	Restore natural drainage patterns and minimize hydrologic connectivity of roads, where feasible. Provide annual funding for restoring natural drainage patterns.	**Potential Lead:** USFS, BLM, NPS, DPR, Counties, Caltrans, Landowners	Long-term	*RW-VI-B-01*
D	RW-SD-05	Continue to fund and provide technical support to local government and private landowner actions to reduce identified sediment input from upslope sources. Basin-wide assessments should prioritize remediation activities, which would include slope stabilization and minimizing sediment production.	**Potential Lead:** CDFG, Counties, Watershed Groups	Interim/ Ongoing	*RW-VI-B-02*
E	RW-SD-06	Prioritize basin-wide assessments for remediation activities, including slope stabilization and minimizing sediment production.	**Potential Lead:** CDF, CDFG, NOAA Fisheries, CGS	Interim	*RW-VI-B-02b*
D	RW-SD-07	Continue road and watershed assessments to identify and prioritize sources and risks of road-related sediment delivery to watercourses.	**Potential Lead:** Counties, Watershed Groups, Landowners, USFS	Interim/ Ongoing	*RW-VI-D-01b*
D	RW-SD-08	Where sediment has been identified as impacting water quality and habitat condition, reduce road densities where necessary and appropriate.	**Potential Lead:** CDFG, Caltrans, Counties	Interim/ Continual	*RW-VI-D-01*
D	RW-SD-09	Where sediment has been identified as impacting water quality and habitat condition, upgrade roads and road-maintenance practices to eliminate or reduce the potential for concentrating run-off to streams during rainfall events. Employ best available technology when appropriate.	**Potential Lead:** CDFG, Caltrans, Counties	Interim/ Continual	*RW-VI-D-01c*
D	RW-SD-10	Where sediment has been identified as impacting water quality and habitat condition, decrease potential for streamflow to become diverted at road crossings during high flow events, resulting in flow along the road that returns to the channel at undesirable locations.	**Potential Lead:** CDFG, Caltrans, Counties	Interim/ Continual	*RW-VI-D-01d*
D	RW-SD-11	Where sediment has been identified as impacting water quality and habitat condition, stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams.	**Potential Lead:** CDFG, Caltrans, Counties	Interim/ Continual	*RW-VI-D-01e*
D	RW-SD-12	Where sediment has been identified as impacting water quality and habitat condition, minimize alteration of natural hill slope drainage patterns.	**Potential Lead:** CDFG, Caltrans, Counties	Interim/ Continual	*RW-VI-D-01f*
D	RW-SD-13	Encourage funding authorities to allocate adequate budgets to Federal, State, and local agencies and private landowners for road maintenance activities.	**Potential Lead:** Federal, Tribal, State, and Local Government; Ranching, Agricultural, Forestry, Fishing, Conservation Stakeholders	Interim/ Continual	*RW-VI-D-01g*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
WATER TEMPERATURE					
E	RW-WT-01	Identify actions to maintain and restore water temperatures to meet habitat requirements for coho salmon in specific streams.	**Potential Lead:** CDFG, CDF, USFS, Academia, Counties, Landowners	Interim/ Continual	*RW-X-B-01*
D	RW-WT-02	Implement actions to maintain and restore water temperatures to meet habitat requirements for coho salmon in specific streams.	**Potential Lead:** Counties, Landowners, USFS CDFG, NOAA Fisheries, CDF	Long-term	*RW-X-B-01b*
C	RW-WT-03	Provide funding and permit incentives to restore stream habitat where lack of LWD, riparian cover, simplified stream morphology and other conditions have been determined to be limiting factors to coho salmon habitat.	**Potential Lead:** CDFG, NOAA Fisheries, USFWS, USFS, Counties	Interim/ Continual	*RW-X-B-02*
LARGE WOODY DEBRIS					
E	RW-LW-01	Identify near stream vegetation communities that provide good opportunities for conifer LWD recruitment to coho salmon habitat. Address and identify possible solutions to potential conflicts between flood management activities and maintenance of riparian vegetation and LWD.	**Potential Lead:** CDF, USFS, DPR, NPS, CDFG, Watershed Groups, Landowners	Long-term	*RW-XIII-B-01a*
C	RW-LW-02	Provide education and information on the importance of these near stream communities to appropriate agencies, restoration funding groups, and landowners, and work to maintain them in a healthy condition.	**Potential Lead:** CDFG, NOAA Fisheries, USFS, Academia	Long-term	*RW-XIII-B-01a.ii*
E	RW-LW-03	Prioritize near stream vegetation communities for the purposes of restoring conifer LWD recruitment.	**Potential Lead:** CDF, USFS, DPR, NPS, CDFG, Watershed Groups, Landowners	Long-term/ Continual	*RW-XIII-B-01b*
E	RW-LW-04	Prioritize near stream vegetation communities for the purposes of restoring conifer LWD recruitment.	**Potential Lead:** CDF, USFS, DPR, NPS, CDFG, Watershed Groups, Landowners	Long-term/ Continual	*RW-XIII-B-01b*
E	RW-LW-05	Encourage funding authorities to provide funding and technical support for riparian restoration.	**Potential Lead:** Federal, Tribal, State, and Local Government; Ranching, Agricultural, Forestry, Fishing, and Conservation Stakeholders	Long-term/ Continual	*RW-XII-B-02*
D	RW-LW-06	Allocate funding and technical support for riparian restoration.	**Potential Lead:** CDFG, CDF, NOAA Fisheries, USFS, Watershed Groups	Long-term	*RW-XII-B-02b*
D	RW-LW-07	Encourage management practices that promote conifer recruitment to provide short-term and long-term restoration of LWD and stream shade.	**Potential Lead:** CDFG, NOAA Fisheries **Other:** RCDs, Watershed Groups, CDF, USFS, Counties	Ongoing/ Continual	*None*
D	RW-LW-08	Encourage Federal, State, and county agencies and private landowners to protect instream LWD to the greatest extent practicable without endangering public safety, life or property.	**Potential Lead:** Counties, Landowners, USFS **Other:** CDFG, CDF, NOAA Fisheries	Interim/ Continual	*None*
STREAM COMPLEXITY					
C	RW-SC-01	Modify channel, flood control, and road maintenance manuals for consistency with habitat requirements and protection for coho salmon.	**Potential Lead:** Caltrans, USFS, Counties	Long-term	*RW-XIII-C-01*
D	RW-SC-02	Where appropriate and feasible, reconfigure levees and channelized streams to benefit coho salmon.	**Potential Lead:** USACE, Counties, Landowners, CDFG, NOAA Fisheries	Long-term/ Continual	*RW-XIII-C-02*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
ECOLOGICAL REFUGIA					
E	RW-ER-01	Identify and characterize coho salmon refugia.	**Potential Lead:** CDFG, NOAA Fisheries **Other:** USFS, Watershed Groups, Academia, Landowners	Long-term	*RW-XV-A-01*
D	RW-ER-02	Provide information to land managers, agencies, and landowners of the location and characteristics of coho salmon refugia.	**Potential Lead:** CDFG, NOAA Fisheries	Long-term	*RW-XV-A-01b*
E	RW-ER-03	Identify key coho salmon populations.	**Potential Lead:** CDFG and NOAA Fisheries **Others:** USFS, Watershed Councils, Landowners	Interim/ Continual	*RW-XV-A-02*
D	RW-ER-04	Inform land managers, agencies, and landowners of locations of key coho salmon populations.	**Potential Lead:** CDFG, NOAA Fisheries	Interim/ Continual	*RW-XV-A-02b*
D	RW-ER-05	Implement measures to maintain key coho salmon populations.	**Potential Lead:** Landowners, USFS	Interim/ Continual	*RW-XV-A-02c*
D	RW-ER-06	Allocate substantial improvement efforts towards identified biological refugia, spawning coho salmon populations, suitable habitat accessible to coho salmon.	**Potential Lead:** All Local, State, Federal Agencies; Landowners	Long-term	*RW-XV-B-01*
HABITAT FRAGMENTATION					
D	RW-HF-01	Restore habitat connectivity between coho salmon populations in coastal and low-gradient inland streams.	**Potential Lead:** CDFG, Counties, Watershed Groups	Interim/ Continual	*RW-XVI-B-01*
D	RW-HF-02	Within prioritized watersheds, reduce habitat fragmentation by restoring fish passage to high quality habitat.	**Potential Lead:** CDFG, Counties, Watershed Groups	Interim/ Ongoing	*RW-XVI-B-02*
COMPETITION					
C	RW-CM-01	Develop a rapid-response eradication plan for invasive, non-native fish species that negatively affect coho salmon.	**Potential Lead:** CDFG and NOAA Fisheries	Long-term	*RW-XVIII-A-01*
C	RW-CM-02	Develop management guidelines to mitigate the impacts of non-native fish species on coho salmon.	**Potential Lead:** CDFG and NOAA Fisheries	Long-term	*RW-XVIII-A-02*
D	RW-CM-03	Remove non-native fish species from stock ponds where these fish pose a threat to coho salmon.	**Potential Lead:** Landowners, Counties **Other:** CDFG, Watershed Groups, NOAA Fisheries	Interim/ Continual	*RW-XVIII-A-03*
HATCHERY OPERATIONS, GENETICS, AND RELOCATION					
D	RW-HO-01	Maintain the local genetic diversity of coho salmon populations.	**Potential Lead:** NOAA Fisheries, CDFG, Academia **Other:** landowners, Counties, USFS	Long-term/ Continual	*RW-XXI-B-01*
E	RW-HO-02	Adopt draft policies for recovery hatcheries (see Appendix G).	**Potential Lead:** CDFG, NOAA Fisheries **Other:** Counties	Interim	*RW-XXI-B-04*
E	RW-HO-03	Adopt draft guidelines for recovery hatcheries (see Appendix H).	**Potential Lead:** CDFG, NOAA Fisheries **Other:** Counties	Interim	*RW-XXI-B-05*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
HATCHERY OPERATIONS, GENETICS, AND RELOCATION (continued)					
D	RW-HO-04	Implement guidelines for recovery hatcheries (see Appendix H)	**Potential Lead:** CDFG, NOAA Fisheries **Other:** Counties	Interim	*RW-B-05b*
C	RW-HO-05	Evaluate the desirability and feasibility of relocating stranded juvenile coho salmon to nearby underutilized high quality habitat.	**Potential Lead:** CDFG, NOAA Fisheries, Academia	Interim/ Ongoing	*RW-III-C-03*
C	RW-HO-06	Develop a policy for relocation of stranded juvenile coho salmon, especially for under-utilized, high quality habitat.	**Potential Lead:** CDFG, NOAA Fisheries, Academia	Long-term	*RW-III-C-03b*
RIPARIAN VEGETATION					
D	RW-RV-01	Where necessary to protect coho salmon habitat, protect riparian communities from livestock while providing off-stream watering.	**Potential Lead:** Landowners, NOAA Fisheries, CDFG **Other:** USFS, Counties	Interim/ Continual	*RW-XXII-A-02*
C	RW-RV-02	Plant and release conifers or other appropriate native species, and control blackberries and other competitors, to restore short term and long term LWD and shade.	**Potential Lead:** CDFG, RCDs, NOAA Fisheries, USFS, Landowners, Counties, **Other:** Watershed Groups, CDF	Interim/ Continual	*RW-XXII-A-04*
C	RW-RV-03	Provide incentives to landowners, including technical support, to plant conifers and control competing plant species.	**Potential Lead:** CDFG, NOAA Fisheries, Landowners, USFS, Counties **Other:** RCDs, Watershed Groups, CDF	Long-term	*RW-XXII-A-04b*
E	RW-RV-04	Inventory and evaluate the adequacy of buffer zones around riparian and wetland habitat on public and private lands.	**Potential Lead:** CDFG, NOAA Fisheries, USFWS, USFS, USACE, Counties, Landowners	Interim/ Continual	*RW-XXII-A-05*
E	RW-RV-05	Develop initiatives, including funding, to improve stream buffers that have been determined to be inadequate to protect coho salmon habitat.	**Potential Lead:** Counties **Other:** CDFG, NOAA Fisheries	Long-term	*RW-XXII-A-06*
D	RW-RV-06	Implement initiatives, including funding where appropriate, to improve stream buffers that have been determined to be inadequate to protect coho salmon habitat.	**Potential Lead:** Counties **Other:** CDFG, NOAA Fisheries	Long-term	*RW-XXII-A-06b*
ESTUARIES					
E	RW-ES-01	Adopt a policy of restoring estuarine habitat and the associated wetlands to provide fully functioning habitat. The policy should address: a. Restoration of historic estuarine areas; b. Maximizing available estuarine and tidal prism habitat; c. Free passage of all coho salmon life-stages to estuaries; d. Adequate instream cover and complexity; e. Eradication of exotic flora and fauna; f. Protection of habitat quality by providing suitable water quality and quantity input to estuaries; g. Protection/restoration of coho salmon prey habitat; and h. Minimizing artificial breaching and associated potential negative impacts.	**Potential Lead:** CDFG, NOAA Fisheries **Other:** Counties, Coastal Commission, Academia, Landowners	Long-term	*RW-XXIII-E-01*
D	RW-ES-02	Restore estuarine and associated wetland ecosystems.	**Potential Lead:** CDFG, NOAA Fisheries **Other:** Counties, Coastal Commission, Academia, Landowners	Long-term	*RW-XXIII-E-01b*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
LAND USE					
D	RW-LU-01	Continue providing subvention funds to counties for Williamson Act contracts to help preserve a rural landscape.	**Potential Lead:** State Government	Interim/ Continual	*RW-XXV-A-01*
D	RW-LU-02	Where necessary, revise General Plans, Local Coastal Plans, and/or Community Development Plans to direct development away from riparian habitats on coho salmon streams or tributaries, include setbacks for development, restrictions on grading activities, and setbacks for septic system development.	**Potential Lead:** Counties, Coastal Commission **Other:** CDFG, NOAA Fisheries	Long-term	*RW-XXV-B-03*
D	RW-LU-03	Establish incentives and standards to protect riparian and wetland areas on private lands.	**Potential Lead:** Counties	Interim	*RW-XXV-B-03b*
C	RW-LU-04	Encourage continued economically sustainable management of forest and agricultural lands in the range of coho salmon to reduce the potential for conversion to residential or commercial development.	**Potential Lead:** CDF, CDFG, Counties	Long-term	*RW-XXV-B-04*
D	RW-LU-05	Evaluate the adequacy of riparian buffers and development setbacks where needed for protecting riparian and wetland habitat on county, city, and private lands adjacent to coho salmon streams.	**Potential Lead:** CDFG, Counties	Long-term	*RW-XXV-B-05*
E	RW-LU-06	Develop county, city, and landowner initiatives to expand inadequate stream buffers and protect riparian and wetland habitat for coho salmon recovery.	**Potential Lead:** Counties and cities, Landowners **Other:** CDFG, NOAA Fisheries	Interim	*RW-XXV-B-07*
D	RW-LU-07	Implement county, city, and landowner initiatives to expand inadequate stream buffers and protect riparian and wetland habitat for coho salmon recovery.	**Potential Lead:** Counties and cities, Landowners	Long-term	*RW-XXV-B-07b*
D	RW-LU-08	Acquire conservation easements or land in fee title from willing landowners to protect habitat essential to coho salmon.	**Potential Lead:** Wildlife Conservation Board **Other:** USFS, BLM, Counties, Land Conservancies	Long-term	*RW-XXV-C-01*
PUBLIC OUTREACH					
C	RW-PO-01	Develop and provide informative programs to Registered Professional Foresters, Licensed Timber Operators, and other natural resource professionals regarding coho salmon and their habitat.	**Potential Lead:** CDFG, CDF	Interim/ Continual	*RW-XXVIII-A-01*
C	RW-PO-02	Establish a recognition program for periodically identifying the efforts of Watershed Groups and stakeholders that are helping to implement the coho salmon recovery strategy.	**Potential Lead:** FGC, CDFG	Long-term	*RW-XXVIII-A-03*
C	RW-PO-03	Develop incentives for landowners who participate in activities that exceed legal requirements or timelines to protect and/or restore coho salmon habitat and watershed processes.	**Potential Lead:** CDFG, NOAA Fisheries, Watershed Groups, Local Governments	Long-term	*RW-XXVIII-B-01*
D	RW-PO-04	Educate local governments on how to incorporate protection of coho salmon in flood management activities consistent with CDFG, RWQCB, NOAA Fisheries, and USACE requirements.	**Potential Lead:** Local Governments	Interim/ Continual	*RW-XXVIII-B-03*
D	RW-PO-05	Provide information to staff of counties and incorporated areas about the importance and requirements to develop and implement performance standards in Stormwater Management Plans.	**Potential Lead:** SWRCB, RWQCBs **Other:** CDFG, NOAA Fisheries, Watershed Groups, Education Extension Programs	Interim/ Continual	*RW-XXVIII-B-04*
D	RW-PO-06	Educate and train restoration specialists and watershed restoration groups on the coho salmon recovery strategy.	**Potential Lead:** CDFG, NOAA Fisheries, Education Extension Programs	Interim/ Continual	*RW-XXVIII-C-01*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
PUBLIC OUTREACH (continued)					
C	RW-PO-07	Provide educational materials, outreach and training for issues such as sport fishing (inadvertent incidental take), poaching (directed take) and habitat destruction (LWD removal, riparian destruction, illegal stream crossings, pollution, illegal water withdrawal, etc.).	**Potential Lead:** CDFG	Long-term	*RW-XXXIII-A-23*
INTEGRATION WITH OTHER PLANS AND PROGRAMS					
D	RW-IN-01	Continue to support the Threatened and Impaired Watersheds rules.	**Potential Lead:** BOF	Interim/ Potentially Continual	*RW-XXX-A-01*
D	RW-IN-02	Amend Forest Practice Rules to require that Registered Professional Foresters certify in timber harvesting plans that they have followed the California Licensed Foresters Association *Guide to Determining the Need for Input From a Licensed Geologist During THP Preparation*.	**Potential Lead:** BOF	Long-term	*RW-XXX-A-02*
D	RW-IN-03	Use statistical analysis of land failure and sediment yield to strengthen protection in geologically unstable areas.	**Potential Lead:** CDF **Other:** CGS	Long-term	*RW-XXX-A-03*
C	RW-IN-04	Conduct implementation and effectiveness monitoring for Nonindustrial Timber Management Plans.	**Potential Lead:** CDF	Long-term	*RW-XXX-A-04*
C	RW-IN-05	As feasible, prepare and implement TMDL plans on a schedule that gives priority to priority coho salmon watersheds.	**Potential Lead:** SWRCB	Long-term	*RW-XXX-B-01*
C	RW-IN-06	Consider necessary coho salmon restoration projects within the sediment allocation of TMDL or watershed basin restoration plan implementation.	**Potential Lead:** RWQCBs, Counties, Landowners **Other:** SWRCB, CDFG, NOAA Fisheries	Long-term	*RW-XXX-B-02*
E	RW-IN-07	Ensure that TMDL standards provide protection for coho salmon.	**Potential Lead:** CDFG, SWRCB	Long-term	*RW-XXX-B-05*
C	RW-IN-08	Conduct outreach to State agencies and local governments to encourage their participation in the TMDL process to ensure the standards provide protection of coho salmon.	**Potential Lead:** SWRCB, RWQCBs	Long-term	*RW-XXX-B-06*
C	RW-IN-09	Implement Fire Safe Councils' recommendations promoting the reduction of fuel near residences to reduce human-caused fires spreading into the forest and causing harm to coho salmon habitat.	**Potential Lead:** CDF, State Fire Safe Council, local FSCs **Other:** CDFG, NOAA Fisheries, USFS	Interim/ Continual	*RW-XXX-D-01*
C	RW-IN-10	Develop a process to incorporate coho recovery considerations in fire reduction and fuel management strategies, including identification of drafting sites in advance of wildland fire incident response.	**Potential Lead:** CDF, USFS, BLM, USGS, CDFG, CFSC, local FSCs, Landowners	Long-term	*RW-XXX-D-03*
D	RW-IN-11	Establish fire regimes to promote watershed function and health and to reduce the risk and impact of extensive, high severity fire on coho salmon and habitat.	**Potential Lead:** California Fire Alliance, CFSC, Counties, Academia, USGS, Landowners	Long-term	*RW-XXX-D-04*
E	RW-IN-12	Identify areas within coho salmon range that are susceptible to extensive, high severity fires.	**Potential Lead:** CDF, USFS	Interim	*RW-XXX-D-05*
E	RW-IN-13	Identify state of perturbation (=disturbance regime) in watersheds within coho salmon range to determine potential, deleterious shifts from ecological functioning regimes.	**Potential Lead:** USFS, USGS	Long-term	*RW-XXX-D-06*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
INTEGRATION WITH OTHER PLANS AND PROGRAMS (continued)					
D	RW-IN-14	Restore aquatic habitat structure and life history complexity of coho salmon populations in areas susceptible to extensive, high severity fires.	**Potential Lead:** USFS, CDFG, NOAA Fisheries, Landowners	Long-term	*RW-XXX-D-07*
D	RW-IN-15	Continue to implement FishNet 4C and Five County salmon restoration goals, including adopting and implementing Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance (FishNet 4C 2004), training staff on guidelines, addressing fish passage and road sedimentation issues, developing riparian protections, promoting alternatives to conventional bank stabilization, and developing land-use policies beneficial to coho salmon.	**Potential Lead:** Counties	Interim/ Ongoing	*RW-XXX-E-01*
D	RW-IN-16	Incorporate the Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance (FishNet 4C 2004) within incidental take authorizations.	**Potential Lead:** CDFG	Interim/ Continual	*RW-XXX-E-02*
D	RW-IN-17	Work with USACE to reduce the impacts to coho salmon of USACE projects.	**Potential Lead:** NOAA Fisheries	Interim	*RW-XXX-F-01*
C	RW-IN-18	After delisting is achieved, review the recovery strategy to determine how to continue implementation of appropriate elements of the recovery strategy.	**Potential Lead:** CDFG	Long-term	*RW-XXX-J-01*
D	RW-IN-19	Implement the Aquatic Conservation Strategy as outlined in the Northwest Forest Plan, and specific Standards and Guidelines identified in the Land and Resource Management Plan for each National Forest in the range of California coho salmon.	**Potential Lead:** USFS **Other:** USFWS, CDFG, CDF, NOAA Fisheries	Long-term	*None*
PERMITTING					
C	RW-PR-01	Develop regulatory assurance mechanisms to encourage land managers, local governments, and landowners to implement coho salmon habitat restoration and/or enhancement projects.	**Potential Lead:** Federal, State, and Local Governments	Long-term	*RW-XXXI-A-01*
C	RW-PR-02	Coordinate with the State Water Resources Control Board and appropriate Regional Water Quality Control Boards to implement water quality monitoring and streamline permitting of coho habitat enhancement and/or restoration projects.	**Potential Lead:** NOAA Fisheries, CDFG	Long-term	*RW-XXXI-A-02*
E	RW-PR-03	Identify ways to remove regulatory barriers (e.g., permitting and environmental review) to expedite activities that will contribute to the recovery of coho salmon. Examples of ideas to consider may be: (1) the creation of local permit assistance centers; (2) seeking categorical exemptions from CEQA; and (3) seeking a certified regulatory program under CEQA for certain activities.	**Potential Lead:** Federal, State, and Local Governments; Landowners	Interim	*RW-XXXI-A-03*
D	RW-PR-04	Remove regulatory barriers (e.g., permitting and environmental review) to expedite activities that will contribute to the recovery of coho salmon.	**Potential Lead:** Federal, State, and Local Governments	Long-term	*RW-XXXI-A-03b*
E	RW-PR-05	Encourage the Department, NOAA Fisheries, U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers to coordinate and develop programmatic incidental take authorizations (e.g., 404 permits, Section 7 consultations, 4(d) rules) for activities that will contribute to the recovery of coho salmon, including but not limited to the Department's Fisheries Restoration Grants Program.	**Potential Lead:** USACE, CDFG, NOAA Fisheries, USFWS	Long-term	*RW-XXXI-A-04*
C	RW-PR-06	Obtain funding to pay for environmental review and permitting of voluntary projects that will contribute to the recovery of coho salmon.	**Potential Lead:** CDFG, FGC	Long-term	*RW-XXXI-A-05*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
PERMITTING (continued)					
E	RW-PR-07	Develop management memoranda of understanding under §2081(a) to participants as an incentive for voluntary activities that will contribute to the recovery of coho salmon.	**Potential Lead:** CDFG	Interim	*RW-XXXI-A-06*
E	RW-PR-08	Issue management memoranda of understanding under §2081(a) to participants as an incentive for voluntary activities that will contribute to the recovery of coho salmon.	**Potential Lead:** CDFG	Long-term	*RW-XXXI-A-06b*
E	RW-PR-09	Evaluate the merit of counties adopting ordinances to exempt restoration and/or enhancement projects from indemnification requirements in context of coho salmon recovery.	**Potential Lead:** Counties, CDFG, NOAA Fisheries	Interim	*RW-XXXI-A-07*
C	RW-PR-10	If found to be of merit, adopt ordinances to exempt restoration and/or enhancement projects from indemnification requirements in context of coho salmon recovery.	**Potential Lead:** Counties	Long-term	*RW-XXXI-A-07b*
D	RW-PR-11	Bring into line the timing of instream restoration with THP activities (that require similar §1600 agreements; this will allow for add an addition month at the beginning of the restoration season).	**Potential Lead:** CDFG	Interim	*RW-XXXI-A-09*
D	RW-PR-12	Amend grading ordinances to exempt habitat restoration and enhancement activities within certain categories.	**Potential Lead:** Counties, Caltrans **Other:** CDFG, NOAA Fisheries	Long-term	*RW-XXXI-A-010*
C	RW-PR-13	Support adequate staffing and funding for the CDFG restoration program to complete contracts in a timely manner.	**Potential Lead:** Congress, State Legislature, Governor	Long-term/ Continual	*RW-XXXI-A-11*
C	RW-PR-14	Support the Small Restoration Projects Categorical Exemption.	**Potential Lead:** Resources Agency, CDFG	Interim	*RW-XXXI-A-12*
C	RW-PR-15	Establish a new categorical exemption under CEQA for fish passage barrier removal projects that meet Department and NOAA Fisheries natural stream simulation criteria.	**Potential Lead:** State Legislature, Resources Agency **Other:** CDFG, NOAA Fisheries	Long-term	*RW-XXXI-A-13*
C	RW-PR-16	Increase interagency coordination on environmental review, permitting, and implementation of programs when coho salmon and habitat can be affected.	**Potential Lead:** CDFG, NOAA Fisheries **Other:** Federal, State, and Local Agencies	Interim/ Continual	*RW-XXXI-B-02*
C	RW-PR-17	Where mitigation for otherwise lawful activities would mitigate for authorized take of coho and contribute to recovery of coho salmon, streamline the incidental take permitting process by developing guidelines for allowable take and for the issuance of incidental take permits under §2081(b).	**Potential Lead:** CDFG	Long-term	*RW-XXXI-B-06*
E	RW-PR-18	Coordinate and make recommendations needed to implement provisions of FGC §1600.	**Potential Lead:** CDFG, SWRCB	Interim/ Ongoing	*RW-XXXI-B-07*
C	RW-PR-19	Implement recommendations on provisions of the FGC §1600.	**Potential Lead:** CDFG	Long-term	*RW-XXXI-B-07b*
E	RW-PR-20	Identify actions to improve coordination between the agencies and others to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and their habitat including spawning gravel and natural hydrograph, and avoidance of adverse impacts caused by water diversion.	**Potential Lead:** CDFG, NOAA Fisheries, USGS	Interim	*RW-XXXI-B-07c*
D	RW-PR-21	Implement actions to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and their habitat including spawning gravel and natural hydrograph, and avoidance of adverse impacts caused by water diversion.	**Potential Lead:** CDFG, NOAA Fisheries, USGS, USFS, Counties, Landowners	Long-term	*RW-XXXI-B-07d*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
PERMITTING (continued)					
D	RW-PR-22	Determine and monitor §1600 compliance related to water diversions.	**Potential Lead:** CDFG, Counties, RCDs	Long-term	*RW-XXXI-B-07f*
C	RW-PR-23	Evaluate requests for on-stream dams on coho streams above coho migratory reaches for the effects on the natural hydrograph and the effects on the supply of spawning gravel for recruitment downstream.	**Potential Lead:** CDFG	Interim/ Continual	*RW-XXXI-B-07g*
C	RW-PR-24	Develop incidental take guidelines that state that those diversion screens that comply with the Department/NOAA Fisheries Screening Criteria should be assumed by the Department to not take coho salmon with respect to the screens.	**Potential Lead:** CDFG	Interim	*RW-II-B-03*
WATERSHED PLANNING					
D	RW-WP-01	Provide adequate funding to the agencies to coordinate and support preparation of comprehensive watershed assessments and restoration plans: a. Include a professional fisheries scientist; b. Assess streamflow, water diversions, water quality, sediment sources, fish barriers, riparian corridors, instream habitat, estuarine habitat, and land use, as necessary; and, c. Identify and prioritize site-specific restoration to benefit coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, Counties, CDF, USFS, RCDs, Watershed Groups	Interim/ Ongoing	*RW-XXXII-B-02*
E	RW-WP-02	Review existing, approved watershed management or restoration plans within the range of coho.	**Potential Lead:** Watershed Groups, CDFG, NOAA Fisheries	Interim/ Continual	*RW-XXXII-B-03*
D	RW-WP-03	Implement actions from watershed plans consistent with priority recommendations of the coho salmon recovery strategy.	**Potential Lead:** Landowners, Counties, Watershed Groups, USFS **Other:** CDFG, NOAA Fisheries	Long-term/ Continual	*RW-XXXII-B-03b*
ENFORCEMENT OF EXISTING LAWS					
D	RW-EN-01	Restore impacted coho salmon habitat resulting from project construction without proper review and approvals.	**Potential Lead:** Coastal Commission, Landowners	Interim/ Continual	*RW-XXX-C-01*
C	RW-EN-02	Fully enforce existing laws, codes, regulations, and ordinances that address the protection of coho salmon and their habitat. Habitat includes but is not limited to water (quality and quantity), pools, riffles, instream LWD, riparian vegetation, and estuaries.	**Potential Lead:** CDFG, NOAA Fisheries, District Attorneys	Interim/ Ongoing	*RW-XXXIII-A-01*
C	RW-EN-03	Provide adequate funding and positions for agencies with enforcement authority to enforce laws and codes relevant to coho salmon protection.	**Potential Lead:** CDFG, NOAA Fisheries, District Attorneys	Long-term/ Ongoing	*RW-XXXIII-A-02*
E	RW-EN-04	Review diversions and use of water in priority coho salmon streams to determine which permits and/or licenses need modification for the protection of coho salmon.	**Potential Lead:** SWRCB, RWQCBs **Other:** CDFG, NOAA Fisheries, Counties	Long-term/ Continual	*RW-XXXIII-A-03*
D	RW-EN-05	Where necessary, formally request that the terms of water rights permits/ licenses be modified for protection of coho salmon.	**Potential Lead:** SWRCB, RWQCBs **Other:** CDFG, NOAA Fisheries, Counties	Long-term/ Continual	*RW-XXXIII-A-03b*
D	RW-EN-06	Conduct field studies to evaluate impacts of water use on coho salmon.	**Potential Lead:** RWQCBs, CDFG, NOAA Fisheries **Others:** Watershed Groups, Counties, Landowners, Academia	Long-term/ Continual	*RW-XXXIII-A-03c*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
ENFORCEMENT OF EXISTING LAWS (continued)					
C	RW-EN-07	Develop supportive evidence and formal hearings to consider proposed changes to water use or permits.	**Potential Lead:** SWRCB, RWQCBs **Other:** CDFG, NOAA Fisheries, Counties	Long-term/ Continual	*RW-XXXIII-A-03d*
C	RW-EN-08	Fund water permit and use review program.	**Potential Lead:** SWRCB	Long-term/ Continual	*RW-XXXIII-A-03e*
C	RW-EN-09	Coordinate enforcement efforts with local, State and Federal agencies with regulatory authority affecting coho salmon.	**Potential Lead:** SWRCB, RWQCBs, EPA, NOAA Fisheries, CDFG, USFWS	Interim/ Continual	*RW-XXXIII-A-04*
C	RW-EN-10	Make a high priority of efforts to prevent unauthorized diversion and use of water and water permit processing.	**Potential Lead:** CDFG, DWR, SWRCB, District Attorneys	Long-term	*RW-XXXIII-A-05*
C	RW-EN-11	Adequately fund water diversion enforcement and permit programs.	**Potential Lead:** CDFG, DWR, SWRCB, Counties	Long-term	*RW-XXXIII-A-05b*
C	RW-EN-12	Support continued funding for the California District Attorneys' Association's Environmental Circuit Prosecutors program and/or Environmental Project for applicable district attorney offices in the range of coho salmon.	**Potential Lead:** CDFG, CalEPA, Counties	Long-term	*RW-XXXIII-A-06*
C	RW-EN-13	Dedicate fines from violations affecting coho salmon or coho salmon habitat to coho salmon recovery and restoration activities consistent with the Recovery Strategy, including but not limited to education and outreach. Emphasis should be placed on keeping fine money in watersheds where the violation occurred to address existing coho salmon restoration plans and projects. This recommendation applies to fines that are not otherwise mandated by law to be directed to other purposes.	**Potential Lead:** Counties	Long-term	*RW-XXXIII-A-07*
C	RW-EN-14	Examine penalty schedules with regard to the impact of violations to coho salmon.	**Potential Lead:** CDFG, Counties, District Attorneys	Long-term	*RW-XXXIII-A-08*
C	RW-EN-15	If necessary, adjust penalty schedules to reflect the impact that violations have on coho salmon, taking into account other penalties that may be enforced in association with the same activity.	**Potential Lead:** Counties	Long-term	*RW-XXXIII-A-08b*
E	RW-EN-16	Develop an outreach/information and education program that targets agency personnel, judges, district attorneys, the Attorney General's Office, municipalities, and other affected or interested parties concerning the status of coho salmon and the value and importance of coho salmon resources and coho salmon recovery.	**Potential Lead:** CDFG, NOAA Fisheries, USFS **Other:** Academia	Long-term	*RW-XXXIII-A-10*
C	RW-EN-17	Provide educational materials, outreach and training for issues such as sport fishing, poaching, and habitat destruction to counties, district attorneys, municipalities, and affected and interested parties.	**Potential Lead:** CDFG, NOAA Fisheries, USFS **Other:** Academia	Long-term	*RW-XXXIII-A-10b*
C	RW-EN-18	Support existing and promote, if necessary, new neighborhood watch programs that discourage illegal dumping, poaching, and other illegal activities in streams and watersheds.	**Potential Lead:** CDFG, CalEPA, SWRQB, Counties **Other:** Landowners, Watershed Groups	Interim/ Continual	*RW- XXXIII-A-11*
C	RW-EN-19	Support funding for increased enforcement of existing laws against dumping of toxic substances.	**Potential Lead:** CDFG, CalEPA, SWRQB, Counties	Long-term/ Continual	*RW-XXXIII-A-14*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
ENFORCEMENT OF EXISTING LAWS (continued)					
D	RW-EN-20	As staffing allows, review all applications for proposed projects that may impact coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, RWQCBs, Counties **Other:** USFWS, USFS, CDF, SWRCB, CalEPA, FEMA	Interim/ Continual	*RW-XXXIII-A-18*
C	RW-EN-21	Establish environmental task force comprised of State, local, and Federal enforcement agencies that operate in the range of coho salmon.	**Potential Lead:** NOAA Fisheries, EPA, USFWS, CDFG, CalEPA, District Attorneys, CHP, CDF	Long-term	*RW-XXXIII-A-27*
C	RW-EN-22	Increase funding for the Department's CalTIP program.	**Potential Lead:** CDFG, State Legislature	Long-term	*RW-XXXIII-A-28*
C	RW-EN-23	Seek programmatic incidental take authority with respect to screen design and installation that conforms to Department/NOAA Fisheries screening criteria.	**Potential Lead:** Counties, Landowners, project proponents **Other:** CDFG, NOAA Fisheries	Long-term	*RW-XXXIII-A-29*
D	RW-EN-24	Encourage Federal, State, and county agencies and private landowners to protect instream LWD to the greatest extent practicable without endangering public safety, life or property.	**Potential Lead:** Counties, Landowners, USFS **Other:** CDFG, CDF, NOAA Fisheries	Interim/ Continual	*None*
IMPLEMENTATION					
C	RW-IM-01	Provide funding and incentives for projects that exceed requirements of existing law or expedite timelines required by law.	**Potential Lead:** CDFG, NOAA Fisheries, USFS, USFWS, EPA, SWRCB	Long-term/ Continual	*RW-XXXIV-A-01*
D	RW-IM-02	Support continued and increased funding for the California Conservation Corps to implement coho salmon restoration projects throughout the coho salmon range in California.	**Potential Lead:** CCC, CDFG	Interim/ Ongoing	*RW-XXXIV-A-02*
INSTREAM GRAVEL EXTRACTION					
C	RW-IG-01	Within known or historic coho salmon habitat, require permits for instream gravel extraction to include: a. A total yearly extraction volume proportionally based on the long-term mean average recruitment of gravel into the mining reach; b. An extraction strategy that will promote species recovery by retaining sufficient gravel to preserve and restore the alluvial structure necessary for forming and maintaining critical physical habitat in, up- and downstream of the mined reach; and c. A monitoring plan capable of demonstrating that the extraction strategy successfully promotes species recovery.	**Potential Lead:** Counties	Interim/ Ongoing	*RW-XXXV-A-01*
ASSESSMENT, MONITORING, AND RESEARCH					
E	RW-AM-01	Support research necessary to understand crucial aspects and uncertainties regarding coho salmon ecology. Three important issues are: a. Genetic relatedness and health; b. Potential of local adaptive differences to environmental factors, specifically water temperature; c. Biological refugia, including non-natal rearing areas.	**Potential Lead:** NOAA Fisheries, CDFG, USFS, Academia	Interim/ Continual	*RW-XXIX-B-03*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
ASSESSMENT, MONITORING, AND RESEARCH (continued)					
E	RW-AM-02	Evaluate and prioritize coho salmon issues and questions in need of research.	**Potential Lead:** NOAA Fisheries, CDFG, Academia	Long-term	*RW-XXIX-C-01*
D	RW-AM-03	Develop and maintain data/information system for compiling, analyzing, and distributing information on the status and trend of coho salmon and the status of coho salmon recovery.	**Potential Lead:** CDFG **Other:** NOAA Fisheries, Academia, USFS, Landowners	Interim/ Ongoing	*RW-XXIX-C-01a*
C	RW-AM-04	Develop a data collection and sharing policy that: a. Requires permission of private landowners for access across private lands to collect data where such access is desired; b. Disclosure of data collected from private lands in a form or by a means that protects landowner privacy (i.e., disclosure of data at stream-reach level or other appropriate scale that protects landowner privacy, but also shows the relationship to the nearest tributary confluences); c. Disclosed data must be quality assured and quality controlled; d. Disclosure should include metadata files indicating who collected the data, and how and for what purposes the data were collected; e. If requested, disclosed data should be in electronic form it if already exists in that form; and f. Data requests should be responded to in a timely manner, recognizing limitations of staff and budgets can affect processing requests.	**Potential Lead:** CDFG	Interim	*RW-XXX-C-02*
D	RW-AM-05	Use field-tested implementation, effectiveness, and validation monitoring protocols for coho salmon restoration activities.	**Potential Lead:** Landowners, CDFG, NOAA Fisheries, USFS, Counties	Interim/ Ongoing	*RW-XXIX-E-01*
E	RW-AM-06	Conduct key assessments to understand essential aspects of coho salmon populations and life-history, including: a. Relative abundance; b. Spawning sites/success; c. Estuary use; d. Barriers to juveniles; e. Over-wintering growth and survival; and f. Ocean condition effects on coho salmon populations.	**Potential Lead:** CDFG, NOAA Fisheries, Academia, Counties, Watershed Groups	Interim/ Continual	*RW- XXIX-F-01*
E	RW-AM-07	Develop and implement a strategic, long-term population assessment and monitoring program for coho salmon.	**Potential Lead:** NOAA Fisheries, CDFG	Interim/ Ongoing	*RW-XXIX-G-01*
C	RW-AM-08	Recommend to agencies and organizations that they assess and prioritize actions within a watershed prior to implementation of comprehensive restoration plans.	**Potential Lead:** Watershed Groups, Landowners, Counties	Interim/ Continual	*RW-XXIX-G-02*
C	RW-AM-09	Fund research, monitoring, and evaluation of the effectiveness of restoration.	**Potential Lead:** CDFG, NOAA Fisheries, USFWS, USFS, CDF, Academia	Interim/ Continual	*RW-XXIX-H-01*
C	RW-AM-10	Develop a comprehensive system to gather, evaluate and manage monitoring information associated with coho salmon recovery.	**Potential Lead:** CDFG, NOAA Fisheries, CDF, CGS, Landowners	Interim/ Ongoing	*RW-XXIX-D-04*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
TIMBER MANAGEMENT					
E	RW-TM-01	Appropriate adequate State and Federal financial, material, and personnel support for on-the-ground recovery actions, identified in the Recovery Strategy. Possible funding mechanisms include but are not limited to: a. Legislation specifically identifying funding for coho salmon recovery; b. Cost-share programs with private landowners, stakeholder groups and local governments; and c. Endowment and/or grant programs cooperatively with private sources.	**Potential Lead:** State Legislature, Congress **Others:** Member organizations of CRT and SSRT	Long-term/ Continual	*ALT-C-1-a*
D	RW-TM-02	Provide adequate financial, material, and personnel support for on-the-ground recovery actions, identified in the Recovery Strategy.	**Potential Lead:** California and Federal Legislature **Others:** CDFG, CDF, SWRCB, Caltrans, NOAA Fisheries, USFS, USFWS	Long-term/ Continual	*ALT-C-1-b*
C	RW-TM-03	Provide technical expertise to support cooperative recovery actions, including but not limited to: a. Technical advisors to assist in the development of restoration proposals; b. Technical expertise to assist in the implementation of recovery activities on-the-ground; and c. Technical expertise to assist in training and education on coho salmon restoration projects.	**Potential Lead:** CDFG, CDF, SWRCB, NOAA Fisheries **Others:** USFS, USFWS, Academic Institutions Tribes, RWQCB, Caltrans	Interim/ Continual	*ALT-C-2*
E	RW-TM-04	Develop a program to design and implement coho recovery plans for individual CALWATER Planning Watersheds. The program should promote and enable cooperative working relationships between agencies, landowners and residents.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** USFS, Tribes, Counties, Landowners, Academic Institutions	Interim	*ALT-C-3*
C	RW-TM-05	Implement a program to design and implement coho recovery plans for individual CALWATER Planning. Watersheds.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** FGC, Planning Watershed Recovery Teams	Long-term	*ALT-C-3*
E	RW-TM-06	Provide Federal and State funding to assist landowners in performing watershed analysis in a manner usable by the Department.	**Potential Lead:** CDFG, CDF, SWRCB, CGS, Caltrans, NOAA Fisheries, USFS, USFWS	Long-term	*ALT-C-3-a*
E	RW-TM-07	Conduct systematic watershed analyses at the watershed level to identify key limiting factors, their sources, and locations affecting coho salmon.	**Potential Lead:** Watershed Groups, Environmental Consulting Companies, Counties, Agency Teams, Landowners **Other:** CDFG, NOAA Fisheries	Long-term	*ALT-C-3-b,c*
D	RW-TM-08	Remedy the sources of key limiting factors.	**Potential Lead:** Watershed Groups, Environmental Consulting Companies, Counties, Agency Teams, Landowners **Others:** CDFG, NOAA Fisheries	Long-term	*ALT-C-3-c*
E	RW-TM-09	Identify restoration projects for watershed transportation systems, fish passage, slope stabilization measures, erosion control measures and drainage structures.	**Potential Lead:** Caltrans, CDFG, CDF, RWQCB, Counties, Watershed Groups, Landowners, NOAA Fisheries **Other:** Academic Institutions, Environmental Consulting Companies	Ongoing/ Continual	*ALT-C-3-d*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
TIMBER MANAGEMENT (continued)					
D	RW-TM-10	Implement restoration projects for watershed transportation systems, fish passage, slope stabilization measures, erosion control measures and drainage structures.	**Potential Lead:** Caltrans, CDFG, CDF, Counties, Watershed Groups, Landowners **Others:** Environmental Consulting Companies	Ongoing/ Continual	*ALT-C-3-d*
E	RW-TM-11	Identify beneficial management practices to protect existing values.	**Potential Lead:** CDF, CDFG, USFS, Landowners **Others:** NOAA Fisheries, SWRCB, RWQCB, CGS	Interim	*ALT-C-3-e*
C	RW-TM-12	Implement beneficial management practices to protect existing values.	**Potential Lead:** CDF, CDFG, USFS, Landowners **Others:** NOAA Fisheries, SWRCB, RWQCB, CGS	Long-term	*ALT-C-3-e*
C	RW-TM-13	Monitor effectiveness of beneficial management practices in protecting existing values.	**Potential Lead:** CDF, CDFG, USFS, Landowners **Others:** NOAA Fisheries, SWRCB, RWQCB, CGS	Long-term	*ALT-C-3-e*
C	RW-TM-14	Where necessary, revise beneficial management practices to improve protection of existing values.	**Potential Lead:** CDF, CDFG, USFS, Landowners **Others:** NOAA Fisheries, SWRCB, RWQCB, CGS	Long-term	*ALT-C-3-e*
C	RW-TM-15	Use CALWATER coho salmon recovery plans, and data that support them as principle reference documents, to avoid costs to landowners and/or project proponents associated with repetitive analysis and paperwork for each project.	**Potential Lead:** Counties, Landowners, CDFG, NOAA Fisheries **Others:** Affected Local, State, and Federal Agencies	Long-term	*ALT-C-3-f*
C	RW-TM-16	Develop an information repository system for individual Planning Watersheds that compiles and integrates existing information.	**Potential Lead:** CDFG	Long-term	*ALT-C-4*
C	RW-TM-17	Add new information as it becomes available to Planning Watershed information system.	**Potential Lead:** CDFG	Long-term	*ALT-C-4*
C	RW-TM-18	Ensure that the Planning Watershed information system provides adequate confidentiality for information specifically pertaining to private property.	**Potential Lead:** CDFG	Long-term	*ALT-C-4E*
E	RW-TM-19	Where appropriate and where costs to landowners are offset, develop Road Management Plans that contribute to the restoration of coho salmon habitat.	**Potential Lead:** Caltrans, CDF, Counties, Landowners, CDFG, NOAA Fisheries, USFS **Others:** Watershed Groups, Academic Institutions	Long-term	*ALT-C-5-a*
D	RW-TM-20	Where appropriate and where costs to landowners are offset, implement Road Management Plans that contribute to the restoration of coho salmon habitat.	**Potential Lead:** Landowners, Counties, USFS, Caltrans, CDF **Others:** CDFG, NOAA Fisheries	Interim	*ALT-C-5-a*
C	RW-TM-21	Where appropriate and where costs to landowners are offset, encourage the use of a licensed engineer to assist in the design and construction of watercourse crossings.	**Potential Lead:** Caltrans, Counties, CDF **Others:** CDFG, SWRCB, CGS, NOAA Fisheries, BOF	Interim/ Continual	*ALT-C-5-b*
C	RW-TM-22	Provide continuing education and training (classroom and field) to ensure watercourse crossings are appropriately designed, constructed and maintained.	**Potential Lead:** CDF, CDFG, NOAA Fisheries, Caltrans, DWR **Others:** Environmental Consulting Companies, Academic Institutions	Long-term	*ALT-C-5-c*
D	RW-TM-23	Conduct cooperative coho salmon habitat restoration projects that extend across ownerships to address habitat restoration efforts in a coordinated and cost effective manner.	**Potential Lead:** Counties, Watershed Groups **Others:** CDFG, NOAA Fisheries, USFS, Landowners	Ongoing/ Continual	*ALT-C-5-d*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
TIMBER MANAGEMENT (continued)					
E	RW-TM-24	Appropriate State funding to assist landowners to implement coordinated watershed riparian vegetation improvement programs, in the range of coho salmon, that: a. Identify appropriate areas within the riparian zone where planting of riparian vegetation, including conifers, is likely to improve coho salmon habitat; and b. Promote vegetation modification (e.g., thinning, removal of undesired competitive vegetation) to accelerate riparian vegetation recovery and enhancement in coho salmon habitat.	**Potential Lead:** State Legislature **Others:** Member Organizations of CRT and SSRT	Interim	*ALT-C-5-e*
C	RW-TM-25	Provide State funding to assist landowners in implementing coordinated watershed riparian vegetation improvement programs in the range of coho salmon.	**Potential Lead:** CDFG, CDF, SWRCB, Caltrans, Counties **Others:** Tribes, USFS, NOAA Fisheries	Long-term	*ALT-C-5-e*
E	RW-TM-26	Conduct long-term monitoring to evaluate the effectiveness of FPRs in maintaining and recovering coho salmon habitat.	**Potential Lead:** CDF, CDFG **Others:** SWRCB, CGS, NOAA Fisheries, USFS, Landowners	Long-term/ Continual	*ALT-C-6*
E	RW-TM-27	Through the CDF Monitoring Study Group, develop a monitoring project to evaluate whether mitigation measures implemented by Registered Professional Foresters as part of THPs are effectively reducing the risk of mass soil movement associated with harvesting operations, including road and landing construction.	**Potential Lead:** BOF, CDF, CGS **Others:** CDFG, NOAA Fisheries, Landowners	Interim	*ALT-C-7*
E	RW-TM-28	Document voluntary efforts by forest landowners beneficial to coho salmon that: a. Exceed FPRs requirements; and/or b. Are recommendations included in the Recovery Strategy.	**Potential Lead:** CDF, BOR **Others:** CDFG, CGS, SWRCB, NOAA Fisheries, Landowners	Interim	*ALT-C-8*
C	RW-TM-29	Evaluate the effectiveness of voluntary efforts to recover coho salmon populations.	**Potential Lead:** CDFG	Long-term	*ALT-C-9*
E	RW-TM-30	Consolidate existing resource assessments and monitoring data.	**Potential Lead:** CDFG	Long-term	*ALT-C-10*
C	RW-TM-31	Analyze resource assessments and monitoring data.	**Potential Lead:** CDFG	Long-term	*ALT-C-10*
C	RW-TM-32	Provide a collaborative watercourse and roads assessment training and watershed academy.	**Potential Lead:** CDFG, CDF, Forestry Industry **Others:** SWRCB, CGS, NOAA Fisheries, USFS	Long-term	*ALT-C-11*
D	RW-TM-33	Acquire conservation easements or land in fee title from willing landowners to protect coho salmon habitat.	**Potential Lead:** WCB **Others:** CDFG, Landowners, Counties, NOAA Fisheries, USFS	Interim/ Continual	*ALT-C-12*
C	RW-TM-34	Seek additional funding for staff to improve the effectiveness of the Department's timberland conservation program.	**Potential Lead:** Resources Agency, CDFG, CDF **Others:** CRT Member Organizations	Long-term	*ALT-C-13*
	RW-TM-35	Appropriate funding for staff to improve effectiveness of the Department timberland conservation program.	**Potential Lead:** State Legislature **Others:** Resource Agency, CDFG	Long-term	*ALT-C-13*
C	RW-TM-36	To the extent staff is available, conduct full review of THPs and other timberland conservation activities associated with managing timberlands in the range of coho salmon.	**Potential Lead:** CDFG **Others:** Resources Agency	Ongoing/ Continual	*ALT-C-14*

TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
TIMBER MANAGEMENT (continued)					
C	RW-TM-37	To the extent staff is available, prepare coho salmon biological assessments as a Lead or Responsible agency under CEQA for timberland conservation activities, including preharvest inspection reports but not limited to the review of timber harvesting plans.	**Potential Lead:** CDFG **Others:** Counties, Landowners, CDF, CGS, SWRCB	Long-term	*ALT-C-15*
D	RW-TM-38	To the extent staff is available, monitor for five years or more, if necessary to develop an adequate sampling regime, the implementation of the FPRs to determine whether these rules are consistent with the long-term survival of coho salmon.	**Potential Lead:** CDFG, CDF, NOAA Fisheries, Landowners **Others:** Academic Institutions	Interim/ Continual	*ALT-C-16*
D	RW-TM-39	If FPRs are found to be inconsistent with the long-term viability of coho salmon, revise FPRs to ensure adequate protection for the long-term survival of coho salmon.	**Potential Lead:** BOF **Others:** CDF, CDFG, FGC, NOAA Fisheries, Landowners, Forest Industry, Academic Institutions	Long-term	*ALT-C-17*
E	RW-TM-40	Develop a "proof of concept" pilot program to test mathematical or scientific methods of cumulative effects analysis as was suggested in A Scientific Basis for the Prediction of Cumulative Watershed Effects (University of California Committee on Cumulative Watershed Effects, Report No. 46, June 2001 or the "Dunne Report").	**Potential Lead:** CDFG, CDF, SWRCB, CGS, Academic Institutions	Long-term	*ALT-B-19*
C	RW-TM-41	Implement a "proof of concept" pilot program to test mathematical or scientific methods of cumulative effects analysis.	**Potential Lead:** CDFG	Long-term	*ALT-B-19*
C	RW-TM-42	Establish a THP procedure to document and evaluate the implementation and effectiveness of coho salmon mitigation measures prior to completion inspections.	**Potential Lead:** BOF, CDF **Others:** FGC, CDFG, SWRCB, CGS, Landowners	Long-term	*ALT-B-20e*

TABLE 9-2: Implementation schedule for the SONCC Coho ESU

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
ROGUE RIVER AND WINCHUCK RIVER HUs						
Illinois River HSA						
4	E	RO-IR-01	Develop a long-term plan to promote retention of LWD.	**Potential Lead:** CDFG **Others:** CDF, NOAA Fisheries, CCC, Landowners, USFS, County, Watershed Groups	Interim	*RO-IR-01*
4	D	RO-IR-02	Implement the long-term plan to promote retention of LWD.	**Potential Lead:** CDFG **Others:** CDF, NOAA Fisheries, CCC, Landowners, USFS, County, Watershed Groups	Long-term	*RO-IR-01b*
4	E	RO-IR-03	Continue to control the input of sediment into the watershed.	**Potential Lead:** CDFG, NCRWQCB **Others:** CDF, Landowners, CCC, USFS, Watershed Groups, NOAA Fisheries, County	Interim/ Continual	*RO-IR-02*
4	D	RO-IR-04	Monitor impacts of suction dredge activities for deleterious effects on coho salmon, taking corrective measures when needed.	**Potential Lead:** CDFG, NCRWQCB **Others:** NOAA Fisheries	Interim/ Continual	*RO-IR-03*
4	E	RO-IR-05	Develop a cooperative management strategy with Oregon Department of Fish and Wildlife to improve habitat conditions for coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Oregon Department of Fish and Wildlife	Interim	*RO-IR-04*
4	D	RO-IR-06	Implement the cooperative management strategy with Oregon Department of Fish and Wildlife.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Oregon Department of Fish and Wildlife	Long-term	*RO-IR-04b*
Winchuck River HSA						
5	E	WR-SF-01	Develop a short-term plan to increase LWD until natural recruitment can be restored.	**Potential Lead:** CDFG **Others:** CCC, CDF, NOAA Fisheries, Landowners, USFS, County, Watershed Groups	Interim	*WR-SF-01*
5	D	WR-SF-02	Implement the short-term plan to increase LWD.	**Potential Lead:** CDFG **Others:** CCC, CDF, NOAA Fisheries, Landowners, USFS, County, Watershed Groups	Interim/ Continual	*WR-SF-01b*
5	E	WR-SF-03	Develop a long-term plan to restore a mature coniferous riparian zone to South Fork Winchuck River.	**Potential Lead:** CDFG **Others:** CCC, CDF, NOAA Fisheries, Landowners, County, Watershed Groups	Interim	*WR-SF-02*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Winchuck River HSA (continued)						
5	D	WR-SF-04	Implement the long-term plan to restore a mature coniferous riparian zone to South Fork Winchuck River.	**Potential Lead:** CDFG **Others:** CCC, CDF, NOAA Fisheries, Landowners, County, Watershed Groups	Long-term	*WR-SF-02b*
5	E	WR-SF-05	Assess sources of sediment and prioritize treatment areas.	**Potential Lead:** CDFG, NCRWQCB **Others:** CDF, CCC, NOAA Fisheries, Landowners, County, Watershed Groups	Interim/ Continual	*WR-SF-03*
5	D	WR-SF-06	Prioritize and treat sources of sediment.	**Potential Lead:** CDFG, NCRWQCB **Others:** CDF, CCC, NOAA Fisheries, Landowners, County, Watershed Groups	Long-term	*WR-SF-03b*
5	D	WR-SF-07	Develop a cooperative management strategy with Oregon Department of Fish and Wildlife to improve habitat conditions for coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries	Interim	*WR-SF-04*
5	D	WR-SF-08	Implement a cooperative management strategy with Oregon Department of Fish and Wildlife to improve habitat conditions for coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries	Interim	*WR-SF-05*
SMITH RIVER HU						
	D	SR-HU-01	Develop a program to control exotic vegetation which impedes access to and use of tributaries by coho salmon.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, Private Landowners	Interim/ Continual	*SR-HU-01*
	D	SR-HU-02	Implement a program to control exotic vegetation which impedes access to and use of tributaries by coho salmon.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, Private Landowners	Interim/ Continual	*SR-HU-01b*
	E	SR-HU-03	Assess and prioritize barriers and impediments to passage (including water diversions), especially those on smaller tributaries, including Cedar, Clarks, Morrison, Peacock, Sultan, and Little Mill creeks.	**Potential Lead:** USFS, DPR, RNSP **Others:** NOAA Fisheries, Caltrans, County, CDFG, CDF, Private Landowners	Interim/ Ongoing	*SR-HU-02*
	D	SR-HU-04	Treat barriers and impediments to passage (including water diversions), especially those on smaller tributaries, including Yontocket, Tillas, and Tyron sloughs.	**Potential Lead:** USFS **Others:** NOAA Fisheries, Caltrans, County, CDFG, CDF, Landowners	Interim/ Ongoing	*SR-HU-02b*
	E	SR-HU-05	Develop a plan to restore the effectiveness and use of off-channel areas, sloughs, and wetlands.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USACE, California Coastal Commission, DPR, County	Interim	*SR-HU-03*
	D	SR-HU-06	Implement the plan to restore the effectiveness and use of off-channel areas, sloughs, and wetlands.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USACE, California Coastal Commission, County	Interim/ Continual	*SR-HU-03b*
	C	SR-HU-07	Investigate the feasibility of restoring channelized reaches of streams to natural meander belts (e.g., Lower Rowdy Creek and Dominie Creek) that would allow recruitment of stored spawning gravel, re-establish scour pools, recruit woody debris from banks, and ultimately restore fluvial processes that maintain coho salmon habitat.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Landowners	Long-term	*SR-HU-04*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
SMITH RIVER HU (continued)						
	C	SR-HU-08	Where feasible, restore channelized reaches back to more natural fluvial processes (e.g. meander belts that recruit stored spawning gravel, re-establish scour pools, recruit woody debris from banks).	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Landowners	Long-term	*SR-HU-04b*
	D	SR-HU-09	Protect existing LWD recruitment potential through the retention of mature coniferous trees in the riparian zone.	**Potential Lead:** CDFG **Others:** USFS, NOAA Fisheries, CDF, RNSP, DPR, Landowners	Interim/ Ongoing	*SR-HU-05*
	D	SR-HU-10	Establish adequate streamside buffer areas that are protected from vegetation removal.	**Potential Lead:** CDFG **Others:** USFS, NOAA Fisheries, CDF, Landowners	Interim/ Ongoing	*SR-HU-05b*
	D	SR-HU-11	Increase the amount of in-channel LWD.	**Potential Lead:** CDFG **Others:** USFS, NOAA Fisheries, CDF, Landowners	Interim/ Ongoing	*SR-HU-05c*
	D	SR-HU-12	Continue to review THPs with regard to potential impacts to coho salmon and their habitat.	**Potential Lead:** CDFG **Others:** USFS, NOAA Fisheries, CDF, Landowners	Interim/ Ongoing	*SR-HU-05d*
	D	SR-HU-13	Continue riparian management projects with landowners.	**Potential Lead:** CDFG **Others:** USFS, NOAA Fisheries, CDF, Landowners	Interim/ Ongoing	*SR-HU-05e*
	C	SR-HU-14	Assess the impacts of steelhead outplanting by the Rowdy Creek Hatchery.	**Potential Lead:** CDFG **Others:** NOAA Fisheries	Interim	*SR-HU-06*
	C	SR-HU-15	If impacts of steelhead outplanting are found, adjust the outplanting of steelhead by the Rowdy Creek Hatchery to minimize any identified impacts to coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries	Interim/ Continual	*SR-HU-06*
	D	SR-HU-16	Treat legacy sources of sediment and minimization the input from new sediment sources.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners, Counties	Interim/ Ongoing	*SR-HU-07*
	C	SR-HU-17	Support and work with the watershed coordinator to aid in implementing recommendations.	**Potential Lead:** CDFG **Others:** Watershed Coordinator	Interim/ Ongoing	*SR-HU-08*
Mill Creek HSA						
4	E	SR-MC-01	Assess and prioritize sediment sources.	**Potential Lead:** DPR **Others:** NPS, NOAA Fisheries, CDFG, CDF	Interim/ Ongoing	*SR-MC-01*
4	D	SR-MC-02	Treat sediment sources.	**Potential Lead:** DPR **Others:** NPS, NOAA Fisheries, CDFG, CDF	Interim/ Ongoing	*SR-MC-01b*
4	E	SR-MC-03	Develop a short-term plan to add LWD and a long-term plan to promote recruitment of LWD.	**Potential Lead:** DPR **Others:** NPS, NOAA Fisheries, CDFG, CDF	Interim/ Ongoing	*SR-MC-02*
4	D	SR-MC-04	Implement the short-term plan to add LWD and a long-term plan to promote recruitment of LWD.	**Potential Lead:** CDFG **Others:** NPS, NOAA Fisheries, CDF	Interim/ Ongoing	*SR-MC-02b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Mill Creek HSA (continued)						
4	D	SR-MC-05	Develop a revegetation plan for the riparian zone which includes planting of coniferous species, along with the release of conifers from competitors, such as alders and blackberries.	**Potential Lead:** CDFG **Others:** NPS, NOAA Fisheries, CDF	Interim/ Ongoing	*SR-MC-03*
4	D	SR-MC-06	Implement the revegetation plan for the riparian zone.	**Potential Lead:** DFG **Others:** NPS, NOAA Fisheries, CDFG, CDF	Interim/ Ongoing	*SR-MC-03b*
Wilson Creek HSA						
5	E	SR-WC-01	Develop a short-term plan to add LWD and a long-term plan to promote recruitment of LWD.	**Potential Lead:** Private Landowners **Others:** CDF, CDFG, NPS, NOAA Fisheries	Interim/ Ongoing	*SR-WC-01*
5	D	SR-WC-02	Implement a short-term plan to add LWD and a long-term plan to promote recruitment of LWD.	**Potential Lead:** Private Landowners **Others:** CDF, CDFG, NPS, NOAA Fisheries	Interim/ Continual	*SR-WC-01b*
5	D	SR-WC-03	Increase connectivity of riparian habitat through fencing and planting.	**Potential Lead:** Landowners **Others:** CDF, CDFG, Caltrans	Interim	*SR-WC-02*
5	D	SR-WC-04	Implement the plan to increase connectivity of riparian habitat through fencing and planting.	**Potential Lead:** Private Landowners **Others:** CDF, CDFG	Interim	*SR-WC-02b*
5	D	SR-WC-05	Assess and prioritize the sources of sediment.	**Potential Lead:** Private Landowners **Others:** CDF, CDFG	Interim/ Ongoing	*SR-WC-03*
5	D	SR-WC-06	Treat the sources of sediment.	**Potential Lead:** Private Landowners **Others:** CDF, CDFG	Interim/ Ongoing	*SR-WC-03b*
Smith River Plain HSA						
4	E	SR-PL-01	Assess and prioritize barriers to coho salmon passage.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Caltrans, County, Private Landowners	Interim/ Ongoing	*SR-PL-01*
4	D	SR-PL-02	Treat the barriers to coho salmon passage.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Caltrans, County, Private Landowners	Interim/ Ongoing	*SR-PL-01b*
4	D	SR-PL-03	Implement the plan developed at the HU-level that speaks to restoring the effectiveness and use of off-channel areas, sloughs, and wetlands; and specifically give immediate attention to Yontocket (partially State-owned), Tillas and Tryon sloughs.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USACE, California Coastal Commission, Department of Parks and Recreation, County	Interim	*SR-HU-03*
KLAMATH RIVER HU						
	E	KR-HU-01	Facilitate development of a cooperative adaptive management plan in preparation for low-flow emergencies.	**Potential Lead:** CDFG, PacifiCorp **Others:** USBR, NOAA Fisheries, USFWS, DOI, Tribes, SWQCB, other stakeholders	Interim	*KR-HU-01*
	E	KR-HU-02	Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage.	**Potential Lead:** CDFG **Others:** RWQCB, NOAA Fisheries, USFS, Yurok Tribe, CDF, Caltrans, Private Landowners	Interim	*KR-HU-03*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
KLAMATH RIVER HU (continued)						
	C	KR-HU-03	Develop a plan (including a feasibility analysis) for coho salmon passage over and above Iron Gate and Copco dams to restore access to historic habitat.	**Potential Lead:** FERC, PacifiCorp **Others:** USFWS, USBR, NOAA Fisheries, CDFG	Interim	*KR-HU-04*
	C	KR-HU-04	Analyze the feasibility and appropriateness of site-specific FGC §2084 permits for sport fishing for hatchery coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries	Interim	*KR-HU-07*
	E	KR-HU-05	Complete comprehensive flow study activities (e.g. Hardy Phase II) and use them to educate water managers on how to reduce impacts to coho salmon.	**Potential Lead:** BIA, USFWS **Others:** NOAA Fisheries, CDFG	Interim	*KR-HU-08*
	D	KR-HU-06	Implement the comprehensive flow study in a manner that will restore natural stream processes.	**Potential Lead:** USBR **Others:** USFWS, NOAA Fisheries, CDFG	Interim	*KR-HU-08b*
	E	KR-HU-07	Apply protective down-ramp rates at Iron Gate Dam to minimize stranding of coho salmon fry.	**Potential Lead:** CDFG, USBR, FERC, PacifiCorp **Others:** USFWS	Interim	*KR-HU-09*
	E	KR-HU-08	Improve water quality coming into the Klamath River mainstem from the Upper Klamath Basin through ongoing efforts.	**Potential Lead:** CDFG **Others:** USBR, USFWS, NOAA Fisheries	Interim/ Ongoing	*KR-HU-10*
	D	KR-HU-09	Perform cost/benefit analysis of full or partial Hydroelectric Project removal for the purposes of improving water quality, fish passage, and sediment transport.	**Potential Lead:** PacifiCorp, FERC **Others:** USBR, USFWS, NOAA Fisheries, CDFG	Interim	*KR-HU-11*
	D	KR-HU-10	Manage the streams and uplands in key cold-water tributaries, to preserve their cold-water thermal regime.	**Potential Lead:** USFS **Others:** Tribes, NOAA Fisheries, USFWS, CDFG, Landowners, Counties, Watershed Groups	Interim/ Continual	*KR-HU-13*
	D	KR-HU-11	Investigate coho salmon non-natal rearing and refugia use in lower reaches of tributaries and mainstem confluences.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USFWS	Interim	*KR-HU-14*
	D	KR-HU-12	Protect and enhance tributary reaches identified as providing refugia to juvenile coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USFWS	Interim	*KR-HU-14b*
	E	KR-HU-13	Develop a plan to address water quality and quantity in Klamath River tributaries that exacerbate mainstem water quality problems.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Private Landowners	Interim/ Ongoing	*KR-HU-15*
	D	KR-HU-14	Implement the plan that addresses water quality and quantity in the Klamath River tributaries that exacerbate mainstem water quality problems.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Private Landowners	Interim/ Ongoing	*KR-HU-15*
	E	KR-HU-15	Assess hatchery operations in terms of coho salmon recovery in accordance with the policies and guidelines included in this document.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USFWS, USBR	Interim	*KR-HU-16*
	E	KR-HU-16	Continue disease monitoring of juvenile salmon emigration in the Klamath River mainstem so that major disease outbreaks can be identified and their causes evaluated.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USFWS	Interim/ Ongoing	*KR-HU-17*
	E	KR-HU-17	Conduct disease monitoring of migrating adult Chinook and coho salmon during fall migration.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USFWS, USBR	Interim/ Continual	*KR-HU-18*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
KLAMATH RIVER HU (continued)						
	D	KR-HU-18	Conduct studies in and around the Klamath River Hydroelectric Project to see if the Project is contributing to habitat for the ceratomyxosis intermediate host.	**Potential Lead:** PacifiCorp **Others:** USBR, CDFG, NOAA Fisheries, USFWS	Interim	*KR-HU-19*
	C	KR-HU-19	Restore appropriate coarse sediment supply and transport near Iron Gate Dam. Means to achieve this could include full or partial removal of the Klamath Project, or gravel introduction such as is done below other major dams (e.g., Trinity Dam).	**Potential Lead:** FERC, PacifiCorp **Others:** USFWS, NOAA Fisheries, CDFG	Long-term	*KR-HU-20*
	E	KR-HU-20	Acquire additional water through conservation easements and purchases of water and water rights from willing sellers, where lack of flows is a limiting factors and dedicate these flows to instream coho salmon needs	**Potential Lead:** CDFG **Others:** USBR, NOAA Fisheries, USFWS	Long-term/ Continual	*KR-HU-22*
	E	KR-HU-21	Acquire interim, emergency water through transfers of water and water rights from willing sellers, when necessary to meet critical instream coho salmon needs.	**Potential Lead:** CDFG **Others:** USBR, NOAA Fisheries, USFWS	Interim	*KR-HU-22b*
	D	KR-HU-22	Provide watermaster service for all diversions with partial funding provided by the State or Federal governments.	**Potential Lead:** DWR **Others:** SWRCB, CDFG, USBR	Interim/ Continual	*KR-HU-24*
	C	KR-HU-23	Promote public interest in the Klamath River Basin's coho salmon, their beneficial use and habitat requirements.	**Potential Lead:** CDFG **Others:** USFWS, RCDs, Watershed Groups	Interim/ Continual	*KR-HU-25*
Klamath Glen HSA						
5	E	KR-KG-01	Resume estuary investigations to better understand the estuary's role in the survival of Klamath Basin River coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Yurok Tribe, Coastal Commission, NPS	Interim/ Ongoing	*KR-KG-01*
5	D	KR-KG-02	Develop a plan to restore off-channel estuarine, wetland, and slough habitat in the Klamath River estuary and adjoining lower tributary reaches that includes: a. Determining if key properties, conservation easements, or development rights need to be purchased and the work with wiling landowners; and b. Determining the need and installation of livestock exclusion fencing to protect restored areas.	**Potential Lead:** CDFG **Others:** Yurok Tribe, Private Landowners	Interim	*KR-KG-02*
5	D	KR-KG-03	Implement the plan to restore off-channel estuarine, wetland, and slough habitat in the Klamath River estuary and adjoining lower tributary reaches.	**Potential Lead:** CDFG **Others:** Yurok Tribe, Private Landowners	Interim	*KR-KG-02*
5	D	KR-KG-04	Develop a plan to maintain Blue Creek watershed tributaries as key thermal refugia for their cool water contributions to the mainstem Klamath River. The plan should emphasize that: a. Sediments from upslope activities do not impact the refugia; b. Upslope stabilization and restoration activities continue, including road assessment and treatment; c. In-channel and riparian restoration efforts (target riparian retention efforts) continue; and d. Feral cattle are removed.	**Potential Lead:** Yurok Tribe **Others:** Simpson, USFS, NOAA Fisheries, CDFG, USFWS	Interim/ Ongoing	*KR-KG-03*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Klamath Glen HSA (continued)						
5	D	KR-KG-05	Implement the plan to maintain Blue creek watershed tributaries as key thermal refugia for their cool water contributions to the mainstem Klamath River.	**Potential Lead:** Yurok Tribe, Simpson **Others:** USFS, CDFG, CCC, SCC	Interim/ Ongoing	*KR-KG-03b*
5	D	KR-KG-06	Develop a plan to protect and restore Klamath River mainstem tributaries, even those that do not support populations of coho salmon but that provide cool water and which improve mainstem Klamath water quality, particularly during warm summer months. Plan should emphasize the: a. Protection and/or restoration of riparian habitat; b. Stabilization of upslope areas to prevent sedimentation and aggradation of tributaries at their mouths; c. Improvement of Federal land management activities to reduce impacts to riparian corridors and decrease sediment loads; and d. Finalize and/or refine the Lower Klamath Sub-Basin Watershed Restoration Plan (Gale and Randolph 2000) that focuses on the tributaries to the Lower Klamath within the Klamath Glen HSA.	**Potential Lead:** Yurok Tribe **Others:** Simpson, USFS, NOAA Fisheries, RWQCB, Yurok Tribe, Hoopa Valley Tribe, USFWS	Interim/ Ongoing	*KR-KG-04*
5	D	KR-KG-07	Finalize and Implement the Lower Klamath Sub-Basin Watershed Restoration Plan (Gale and Randolph 2000) to protect and restore Klamath River mainstem tributaries.	**Potential Lead:** Yurok Tribe, Simpson **Others:** USFS, CDFG, CCC, SCC	Interim/ Ongoing	*KR-KG-04b*
5	D	KR-KG-08	Reduce sediment input from upslope sources, including activities such as: a. Decommissioning skidtrails and unmaintained roads, where possible; b. Upgrading roads and maintenance practices; c. Stabilizing slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams, and d. Minimizing alteration of natural hillslope drainage patterns.	**Potential Lead:** Yurok Tribe, Simpson **Others:** USFS, CDFG, CCC, SCC	Interim/ Ongoing	*KR-KG-05*
5	E	KR-KG-09	Review existing inventory and assessment of barriers (Gale 2003) and prioritize barriers impeding migration of adult and juvenile coho salmon throughout the Lower Klamath River tributaries.	**Potential Lead:** Yurok Tribe **Others:** Simpson, Del Norte County, Caltrans, CDFG, CCC, SCC	Interim/ Ongoing	*KR-KG-06*
5	D	KR-KG-10	Treat prioritized barriers impeding migration of adult and juvenile coho salmon throughout the Lower Klamath River tributaries.	**Potential Lead:** CDFG **Others:** County, Tribes, NOAA Fisheries, USFWS, Landowners, Caltrans	Interim/ Ongoing	*KR-KG-06a*
5	D	KR-KG-11	Investigate temporal and spatial magnitude of tributary deltas and seasonal subsurface flow reaches to determine impacts to juvenile and adult coho migration and to quantify seasonal loss of lower tributary habitat. Investigation should include assessment of long-term delta size trends, annual variation in coho salmon access periodicity by tributary, quantification of seasonal habitat loss and fish stranding, and the relation of delta and subsurface flow formation to upslope erosion, river and tributary flow, mainstem bedload deposition and other causative factors.	**Potential Lead:** Yurok Tribe **Others:** Simpson, CDFG, CCC	Long-term	*KR-KG-06b*
5	D	KR-KG-12	Conduct feasibility study to re-establish adult coho salmon passage above major barriers in lower Roaches and Tully creeks and the Middle and North Forks of Ah Pah Creek.	**Potential Lead:** CDFG, Yurok Tribe **Others:** Simpson, CCC, NOAA Fisheries	Interim	*KR-KG-06c*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Klamath Glen HSA (continued)						
5	D	KR-KG-13	Treat sediment sources and improve riparian and instream habitat conditions to provide adequate and stable spawning and rearing areas for coho salmon.	**Potential Lead:** Yurok Tribe, Simpson, CCC **Others:** USFS, CDFG, SCC	Interim/ Ongoing	*KR-KG-07*
5	D	KR-KG-14	Develop a plan to restore in-channel and riparian habitat in tributaries to address: a. Revegetating riparian zones with native species (e.g., conifers) to stabilize stream banks and promote a long-term supply of LWD; b. Providing adequate protection from development, grazing, etc; and c. Relocating roads out of riparian areas when feasible.	**Potential Lead:** Yurok Tribe, CDFG **Others:** Landowners, CCC, CDF, SCC, NOAA Fisheries	Interim/ Continual	*KR-KG-08*
5	D	KR-KG-15	Implement the plan to restore in-channel and riparian habitat in tributaries.	**Potential Lead:** Yurok Tribe, Simpson, CCC **Others:** NOAA Fisheries, CDFG, CDF, SCC, Landowners	Interim/ Continual	*KR-KG-08b*
5	D	KR-KG-16	Develop a plan to provide suitable accumulations of woody cover in slow-velocity habitats for coho salmon winter rearing on a short-term basis by placing wood in needed areas until natural supplies become available.	**Potential Lead:** CDFG **Others:** Tribes, Landowners, USFS	Interim	*KR-KG-09*
5	D	KR-KG-17	Implement the plan to provide suitable accumulations of woody cover in slow-velocity habitats for coho salmon winter rearing on a short-term basis by placing wood in needed areas until natural supplies become available.	**Potential Lead:** CDFG **Others:** Tribes, Landowners, USFS	Interim	*KR-KG-09b*
5	C	KR-KG-18	Construct livestock exclusionary fencing and corresponding riparian restoration as necessary in Salt, lower High Prairie, lower Hunter and lower Terwer creeks. Provide funding and incentives to landowners and/or restoration groups where necessary to achieve this goal.	**Potential Lead:** CCC, Yurok Tribe **Others:** Landowners, CDFG	Interim	*KR-KG-10a*
5	C	KR-KG-19	Develop a plan to remove feral cattle from lower Blue and Bear Creeks.	**Potential Lead:** Yurok Tribe **Others:** Simpson	Interim	*KR-KG-10b*
5	C	KR-KG-20	Implement the plan to remove feral cattle from lower Blue and Bear creeks.	**Potential Lead:** Landowners	Interim/ Continual	*KR-KG-10b*
5	D	KR-KG-21	Work with Humboldt County, NOAA Fisheries and existing and future gravel-mining operators to restrict gravel-mining operations to appropriate mainstem Klamath locations. Gravel mining should not be conducted within Lower Klamath tributary watersheds until a scientifically valid and peer-reviewed geomorphic analysis is conducted to determine existing channel stability, causes of excess aggradation, and identifies gravel mining as an appropriate restorative measure, as outlined in task RW-IG-01.	**Potential Lead:** CDFG **Others:** County, NOAA Fisheries, existing and future gravel mining operators	Interim/ Continual	*KR-KG-11a*
5	C	KR-KG-22	Encourage cooperation between industrial timber land managers and tribes to restore coho salmon habitat Use the successful Tribal/Simpson Resource Company program as an example.	**Potential Lead:** CDFG **Others:** Tribes, Simpson Timber	Interim	*KR-KG-12*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Klamath Glen HSA (continued)						
5	D	KR-KG-23	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Management to promote conifer recruitment; c. Improvement of existing riparian zones through planting and release of conifers, and control of alders, blackberries, and other competitors; and d. Provide technical support as an incentive for landowners.	**Potential Lead:** CDFG **Others:** USFS, NOAA Fisheries, Yurok Tribe, CDF, Landowners	Interim/ Ongoing	*KR-KG-13*
5	D	KR-KG-24	Provide technical and financial support to implement riparian restoration throughout alluvial reaches in lower Blue, Terwer, Hunter and Salt creeks.	**Potential Lead:** CDFG **Others:** Landowners, CCC, Yurok Tribe	Interim/ Continual	*KR-KG-14*
5	C	KR-KG-25	Investigate straying and impacts of exotic fish (bass and bullhead) populations in an abandoned mill pond in lower Richardson Creek to coho salmon in the adjoining Klamath River estuary.	**Potential Lead:** CDFG **Others:** Yurok Tribe, RNSP, NOAA Fisheries	Interim/ Continual	*KR-KG-15*
5	C	KR-KG-26	Continue funding and technical support for the California Conservation Corps to continue their collaborative participation with the Yurok Tribe and Simpson Resource Company to implement watershed restoration throughout the lower Klamath River subbasin.	**Potential Lead:** CDFG **Others:** Yurok Tribe, Simpson Resource Company	Interim/ Ongoing	*KR-KG-17*
5	E	KR-KG-27	Support continued implementation of the Coho Salmon Regional Abundance Inventory throughout the lower Klamath River subbasin.	**Potential Lead:** CDFG	Interim/ Ongoing	*KR-KG-18*
5	C	KR-KG-28	Develop a plan to restore the historic flood plain on Hoppaw Creek, in cooperation with landowners and Caltrans.	**Potential Lead:** CDFG **Others:** Simpson, Yurok Tribe, Caltrans	Interim	*KR-KG-19*
5	C	KR-KG-29	Implement the plan to restore the historic flood plain on Hoppaw Creek.	**Potential Lead:** CDFG **Others:** Landowners, Caltrans	Interim	*KR-KG-19b*
Orleans HSA						
3	D	KR-OR-01	Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon that provide cool water and which improve mainstem Klamath River water quality and which provide thermal refugia for coho salmon, particularly during warm summer months. The plan should: a. Include improved land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources; b. Request SWRCB to review existing water appropriations for compliance; c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-OR-01*
3	D	KR-OR-02	Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, but which provide cool water and which improve mainstem Klamath River water quality and/or provide thermal refugia for coho salmon, particularly during warm summer months.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-OR-01b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Orleans HSA						
3	D	KR-OR-03	Continue activities that maintain connectivity (flow) between mainstem habitat and tributary habitat in Slate and Red Cap creeks.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG	Interim/ Continual	*KR-OR-02*
3	C	KR-OR-04	Develop a plan to protect and enhance spawning and rearing habitats in Boise and Camp creeks.	**Potential Lead:** USFS	Interim	*KR-OR-03*
3	C	KR-OR-05	Implement the plan to protect and enhance spawning and rearing habitats in Boise and Camp creeks.	**Potential Lead:** USFS	Interim	*KR-OR-03b*
3	E	KR-OR-06	Develop a plan to protect and enhance Bluff and Red Cap creek watersheds, which are classified as Key Watersheds in the Northwest Forest Plan, and are refugia for coho salmon.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG	Interim/ Ongoing	*KR-OR-04*
3	D	KR-OR-07	Implement the plan to protect and enhance Bluff and Red Cap creek watersheds	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG	Interim/ Ongoing	*KR-OR-04b*
3	C	KR-OR-08	Re-establish natural fire regimes consistent with the Northwest Forest Plan to reduce the risk and impact of large, severe fire on coho salmon.	**Potential Lead:** USFS, BLM **Others:** CDF, Landowners	Interim	*KR-OR-05*
3	C	KR-OR-09	Support efforts to provide livestock exclusion fencing where feasible and appropriate, while providing off-site watering.	**Potential Lead:** USFS **Others:** Landowners	Interim/ Ongoing	*KR-OR-06*
3	D	KR-OR-10	Reduce sediment input from upslope sources, including measures to: a. Decommission skid trails and unmaintained roads where possible; b. Upgrade roads and maintenance practices; c. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and d. Minimize alteration of natural hillslope drainage patterns.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-OR-07*
Ukonom HSA						
3	D	KR-UK-01	Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, but which provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should: a. Include improved land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources; b. Request that SWRCB review existing water appropriations for compliance; c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-UK-01*
3	D	KR-UK-02	Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, but which provide cool water, improve mainstem Klamath water River quality, and provide thermal refugia for coho salmon, particularly during warm summer months.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-UK-01b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Ukonom HSA (continued)						
3	D	KR-UK-03	Reduce sediment input from upslope sources, including measures to: a. Decommission skid trails and unmaintained roads where possible; b. Upgrade roads and maintenance practices; c. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and d. Minimize alteration of natural hillslope drainage patterns.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-UK-02*
3	D	KR-UK-04	Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage.	**Potential Lead:** CDFG **Others:** Caltrans, USFS, Karuk Tribe, USFS	Interim	*KR-UK-03*
3	D	KR-UK-05	Implement the plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage.	**Potential Lead:** CDFG **Others:** Caltrans, USFS, Karuk Tribe, USFS	Interim/ Ongoing	*KR-UK-03b*
3	D	KR-UK-06	Implement highest priority barrier repairs as identified in the Caltrans, USFS, and the Karuk Tribe inventories, specifically the identified culverts on Highway 96 at Stanshaw, Sandy Bar, and Coon.	**Potential Lead:** CDFG **Others:** Caltrans, USFS, Karuk Tribe, USFS	Interim/ Ongoing	*KR-UK-3c*
3	D	KR-UK-07	Develop a plan to ensure continued yields of high quality water by the maintenance and ecological function of tributary riparian systems, including measures to: a. Conduct riparian revegetation and stream-bank restoration; b. Where feasible, relocate roads out of riparian areas and off of unstable land features (e.g., active landslides, granitic terrain, toe zones, wet-seepy areas); c. Increase the number of conifers and deciduous trees, where appropriate, for more stable stream banks, stream shading, and eventual recruitment of LWD; and d. Revegetate flood plain areas using native species.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-UK-04*
3	D	KR-UK-08	Implement the plan to ensure continued yields of high quality water by the maintenance and ecological function of tributary riparian systems.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-UK-04b*
3	D	KR-UK-09	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Management to promote conifer recruitment; c. Planting conifers in riparian zones; and d. Release of conifers by controlling alders, blackberries, and other competitors.	**Potential Lead:** USFS **Others:** Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-UK-05*
3	D	KR-UK-10	Provide technical support as an incentive to landowners for ongoing efforts of restoring LWD and shade to the watershed.	**Potential Lead:** USFS **Others:** Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-UK-05b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Ukonom HSA (continued)						
3	C	KR-UK-11	Re-establish natural fire regimes consistent with the Northwest Forest Plan to reduce the risk and impact of large, severe fire on coho salmon.	**Potential Lead:** USFS, BLM **Others:** CDF, Landowners	Interim/ Ongoing	*KR-UK-06*
3	C	KR-UK-12	Where necessary, provide riparian protection from livestock through exclusion fencing, while establishing off-site watering.	**Potential Lead:** RCDs **Others:** Landowners	Interim/ Continual	*KR-UK-07*
3	E	KR-UK-13	Install screens on diversions to Department-NOAA Fisheries standards and provide funding, or other incentives to landowners where necessary to achieve this goal.	**Potential Lead:** CDFG **Others:** DWR, NOAA Fisheries	Interim	*KR-UK-08*
3	E	KR-UK-14	Increase efficiency of water diversions and delivery systems.	**Potential Lead:** SWRCB **Others:** CDFG, DWR	Interim	*KR-UK-09*
3	D	KR-UK-15	Continue restoration and monitoring of Siskon Mine to prevent further degradation of the riparian resource.	**Potential Lead:** CGS **Others:** RWQCB, EPA	Interim/ Ongoing	*KR-UK-10*
3	D	KR-UK-16	Request SWRCB to investigate the legality of diversions and use of water on Stanshaw Creek.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners	Interim	*KR-UK-11*
Happy Camp HSA						
4	D	KR-HC-01	Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath water River quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should: a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources; b. Request that SWRCB review existing water appropriations for compliance; c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-HC-01*
4	D	KR-HC-02	Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-HC-01b*
4	D	KR-HC-03	Reduce sediment input from upslope sources, including measures to: a. Decommission skid trails and unmaintained roads where possible; b. Upgrade roads and maintenance practices; c. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and d. Minimize alteration of natural hillslope drainage patterns.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-HC-02*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Happy Camp HSA (continued)						
4	E	KR-HC-04	Develop a plan to improve coho salmon passage at stream and road crossings, including measures to: a. Replace culverts on both USFS and Caltrans roads with structures allowing fish passage (USFS and Karuk Tribe have identified culverts under Highway 96 at Cade, Portuguese, and Fort Goff creeks as needing treatment); b. Prioritize crossings for upgrade to accommodate 100-year storm runoff and associated bedload and debris; and c. Establish an adequate funding source basin-wide for road maintenance and upgrades (possible funding sources are USFS, County and State agencies).	**Potential Lead:** CDFG **Others:** USFS, Caltrans, Karuk Tribe , Counties	Interim	*KR-HC-03*
4	D	KC-HC-05	Implement the plan to improve coho salmon passage at stream and road crossings.	**Potential Lead:** CDFG **Others:** USFS, Caltrans, Karuk Tribe, Counties	Long-term	*KC-HC-03b*
4	D	KR-HC-06	Develop a plan to ensure continued yields of high quality water by the maintenance and ecological function of tributary riparian systems, including measures to: a. Conduct riparian revegetation and stream-bank restoration; b. If feasible, relocate roads out of riparian areas and off of unstable land features (e.g., active landslides, granitic terrain, toe zones, wet-seepy areas); c. Increase the number of conifers and deciduous trees, where appropriate, for more stable stream banks, stream shading, and eventual recruitment of LWD; and d. Revegetate flood plain areas using native species.	**Potential Lead:** CDFG **Others:** USFS, Tribes, Landowners	Interim	*KR-HC-04*
4	D	KR-HC-07	Implement the plan to ensure continued yields of high quality water by the maintenance and ecological function of tributary riparian systems.	**Potential Lead:** CDFG **Others:** USFS, Tribes, Landowners	Interim/ Continual	*KR-HC-04b*
4	D	KR-HC-08	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Management to promote conifer recruitment; c. Planting conifers in riparian zones; and d. Release of conifers by controlling alders, blackberries, and other competitors.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-HC-05*
4	C	KR-HC-09	Re-establish natural fire regimes consistent with the Northwest Forest Plan to reduce the risk and impact of large, severe fires on coho salmon.	**Potential Lead:** USFS, BLM **Others:** CDF, Landowners	Interim	*KR-HC-06*
4	C	KR-HC-10	Where necessary, provide riparian protection from livestock through exclusion fencing, while establishing off-site watering.	**Potential Lead:** USFS **Others:** Landowners	Interim	*KR-HC-07*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Happy Camp HSA (continued)						
4	E	KR-HC-11	Install screens on diversions to Department-NOAA Fisheries standards and provide funding, or other incentives to landowners where necessary to achieve this goal.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Landowners	Interim	*KR-HC-08*
4	E	KR-HC-12	Increase efficiency of water diversions and delivery systems where feasible and appropriate. Provide funding and incentives to landowners where necessary to meet this goal.	**Potential Lead:** SWRCB **Others:** CDFG, DWR	Interim	*KR-HC-09*
4	D	KR-HC-13	Request the NCRWQCB to continue monitoring Grey Eagle Mine and tailings as a follow-up to remediation that has already been done.	**Potential Lead:** CDFG **Others:** RWQCB	Interim	*KR-HC-10*
	D	KR-HC-14	Request that EPA Region 9 consider coho salmon when dealing with both emergency and remedial actions.	**Potential Lead:** CDFG **Others:** EPA	Interim	*KR-HC-10b*
Seiad Valley HSA						
4	D	KR-SV-01	Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should: a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources; b. Request that the SWRCB review existing water appropriations for compliance; c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-SV-01*
4	D	KR-SV-02	Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for fish, particularly during warm summer months.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-SV-01b4*
4	D	KR-SV-03	Reduce sediment input from upslope sources by: a. Decommissioning unmaintained roads (where possible) and skid trails; b. Upgrade roads and maintenance practices; c. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; and d. Minimize alteration of natural hill slope drainage patterns.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-SV-02E*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Seiad Valley HSA (continued)						
4	E	KR-SV-04	Improve fish passage at stream and road crossings, including measures to: a. Replace culverts on both USFS and Caltrans roads with structures allowing coho salmon passage; b. Treat coho salmon passage problems associated with the USFS roads; c. Prioritize crossings for upgrade to accommodate 100-year storm runoff and associated bedload and debris; and d. Establish an adequate funding source basin-wide for road maintenance and upgrades (possible funding sources are USFS, County and State agencies).	**Potential Lead:** CDFG **Others:** USFS, Caltrans	Interim/ Ongoing	*KR-SV-03*
4	D	KR-SV-05	Develop a plan to ensure continued yields of high quality water by the maintenance and ecological function of tributary riparian systems, including measures to: a. Conduct riparian revegetation and stream-bank restoration; b. Relocate roads out of riparian areas and off of unstable land features (e.g., active landslides, granitic terrain, toe zones, seep areas); c. Increase the number of conifers and deciduous trees, where appropriate, for more stable stream banks, stream shading, and eventual recruitment of LWD; and d. Revegetate flood plain areas using native species.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-SV-04*
4	D	KR-SV-06	Implement the plan to ensure continued yields of high quality water by the maintenance and ecological function of tributary riparian systems	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-SV-04b*
4	D	KR-SV-07	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Management to promote conifer recruitment; c. Planting conifers in riparian zones; and d. Release of conifers by controlling alders, blackberries, and other competitors.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-SV-05*
4	D	KR-SV-08	Provide technical support as an incentive to landowners for ongoing efforts of restoring LWD and shade to the watershed.	**Potential Lead:** USFS, NOAA Fisheries, CDFG **Others:** CDF, Landowners	Interim	*KR-SV-05b*
4	C	KR-SV-09	Manage roadless areas to be consistent with land use allocations under the Northwest Forest Plan to reduce the risk of large, severe fires by re-establishing the natural fire regimes.	**Potential Lead:** USFS	Interim	*KR-SV-06*
4	C	KR-SV-10	Where necessary, provide riparian protection from livestock through exclusion fencing, while establishing off-site watering.	**Potential Lead:** USFS **Others:** Landowners	Interim	*KR-SV-07*
4	E	KR-SV-11	Install screens on diversions to Department-NOAA Fisheries standards and provide funding, or other incentives to landowners where necessary to achieve this goal.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Landowners	Interim	*KR-SV-08*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Seiad Valley HSA (continued)						
4	E	KR-SV-12	Study the likely benefits to instream flow of increasing the efficiency of water diversions and delivery systems where feasible and appropriate. Provide funding and incentives to landowners where necessary to meet actions that are given a high priority.	**Potential Lead:** SWRCB **Others:** CDFG, DWR	Interim	*KR-SV-09*
4	E	KR-SV-13	Identify illegal water diverters and request that the SWRCB take appropriate action.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners	Interim	*KR-SV-10*
4	E	KR-SV-14	Request that the SWRCB review and/or modify water use based on the needs of coho salmon and authorized diverters.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners	Interim	*KR-SV-10b*
4	D	KR-SV-15	Look for opportunities to acquire water rights for instream flow from willing participants who possess valid water rights.	**Potential Lead:** CDFG **Others:** Landowners, RCDs	Interim	*KR-SV-11*
4	D	KR-SV-16	Assess potential coho salmon passage problem associated with private water diversion at the mouth of Middle Creek (tributary to Horse Creek).	**Potential Lead:** CDFG **Others:** Landowners	Interim	*KR-SV-12*
4	D	KR-SV-17	If necessary, design and implement a remediation project for coho salmon fish passage at the mouth of Middle Creek.	**Potential Lead:** CDFG **Others:** Landowners	Interim	*KR-SV-12b*
Beaver Creek HSA						
4	C	KR-BC-01	Re-establish natural fire regimes consistent with the Northwest Forest Plan to reduce the risk and impact of a large, severe fire on coho salmon.	**Potential Lead:** USFS **Others:** BLM, CDF	Long-term	*KR-BC-01*
4	C	KR-BC-02	Encourage landowners to manage fuels to prevent large, severe fires and to evaluate the application of the Watershed Evaluation Mitigation Addendum.	**Potential Lead:** USFS **Others:** CDF, County, Landowners, CDFG	Interim/ Ongoing	*KR-BC-02*
4	D	KR-BC-03	Assess fine sediment production and delivery from the USFS road adjacent to the West Fork of Beaver Creek.	**Potential Lead:** USFS	Interim	*KR-BC-03*
4	D	KR-BC-04	Implement appropriate remediation for the sediment from the USFS road adjacent to the West Fork of Beaver Creek.	**Potential Lead:** USFS	Interim	*KR-BC-03b*
4	C	KR-BC-05	Hydrologically disconnect the USFS Beaver Creek Road north of West Beaver Creek.	**Potential Lead:** USFS	Interim	*KR-BC-04*
4	D	KR-BC-06	Support actions to reduce sediment from upslope sources such as: a. Decommission roads and skid trails; b. Upgrade roads and maintenance practices; c. Ensure adequate coho salmon migration is provided for at stream/road crossings; d. Stabilize slopes to minimize or prevent erosion and to minimize future risk of eroded material entering streams; e. Minimize alteration of natural hillslope drainage patterns; and f. Encourage the relocation of roads out of riparian areas and off of unstable land features (e.g., active landslides, granitic terrain, toe zones, seep areas).	**Potential Lead:** USFS, NOAA Fisheries **Others:** CDFG, CDF, Landowners	Interim/ Ongoing	*KR-BC-05*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Beaver Creek HSA (continued)						
4	D	KR-BC-07	Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should: a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources; b. Request that the SWRCB review existing water appropriations for compliance; c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-BC-06*
4	D	KR-BC-08	Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for fish, particularly during warm summer months.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB, CDFG, CDF, Landowners	Interim	*KR-BC-07*
4	E	KR-BC-09	Improve coho salmon passage at stream and road crossings, including measures to: a. Replace culverts on both USFS and Caltrans roads with structures allowing coho salmon passage; b. Treat coho salmon passage problems associated with the USFS roads; c. Prioritize crossings for upgrade to accommodate 100-year storm runoff and associated bedload and debris; and d. Encourage the USFS and County and State agencies to provide adequate budgets basin-wide for road maintenance and upgrades.	**Potential Lead:** CDFG **Others:** USFS, Caltrans	Interim/ Ongoing	*KR-BC-08*
4	D	KR-BC-10	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Management to promote conifer recruitment; and c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-BC-09*
4	D	KR-BC-11	Provide technical support as an incentive to landowners for ongoing efforts of restoring LWD and shade to the watershed.	**Potential Lead:** USFS, NOAA Fisheries, CDFG **Others:** CDF, Landowners	Interim	*KR-BC-10*
4	C	KR-BC-12	Where necessary, provide riparian protection from livestock while providing off-site watering.	**Potential Lead:** USFS **Others:** Landowners	Interim	*KR-BC-11*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
SALMON RIVER HA						
	D	SA-HA-01	Reduce sediment and provide coho salmon passage for all life history stages where roads affect streams inhabited by coho salmon.	**Potential Lead:** Road Management and Fisheries Barrier Work Group Task Force, USFS **Others:** Landowners, County, CDFG	Interim	*SA-HA-01*
	D	SA-HA-02	Reduce sediment by accelerating the Northwest Forest Plan road assessment schedule.	**Potential Lead:** USFS **Others:** County, CDFG	Interim	*SA-HA-01b*
	D	SA-HA-03	Reduce sediment where roads affect streams inhabited by coho salmon by completing the road sediment inventory assessment of County roads.	**Potential Lead:** County **Others:** USFS, CDFG	Interim/ Ongoing	*SA-HA-01c*
	D	SA-HA-04	Reduce sediment where roads affect streams inhabited by coho salmon by implementing the treatment of the road sediment inventory of county roads.	**Potential Lead:** County **Others:** USFS, CDFG	Interim	*SA-HA-01d*
	D	SA-HA-05	Provide coho salmon passage to all life history stages where roads affect streams inhabited by coho salmon implement the recommendations for the completed assessment of barriers.	**Potential Lead:** County, Road Management and Fisheries Barrier Work Group Task Force **Others:** USFS, CDFG, Landowners	Interim	*SA-HA-01e*
	E	SA-HA-06	Foster the multi-agency task force to identify and prioritize barriers to fish passage, and implement corrective treatments. This task force would include at a minimum, representatives from the Salmon River Restoration Council, Karuk Tribe, USFS, NOAA Fisheries, USFWS, and the Department.	**Potential Lead:** Road Management and Fisheries Barrier Work Group Task Force (Salmon River Restoration Council, Karuk Tribe, USFS, NOAA Fisheries, USFWS, County, and CDFG)	Interim/ Ongoing	*SA-HA-02*
	D	SA-HA-07	Educate landowners, restoration specialist, and watershed groups to reduce the impacts of private roads on coho salmon.	**Potential Lead:** CDFG, Road Management and Fisheries Barrier Work Group Task Force **Others:** Salmon River Restoration Council, Landowners	Interim/ Ongoing	*SA-HA-03*
	C	SA-HA-08	Encourage collaborative efforts among agencies and stakeholders to control or remove invasive exotics using integrated pest management techniques, emphasizing manual treatments.	**Potential Lead:** CDFG, Salmon River Noxious Weed Management Area Groups **Others:** Landowners, Academia, Native Plant Advocates	Interim/ Ongoing	*SA-HA-04*
	C	SA-HA-09	Reduce the risk of large, severe fires through fuels management around residential structures, homes, and fire escape routes. Implement Salmon River Fire Safe Council recommendations promoting the reduction of fuel near residences to reduce human-caused fires spreading into the forest and causing harm to coho salmon habitat.	**Potential Lead:** Salmon River Fire Safe Council **Others:** County, CDFG, CDF, USFS	Interim/ Ongoing	*SA-HA-05*
	C	SA-HA-10	Re-establish fire regimes consistent with Northwest Forest Plan objectives to reduce the risk and impact of large, severe fire on coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, Salmon River Fire Safe Council **Others:** USFS	Interim	*SA-HA-06*
	C	SA-HA-11	If necessary, integrate coho salmon conservation into the Northwest Forest Plan regarding fire suppression and overall fuel management plan.	**Potential Lead:** USFS	Interim	*SA-HA-06b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
SALMON RIVER HA (continued)						
	D	SA-HA-12	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade, primarily in tributaries and key refugia areas, through: a. LWD placement; b. Management to promote conifer recruitment; c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and d. Incentives to landowners, such as technical support.	**Potential Lead:** USFS, CDFG **Others:** NOAA Fisheries, Watershed Groups, County, USFWS, Karuk Tribe, Salmon River Restoration Council, Landowners	Interim/ Ongoing	*SA-HA-09*
	C	SA-HA-13	Develop a plan to prioritize and remediate mine tailings.	**Potential Lead:** CDFG, CGS, North Coast RWQCB, USFS **Others:** NOAA Fisheries, Karuk Tribe, USFWS, Salmon River Restoration Council, Landowners	Interim/ Ongoing	*SA-HA-10*
	C	SA-HA-14	Implement the plan to remediate prioritized mine tailings, focusing on tributaries and key area of the Salmon River.	**Potential Lead:** CGS, USFS, North Coast RWQCB **Others:** NOAA Fisheries, CDFG, USFWS, Karuk Tribe, Salmon River Restoration Council	Interim/ Ongoing	*SA-HA-10b*
Lower Salmon HSA						
3	D	SA-LS-01	Restore and maintain habitat connectivity between the Salmon River and Nordheimer Creek where low flow or sediment aggradation has been known to restrict coho salmon passage.	**Potential Lead:** USFS, Watershed Group **Others:** Karuk Tribe	Interim/ Ongoing	*SA-LS-01*
		SA-LS-02	Support ongoing maintenance and operations for the Nordheimer Creek Fish Ladder.	**Potential Lead:** USFS, Watershed Group **Others:** Karuk Tribe		*SA-LS-02*
Sawyers Bar HSA						
3	D	SA-SB-01	Reduce current and future sediment inputs to Specimen, North Russian, and South Russian creeks: a. Do road upgrade/improvement/maintenance/storm proofing (out sloping roads, reducing hydrologic connectivity); b. Provide slope stabilization where feasible; c. Reduce or avoid alteration of natural hill slope drainage patterns: and d. Upgrade stream/road crossings and ensure coho salmon passage.	**Potential Lead:** USFS, Watershed Group **Others:** Karuk Tribe	Interim/ Ongoing	*SA-SB-01*
3	D	SA-SB-02	Conduct riparian revegetation and stream-bank stabilization along entire North Fork: a. Control vegetation removal in the streamside zone; b. Increase the number of conifers and deciduous trees to provide stable stream shading and which will eventually become a source for LWD; and c. Revegetate flood plain areas using native species.	**Potential Lead:** USFS, Watershed Group **Others:** Karuk Tribe	Interim/ Ongoing	*SA-SB-02*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
SHASTA VALLEY AND SCOTT RIVER HAs – Shasta Valley, Scott Bar, and Scott Valley HSAs						
4	C	SS-HA-01	Reduce the risk of large, severe fires (especially in the Scott) by implementing the Fire Safe Council's recommendations promoting the reduction of fuel near residences to reduce human-caused fires spreading into the forest and causing harm to coho salmon habitat.	**Potential Lead:** CDF, USFS **Others:** County, Landowners, CDFG	Interim/ Ongoing	*SS-HA-01*
4	D	SS-HA-02	Reduce human-caused sediment input from upslope sources identified through public and private inventories.	**Potential Lead:** USFS, CDF, Landowners **Others:** Caltrans, County, CDFG	Interim/ Ongoing	*SS-HA-02*
4	D	SS-HA-03	Prioritize and implement remediation activities for human-caused sediment, which would include slope stabilization, minimizing sediment production, and eliminating coho salmon passage barriers.	**Potential Lead:** USFS, CDF, Landowners **Others:** Caltrans, County, CDFG	Interim/ Ongoing	*SS-HA-02b*
4	D	SS-HA-04	Encourage Federal, State, and county agencies and private landowners to reduce impacts to coho salmon habitat from public and private road systems.	**Potential Lead:** CDFG **Others:** USFS, CDF, Caltrans, County, Landowners	Interim	*SS-HA-03*
4	D	SS-HA-05	Continue road and/or watershed assessments to identify and prioritize sources and risks of road-related sediment delivery to watercourses.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim/ Ongoing	*SS-HA-03b*
4	D	SS-HA-06	Reduce road densities where necessary and appropriate.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim	*SS-HA-03c*
4	D	SS-HA-07	Decrease potential for stream flow to become diverted at road crossings during high flow events, resulting in flow along the road that returns to the channel at undesirable locations.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim/ Ongoing	*SS-HA-03d*
4	D	SS-HA-08	Stabilize slopes along roadways to minimize or prevent erosion and to minimize future risk of eroded material entering streams.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim	*SS-HA-03e*
4	D	SS-HA-09	Minimize alteration of natural hill slope drainage patterns to decrease erosion and sediment input into the streams.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim	*SS-HA-03f*
4	D	SS-HA-10	Encourage funding authorities to allocate adequate budgets to Federal, State, and local agencies and private landowners for road maintenance activities, capital project activities, and dedicated funding to pay for coho salmon passage projects.	**Potential Lead:** CDFG, Counties, USFS, NOAA Fisheries **Others:** CDF, Caltrans, Landowners	Interim	*SS-HA-03g*
4	E	SS-HA-11	Encourage funding authorities to allocate adequate resources to prioritize and upgrade crossings to provide coho salmon passage within the range of coho salmon to pass 100-year flows and the expected debris loads (e.g., LWD that might be mobilized).	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USFS, CDF, Landowners	Interim/ Ongoing	*SS-HA-04*
4	E	SS-HA-12	Identify barriers to passage and prioritize them for removal, through collaborative efforts with other agencies.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, USFS, Caltrans, CDF, County, Landowners	Interim/ Ongoing	*SS-HA-05*
4	C	SS-HA-13	Design a reclamation plan to remediate effects of historical mining (e.g., tailings near Callahan) with the goal of enhancing the production and survival of coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, County, CGS, Landowners	Interim	*SS-HA-06*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
SHASTA VALLEY AND SCOTT RIVER HAs – Shasta Valley, Scott Bar, and Scott Valley HSAs (continued)						
4	C	SS-HA-14	Implement the reclamation plan that remedies effects of historical mining (e.g., tailings near Callahan) with the goal of enhancing the production and survival of coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, County, CGS, Landowners	Interim	*SS-HA-06b*
4	C	SS-HA-15	Identify locations, costs, and restoration potential of intensively mined areas.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, County, CGS, Landowners	Interim	*SS-HA-06c*
4	D	SS-HA-16	Improve water quality by reducing or minimizing both domestic and municipal sources of nutrient input (i.e., sewage treatment plant discharge and storm drain runoff). Support efforts by cities and rural communities to complete system upgrades to achieve CWA compliance.	**Potential Lead:** RWQCB **Others:** County, Landowners, CDFG	Interim/ Ongoing	*SS-HA-07*
4	D	SS-HA-17	Minimize impacts of cattle grazing on watercourses though exclusion fencing as necessary and appropriate (e.g., providing off-site watering, preventing overgrazing, etc.).	**Potential Lead:** RCDs **Others:** Landowners, CDFG, NOAA Fisheries	Interim, Ongoing	*SS-HA-08*
4	D	SS-HA-18	Support cooperative State and local efforts to redirect Big Mill Creek into its historic channel under State Route 3, thereby restoring adult and juvenile coho salmon access to approximately 1.25 miles of quality spawning and rearing habitat.	**Potential Lead:** CDFG **Others:** Caltrans, Landowners	Interim	*SS-HA-09*
4	E	SS-HA-19	Assess the potential benefits and technical feasibility of increasing stream flows in the Scott River for fish and wildlife within the Klamath National Forest.	**Potential Lead:** CDFG **Others:** SWRCB, DWR, Landowners	Interim	*SS-HA-10*
4	D	SS-HA-20	Request the USBR to study the potential benefits of adjusting Iron Gate flows to better meet the needs of adult and juvenile life stages to enhance Scott/Shasta coho salmon production, consistent with the flow needs of the Klamath and Trinity rivers.	**Potential Lead:** CDFG **Others:** USBR	Interim	*SS-HA-11*
4	D	SS-HA-21	Complete the comprehensive, peer-reviewed watershed restoration plans for the Shasta and Scott rivers that include identification and prioritization of all restorative needs in each basin. When restoration funds are limited, implementation should occur on the highest priority issues most likely to effectively address coho salmon needs within each basin.	**Potential Lead:** RCDs, Watershed Council **Others:** CDFG, NOAA Fisheries, USFWS	Interim/ Ongoing	*SS-HA-18*
	C	SS-HA-22	Financially support ongoing watershed planning.	**Potential Lead:** RCDs, Watershed Council **Others:** CDFG, NOAA Fisheries, USFWS	Interim/ Ongoing	*SS-HA-18b*
4	E	SS-HA-23	Preserve water quality, quantity and coho salmon habitat in the Big Springs area in the Shasta River by possibly using incentive-based alternatives with willing participants.	**Potential Lead:** CDFG **Others:** Landowners, RCD	Interim/ Continual	*SS-HA-24*
4	E	SS-HA-24	Maintain and revegetate, where appropriate, riparian trees in headwaters and along creeks that provide shade habitat essential for coho salmon.	**Potential Lead:** CDFG **Others:** Landowners, RCD	Interim/ Continual	*SS-HA-25*
4	D	SS-HA-25	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; and b. Management to promote conifer recruitment.	**Potential Lead:** CDFG **Others:** Landowners, RCD	Interim/ Ongoing	*SS-HA-26*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
KLAMATH RIVER HU – Hornbrook HSA						
4	D	KR-HB-01	Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should: a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources; b. Request that the SWRCB review existing water appropriations for compliance; c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB,CDFG, CDF, Landowners	Interim/ Ongoing	*KR-HB-01*
4	D	KR-HB-02	Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB,CDFG, CDF, Landowners	Interim/ Ongoing	*KR-HB-02*
4	E	KR-HB-03	Improve coho salmon passage at stream and road crossings, including measures to: a. Replace culverts on both the USFS and Caltrans roads with structures allowing coho salmon passage; b. Treat coho salmon passage problems associated with the USFS roads; c. Prioritize crossings for upgrade to accommodate 100-year storm runoff and associated bedload and debris; and d. Encourage the USFS, County and State agencies to provide adequate budgets basin-wide for road maintenance and upgrades.	**Potential Lead:** CDFG **Others:** USFS, Caltrans	Interim/ Ongoing	*KR-HB-03*
4	D	KR-HB-04	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Management to promote conifer recruitment; c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and d. Incentives to landowners, such as technical support.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-HB-05*
4	E	KR-HB-05	Study the likely benefits to instream flow of increasing the efficiency of water diversions and delivery systems where feasible and appropriate. Provide funding and incentives to landowners where necessary to meet actions that are given a high priority.	**Potential Lead:** SWRCB **Others:** CDFG, DWR	Interim	*KR-HB-09*
4	E	KR-HB-06	Identify water diverters; request that the SWRCB review and/or modify water use based on the needs of coho salmon and authorized diverters.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners	Interim	*KR-HB-10*
4	D	KR-HB-07	Look for opportunities to acquire water rights for instream flow from willing participants who possess valid water rights.	**Potential Lead:** CDFG **Others:** Landowners, RCDs	Interim	*KR-HB-11*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
KLAMATH RIVER HU – Irongate HSA						
4	D	KR-IG-01	Develop a plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months. The plan should: a. Improve land management to reduce impacts to riparian corridors, reduce sediment loads, and protect water resources; b. Request that the SWRCB review existing water appropriations for compliance; c. Petition the SWRCB to designate streams with critical summer flows as fully appropriated streams during the appropriate period; and d. Provide measures that reduce hydrologic connectivity between streams and roads where feasible.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB,CDFG, CDF, Landowners	Interim/ Ongoing	*KR-IG-01*
4	D	KR-IG-02	Implement the plan to protect and restore tributaries, even those that do not support populations of coho salmon, that provide cool water, improve mainstem Klamath River water quality, and provide thermal refugia for coho salmon, particularly during warm summer months.	**Potential Lead:** USFS **Others:** NOAA Fisheries, RWQCB,CDFG, CDF, Landowners	Interim/ Ongoing	*KR-IG-02*
4	E	KR-IG-03	Improve coho salmon passage at stream and road crossings, including measures to: a. Replace culverts on both USFS and Caltrans roads with structures allowing coho salmon passage; b. Treat coho salmon passage problems associated with the USFS roads; c. Prioritize crossings for upgrade to accommodate 100-year storm runoff and associated bedload and debris; and d. Encourage the USFS, County and State agencies to provide adequate budgets basin-wide for road maintenance and upgrades.	**Potential Lead:** USFS, Caltrans **Others:** CDFG	Interim/ Ongoing	*KR-IG-03*
4	D	KR-IG-04	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Management to promote conifer recruitment; c. Improvement of existing riparian zones through plantings, release of conifers, and control of alders, blackberries, and other competitors; and d. Incentives to landowners, such as technical support.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*KR-IG-05*
4	E	KR-IG-05	Study the likely benefits to instream flow of increasing the efficiency of water diversions and delivery systems where feasible and appropriate. Provide funding and incentives to landowners where necessary to meet actions that are given a high priority.	**Potential Lead:** SWRCB **Others:** CDFG, DWR	Interim	*KR-IG-09*
4	E	KR-IG-06	Identify water diverters and request that the SWRCB review and/or modify water use based on the needs of coho salmon and authorized diverters.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners	Interim	*KR-IG-10*
4	D	KR-IG-07	Look for opportunities to acquire water rights for instream flow from willing participants who possess valid water rights.	**Potential Lead:** CDFG **Others:** Landowners, RCDs	Interim	*KR-IG-11*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
TRINITY RIVER HU						
	E	TR-HU-01	Implement the Trinity River Record of Decision (ROD), which would provide: a. Variable annual instream flows for the Trinity River from the Trinity River Dam (TRD) based on forecasted hydrology for the Trinity River basin as of April 1st of each year, ranging from 369,000 acre-feet in critically dry years to 815,000 af in extremely wet years; b. Physical channel rehabilitation, including the removal of riparian berms and the establishment of side-channel habitat; c. Sediment management, including the supplementation of spawning gravels below the TRD and reduction in fine sediments which degrade coho salmon habitats; d. Watershed restoration efforts, addressing negative impacts which have resulted from land use practices in the Basin; and e. Infrastructure improvements or modifications, including rebuilding or fortifying bridges and addressing other structures affected by the peak instream flows provided by the ROD.	**Potential Lead:** USBR **Others:** USFS, NOAA Fisheries, USFWS, CDFG	Interim	*TR-HU-01*
	C	TR-HU-02	Recommend to the NCRWQCB that the TMDL process consider alterations in the sediment load allocations and targets due to implementation of the ROD.	**Potential Lead:** CDFG **Others:** RWQCB	Interim	*TR-HU-02*
	D	TR-HU-03	Implement the Trinity River TMDL instream flushing flows without affecting ROD allocations.	**Potential Lead:** CDFG, USBR **Others:**, RWQCB	Interim	*TR-HU-06*
	D	TR-HU-04	Establish TMDL implementation plans for the mainstem and South Fork using the upslope indicators and targets established in the Main Stem Load Allocation.	**Potential Lead:** CDFG, RWQCB **Others:** USBR	Interim	*TR-HU-07*
	E	TR-HU-05	Develop a County grading ordinance based on exemption, certification, and permitting criteria.	**Potential Lead:** County **Others:** CDFG	Long-term	*TR-HU-08*
	C	TR-HU-06	Implement county grading ordinance based on exemption, certification, and permitting criteria.	**Potential Lead:** County **Others:** CDFG	Long-term/ Continual	*TR-HU-08b*
	C	TR-HU-07	Implement the Five Counties Water Quality and Stream Habitat Protection Manual for County Road Maintenance in Northwestern California Watersheds.	**Potential Lead:** Trinity County **Others:** CDFG	Interim/ Continual	*TR-HU-09*
	D	TR-HU-08	Support continued State and Federal funding for the implementation of sediment reduction programs for private lands and the implementation and funding of treatment of sediment source sites on County roads using the prioritization of the Direct Inventory of Roads and Their Treatment (DIRT).	**Potential Lead:** County **Others:** Landowners, CDFG	Interim/ Ongoing	*TR-HU-10*
	C	TR-HU-09	Establish incentives and standards for private riparian and wetland areas protection based on flexible subdivision design; road, curb and gutter requirements; minimum lot size and density; clustering and other techniques.	**Potential Lead:** CDFG **Others:** County	Interim	*TR-HU-11*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
TRINITY RIVER HU (continued)						
	C	TR-HU-10	Establish riparian setbacks for grading activities on private lands, based on Department 1994 recommendations to District I counties.	**Potential Lead:** CDFG **Others:** County	Interim	*TR-HU-12*
	D	TR-HU-11	Evaluate the impacts of non-native fish species on coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries	Interim	*TR-HU-13*
	D	TR-HU-12	Develop management guidelines to reduce impacts from non-native fish species.	**Potential Lead:** CDFG **Others:** NOAA Fisheries	Interim	*TR-HU-13*
	C	TR-HU-13	Develop or amend existing County Conservation, Open Space and Land Use Elements and Community Plans to focus development away from riparian habitats, wetland habitats, or steep slopes. Consider all species habitats, wildland-urban fire hazard, and other land uses factors in making allocations.	**Potential Lead:** CDFG **Others:** Trinity County	Interim	*TR-HU-14*
	C	TR-HU-14	Analyze the feasibility and appropriateness of site-specific 2084 authorization for sport fishing for hatchery coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries	Interim	*TR-HU-15*
Douglas City HSA						
5	E	TR-DC-01	Investigate all water diversions on Reading Creek, Indian Creek, and Browns Creek.	**Potential Lead:** CDFG **Others:** SWRCB, NOAA Fisheries	Interim	*TR-DC-01*
5	E	TR-DC-02	Restore coho salmon passage and instillation of screens to Department-NOAA Fisheries standards. Provide incentives to landowners when necessary to reach this goal.	**Potential Lead:** CDFG **Others:** SWRCB, NOAA Fisheries	Interim	*TR-DC-01*
5	D	TR-DC-03	Increase riparian function in lower Reading, Indian, Browns creeks with conservation easements or landowner incentives that reduce agricultural and grazing impacts.	**Potential Lead:** CDFG **Others:** RCD, Landowners	Interim/ Ongoing	*TR-DC-02*
5	D	TR-DC-04	Implement sediment reduction plans consistent with County plans and policies.	**Potential Lead:** CDFG **Others:** RCD, County, Landowners	Interim/ Ongoing	*TR-DC-03*
Grouse Creek HSA						
3	D	TR-GC-01	Continue implementation of habitat restoration, including measures to stabilize upslope areas, enhance riparian zones, storm proof, stabilize, and/or decommission roads, and replace culverts.	**Potential Lead:** USFS **Others:** NOAA Fisheries, County, RCD, CDFG, CDF, Landowners	Interim/ Ongoing	*TR-GC-01*
Hyampom HSA						
2	D	TR-HY-01	Develop a management plan for Big Slide to reduce human contributions to mobilization of sediments, including evaluating relocation of the county road that crosses Big Slide.	**Potential Lead:** USFS **Others:** CDFG, County	Interim	*TR-HY-01*
2	D	TR-HY-02	Implement the management plan for Big Slide to reduce human contributions to mobilization of sediments, including evaluating relocation of the county road that crosses Big Slide.	**Potential Lead:** USFS, County **Others:** CDFG	Interim	*TR-HY-01b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Hyampom HSA (continued)						
2	C	TR-HY-03	Manage forest stands to reduce their susceptibility to large, severe fires. Where appropriate, this should include actions to accelerate the growth of conifers for LWD recruitment, develop mature shade canopy in the riparian zone, and provide for other multiple use goals.	**Potential Lead:** CDFG **Others:** USFS	Interim/ Ongoing	*TR-HY-02*
2	D	TR-HY-04	Continued implementation of habitat restoration, including measures to stabilize upslope areas, enhance riparian zones, storm proof, stabilize, and/or decommission roads, and replace culverts.	**Potential Lead:** USFS **Others:** NOAA Fisheries, County, RCD, CDFG, CDF, Landowners	Interim/ Ongoing	*TR-HY-03*
Hayfork HSA						
2	E	TR-HA-01	Establish agricultural/residential water conservation programs using incentive programs if necessary.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners	Interim/ Ongoing	*TR-HA-01*
2	D	TR-HA-02	Amend Trinity County's Critical Water Resources Overlay zone to address new riparian water rights developed as a result from parcel subdivision. The amendment should include expanding the overlay zoning to additional watersheds where summer surface flows are limiting factors for residents and coho salmon.	**Potential Lead:** CDFG **Others:** County	Interim	*TR-HA-02*
2	C	TR-HA-03	Continue implementation of riparian improvements through restoration activities, land use planning, and conservation easements.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Private Landowners	Interim/ Ongoing	*TR-HA-03*
2	D	TR-HA-04	Support efforts to provide livestock exclusion fencing where feasible and appropriate, while providing off-site watering.	**Potential Lead:** Landowners, RCDs **Others:** NRCS	Interim/ Continual	*TR-HA-04*
2	D	TR-HA-05	Continue to implement habitat restoration, including measures to stabilize upslope areas, enhance riparian zones, storm proof, stabilize, and/or decommission roads, and replace culverts.	**Potential Lead:** USFS **Others:** NOAA Fisheries, County, RCD, CDFG, CDF, Landowners	Interim/ Ongoing	*TR-HA-05*
MAD RIVER HU						
	D	MR-HU-01	Work with landowners and other entities to reduce coho salmon tributary stream temperature through the development of mature coniferous stream-side over-story within the riparian zone by continuing: a. Planting programs in stream corridors barren of mature conifers; b. THP review; and c. Riparian management with cattle ranchers.	**Potential Lead:** CDFG , NCRWQCB, CDF **Others:** Landowners, CCC, Watershed Groups, NOAA Fisheries, USFS, RCD	Interim/ Continual	*MR-HU-01*
	C	MR-HU-02	Recommend the SWRCB make a high priority the: a. Review of authorized diversions that have no provisions to protect coho salmon; and b. Identification of unauthorized diversions and enforcement actions to stop them.	**Potential Lead:** NCRWQCB, SWQCB **Others:** DWR, CDFG	Long-term	*MR-HU-02*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
MAD RIVER HU (continued)						
	E	MR-HU-03	Work with landowners and other entities to: a. Protect existing LWD recruitment potential through the retention of mature coniferous trees in the riparian zone; b. Establish adequate streamside buffer areas; c. Increase the amount of in-channel LWD; d Continue to review THPs; and e. Continue riparian management projects.	**Potential Lead:** CDFG **Others:** CCC, CDF, Landowners, NOAA Fisheries, County, Watershed Groups	Interim/ Continual	*MR-HU-03*
	E	MR-HU-04	Conduct pre-project geological surveys where needed.	**Potential Lead:** NCRWQCB, CDF, CDFG, County, CGS	Interim/ Continual	*MR-HU-04*
	D	MR-HU-05	Develop permit conditions to limit activities within unstable areas, identifying appropriate mitigation measures.	**Potential Lead:** NCRWQCB, CDF,CDFG, County, CGS	Interim/ Continual	*MR-HU-04b*
	D	MR-HU-06	Adopt measures to protect riparian vegetation for all development over which counties and incorporated areas have jurisdiction.	**Potential Lead:** Counties and Incorporated Areas **Others:** CDFG, NOAA Fisheries	Long-term	*MR-HU-05*
	E	MR-HU-07	Assess barriers to coho salmon passage, prioritize barriers for removal, and develop a plan to treat the barriers, with Warren Creek given a high priority for treatment.	**Potential Lead:** CDFG **Others:** Caltrans, Landowner, County, NOAA Fisheries	Interim	*MR-HU-07*
	E	MR-HU-08	Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage. This is a known problem at Cañon Creek, Dry Creek, and North Fork Mad River. The plan should: a. Evaluate management techniques; b. Implement the identified strategy; and c. Address permitting complexity for identified implementation measures.	**Potential Lead:** CDFG , NOAA Fisheries, Landowners	Long-term	*MR-HU-08*
	D	MR-HU-09	Consider the mouths of Cañon Creek, Dry Creek, and North Fork Mad River as locations to: a. Identify causes of loss of connectivity; b. Evaluate management techniques; c. Implement the identified strategy; and d. Address permitting complexity for identified implementation measures.	**Potential Lead:** CDFG **Others:** County	Long-term	*MR-HU-09*
	C	MR-HU-10	Continue stream management activities with landowners in Lindsay Creek.	**Potential Lead:** CDFG **Others:** Landowners, Watershed Groups	Interim/ Continual	*MR-HU-10*
	C	MR-HU-11	Develop programs to control exotic and invasive vegetation, especially reed canary grass, where necessary to protect coho salmon habitat.	**Potential Lead:** CDFG, UCCE **Others:** Redwood Science Lab, HSU	Interim	*MR-HU-11*
	C	MR-HU-12	Evaluate the impact of the Mad River Hatchery steelhead production on coho salmon.	**Potential Lead:** CDFG **Others:** USFWS	Long-term	*MR-HU-12*
	E	MR-HU-13	Encourage Federal, State, and county agencies and private landowners to reduce impacts to coho salmon habitat from public and private road systems.	**Potential Lead:** CDFG **Others:** USFS, CDF, Caltrans, County, Landowners	Interim	*MR-HU-13*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
MAD RIVER HU (continued)						
	D	MR-HU-14	Continue road and/or watershed assessments to identify and prioritize sources and risks of road-related sediment delivery to watercourses.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim/ Ongoing	*MR-HU-14*
	D	MR-HU-15	Reduce road densities where necessary and appropriate.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim	*MR-HU-15*
	D	MR-HU-16	Decrease potential for stream flow to become diverted at road crossings during high flow events, resulting in flow along the road that returns to the channel at undesirable locations.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim/ Ongoing	*MR-HU-16*
	D	MR-HU-17	Stabilize slopes along roadways to minimize or prevent erosion and to minimize future risk of eroded material entering streams.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim	*MR-HU-17*
	D	MR-HU-18	Minimize alteration of natural hill slope drainage patterns to decrease erosion and sediment input into the streams.	**Potential Lead:** Counties, USFS **Others:** CDFG, CDF, Caltrans, Landowners	Interim	*MR-HU-18*
	D	MR-HU-19	Encourage funding authorities to allocate adequate budgets to Federal, State, and local agencies and private landowners for road maintenance activities, capital project activities, and dedicated funding to pay for fish passage projects.	**Potential Lead:** CDFG, Counties, USFS, NOAA Fisheries **Others:** CDF, Caltrans, Landowners	Interim	*MR-HU-19*
	D	MR-HU-20	Encourage CHERT to incorporate coho salmon friendly measures.	**Potential Lead:** CDFG **Others:** CHERT, NOAA Fisheries, USACE	Interim/ Continual	*MR-HU-20*
Blue Lake HSA						
4	C	MR-BL-01	Develop a watershed restoration plan in conjunction with landowners, municipalities, and Tribal interests.	**Potential Lead:** Watershed Groups **Others:** Landowners, County, Tribes, Municipalities, CDFG	Long-term	*MR-BL-01*
4	C	MR-BL-02	Implement the watershed restoration plan.	**Potential Lead:** Watershed Groups **Others:** Landowners, County, Tribes, Municipalities, CDFG	Long-term	*MR-BL-01*
4	C	MR-BL-03	Agencies and land managers should work with qualified Watershed Groups to develop and support well-informed watershed communities with regards to coho salmon habitat issues.	**Potential Lead:** Watershed Groups	Long-term	*MR-BL-02*
4	C	MR-BL-04	Develop and implement an outreach program regarding activities that protect and/or restore coho salmon habitat, and the public's responsibility for protecting and restoring coho salmon habitat.	**Potential Lead:** Watershed Groups, CDFG	Long-term	*MR-BL-02*
Butler Valley HSA						
5	D	MR-BV-01	Establish adequate streamside buffer areas to promote appropriate water temperatures for coho salmon.	**Potential Lead:** Humboldt County, Landowners CDF, CDFG, NOAA Fisheries	Long-term	*MR-BV-01*
5	C	MR-BV-02	Protect streamside vegetation from unnecessary vegetation removal.	**Potential Lead:** Humboldt County, Landowners CDF, CDFG, NOAA Fisheries	Long-term	*MR-BV-01b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Butler Valley HSA (continued)						
5	C	MR-BV-03	Maintain large conifers within the riparian zone.	**Potential Lead:** Humboldt County, Landowners, **Others:** CDF, CDFG, NOAA Fisheries	Interim/ Continual	*MR-BV-01c*
5	E	MR-BV-04	Assess and prioritize the road-related sources of input of fine and coarse sediments into streams.	**Potential Lead:** Humboldt County, Landowners, CDFG, NOAA Fisheries, CDF	Interim	*MR-BV-02*
5	D	MR-BV-05	Address priority sources of fine and coarse sediments into streams.	**Potential Lead:** Humboldt County, Landowners **Others:** CDF, CDFG, NOAA Fisheries	Long-term	*MR-BV-02b*
5	C	MR-BV-06	Where appropriate, reduce management activities within unstable areas.	**Potential Lead:** Humboldt County, Landowners **Others:** CDF, CDFG, NOAA Fisheries	Interim/ Continual	*MR-BV-02c*
5	E	MR-BV-07	Identify and prioritize culverts that are passage barriers to suitable habitat for juvenile or adult coho salmon.	**Potential Lead:** Humboldt County, Caltrans, Landowners **Others:** CDF, CDFG, NOAA Fisheries	Interim	*MR-BV-03*
5	D	MR-BV-08	Upgrade prioritized culverts that to allow access to suitable habitat for juvenile or adult coho salmon.	**Potential Lead:** Humboldt County, Caltrans, Landowners **Others:** CDF, CDFG, NOAA Fisheries	Long-term	*MR-BV-03b*
REDWOOD CREEK HU						
	E	RC-HU-01	Work with Redwood National and State Parks (RNSP), private landowners, and interested parties to improve habitat conditions of the estuary while protecting Highway 101 and the Town of Orick. These plans should aim toward restoring the historic form and function of the estuary/lagoon and slough channels, riparian forests, and adjacent wetlands. This includes providing for: a. Unconfined channels by modifying levees; b. Restoration of riparian vegetation, tree cover, wetlands, and off-channel and rearing habitat; c. Increased sediment transport, pool depth, and LWD; d. Restoring natural drainage patterns from adjacent wetlands; and e. Improving the conditions of sloughs and tributaries to the estuary (Strawberry, Dorrance, and Sand Cache creeks).	**Potential Lead:** RNSP, USACE, County **Others:** RNSP, CDF, NOAA Fisheries, Landowners, County, CCC, Watershed Groups, Coastal Conservancy, CDFG	Interim	*RC-HU-01*
	E	RC-HU-02	Modify levee requirements to maintain habitat for coho salmon while maintaining flood control, including modifying maintenance manuals to be consistent with habitat requirements of coho salmon.	**Potential Lead:** USACE, RNSP, DPR, and Humboldt County Public Works Department, NOAA Fisheries **Others:** CDFG	Long-term	*RC-HU-02*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
REDWOOD CREEK HU (continued)						
	E	RC-HU-03	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Management to promote conifer recruitment; c. Improvement of existing riparian zones through plantings, release of small, suppressed conifers, and where appropriate, control of alders, blackberries, and other competitors; and d. Incentives to landowners, such as funding and technical support.	**Potential Lead:** CDFG **Others:** CCC, CDF, NOAA Fisheries, Landowners, RNSP, County, Watershed Groups	Interim	*RC-HU-03*
	C	RC-HU-04	Complete the assessments of sediment sources and road upgrade assessments.	**Potential Lead:** CDFG, **Others:** NCRWQCB, CDF, Landowners, CCC, RNSP, Watershed Groups, NOAA Fisheries, County	Interim/ Ongoing	*RC-HU-04*
	C	RC-HU-05	Implement the recommendations contained in the assessments for sediment paying particular attention to road assessment and improvement projects; also incorporate measures to preclude sediment delivery to stream systems in near-stream land use planning (especially on slopes greater than 35%).	**Potential Lead:** CDFG **Others:** NCRWQCB, CDF, Landowners, CCC, RNSP, Watershed Groups, NOAA Fisheries, County	Interim/ Ongoing	*RC-HU-04b*
	E	RC-HU-06	Develop measures to protect existing LWD recruitment potential through retention of mature trees in the riparian zone, establishing adequate near stream buffer areas protected from vegetation removal, and increasing the amount of in-channel LWD (Root wads should be left on LWD).	**Potential Lead:** CDFG **Others:** CCC, CDF, NOAA Fisheries, Landowners, RNSP, County, Watershed Groups	Interim	*RC-HU-05*
	D	RC-HU-07	Implement measures to protect existing LWD recruitment potential through retention of mature trees in the riparian zone, establish adequate near stream buffer areas protected from vegetation removal, and increase the amount of in-channel LWD.	**Potential Lead:** CDFG **Others:** CCC, CDF, NOAA Fisheries, Landowners, RNSP, County, Watershed Groups	Interim/ Continual	*RC-HU-05b*
	E	RC-HU-08	Coordinate a long-term, concerted effort between land owners, interested parties, and responsible agencies to determine the current population size and trends of coho salmon of Redwood Creek.	**Potential Lead:** RNSP, CDFG **Others:** NOAA Fisheries, USFWS, Landowners	Interim/ Ongoing	*RC-HU-06*
	E	MR-HU-09	Conduct pre-project geological surveys where needed.	**Potential Lead:** NCRWQCB, CDF,CDFG, County, CGS	Interim/ Continual	*MR-HU-04*
	C	RC-HU-10	Continue to review and improve THPs with regard to protection of coho salmon and their habitat.	**Potential Lead:** CDFG	Ongoing/ Continual	*RC-HU-08*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
TRINIDAD HU						
	E	TP-HU-01	Assess and prioritize sediment sources, particularly roads that have not been assessed, and acknowledge progress that has been made in addressing sediment sources.	**Potential Lead:** County, Landowners, Caltrans **Others:** CDF, CDFG, CCC, NCRWQCB, Watershed Groups, NOAA Fisheries	Interim	*TP-HU-01*
	D	TP-HU-02	Prioritize and treat sediment sources.	**Potential Lead:** County, Landowners, Caltrans **Others:** CDF, CDFG, CCC, NCRWQCB, Watershed Groups, NOAA Fisheries	Interim	*TP-HU-01b*
	D	TP-HU-3	Work with Humboldt County and landowners to maintain flood plain capacity and prevent future encroachment on the flood plain.	**Potential Lead:** County, Army Corps **Others:** Caltrans, CDFG, NOAA Fisheries, Landowners	Long-term	*TP-HU-02*
Big Lagoon HSA						
4	E	TP-BL-01	Continue to work with private landowners to develop riparian buffers with an adequate conifer component and canopy closure to reduce temperatures, increase LWD, and provide sediment filtration.	**Potential Lead:** CDFG **Others:** Landowners, CDF, County, CCC, Watershed Groups, NOAA Fisheries	Interim/ Ongoing	*TP-BL-01*
4	C	TP-BL-02	Develop a plan to restore the historic flood plain on Mill Creek (a.k.a. Pitcher Creek), in cooperation with landowners.	**Potential Lead:** CDFG **Others:** Landowners	Long-term	*TP-BL-02*
4	C	TP-BL-03	Implement the plan to restore the historic flood plain on Mill Creek (a.k.a. Pitcher Creek), in cooperation with landowners.	**Potential Lead:** CDFG **Others:** Landowners	Long-term	*TP-BL-02b*
Little River HSA						
5	E	TP-LR-01	Develop a plan to improve the functioning of the lower river and estuary by re-establishing a functional flood plain and a more complex instream habitat and riparian zone. The plan should include the release of conifers, exclusion fencing where necessary, and riparian planting.	**Potential Lead:** Landowners, Watershed Groups **Others:** CDFG, CCC, NOAA Fisheries, County	Interim	*TP-LR-01*
5	D	TP-LR-02	Implement the plan to improve the functioning of the lower river and estuary.	**Potential Lead:** Landowners, Watershed Groups **Others:** CDFG, CCC, NOAA Fisheries, County	Interim	*TP-LR-01b*
5	C	TP-LR-03	Work with landowners to minimize the impacts of agricultural activities on the estuary.	**Potential Lead:** Watershed Groups, CDFG **Others:** County, NOAA Fisheries	Interim/ Continual	*TP-LR-02*
5	E	TP-LR-04	Appropriate agencies should enforce any violation of law that occurred from construction of cranberry bogs in the Little River; completion of appropriate mitigation should also be enforced.	**Potential Lead:** USACE, CDFG, NOAA Fisheries	Interim	*TP-LR-03*
5	C	TP-LR-05	Work with Humboldt County and landowners to maintain current flood plain capacity and prevent future encroachment on the flood plain.	**Potential Lead:** County, USACE **Others:** CDFG, NOAA Fisheries, Landowners	Long-term	*TP-LR-04*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
EUREKA PLAIN HU – Eureka Plain HSA						
5	D	EP-HU-01	Support implementation of Humboldt County's provisions to protect Stream Management Areas and evaluate their effectiveness; recommend revisions as necessary.	**Potential Lead:** CDFG **Others:** Humboldt County	Interim/ Continual	*EP-HU-02*
5	E	EP-HU-02	Work with agencies and landowners, to re-establish estuarine function.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Coastal Commission, USACE, U.S. Coast Guard, City of Eureka, City of Arcata, Landowners	Interim	*EP-HU-03*
5	C	EP-HU-03	Acknowledge the Arcata City Sewage Treatment Project and encourage similar projects elsewhere where possible.	**Potential Lead:** CDFG **Others:** City of Arcata, California State University	Interim	*EP-HU-04*
5	E	EP-HU-04	Assess and prioritize sources of sediment and implement remediation projects.	**Potential Lead:** CDF **Others:** County, CDFG, Landowners, California Conservation Corps	Interim/ Ongoing	*EP-HU-05*
5	D	EP-HU-05	Implement the prioritized remediation projects for the sources of sediment.	**Potential Lead:** CDF **Others:** County, CDFG, Landowners, California Conservation Corps	Interim/ Ongoing	*EP-HU-05b*
5	E	EP-HU-06	Identify gaps in recent coho salmon habitat survey data.	**Potential Lead:** CDFG	Interim	*EP-HU-06a*
5	E	EP-HU-07	Conduct coho salmon habitat surveys in identified areas lacking data.	**Potential Lead:** CDFG	Interim	*EP-HU-06a*
5	E	EP-HU-08	Identify and prioritize rearing habitat reaches for protection.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim	*EP-HU-06b*
5	D	EP-HU-09	Improve quality and quantity of deep pools and spawning gravels.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim	*EP-HU-06c*
5	D	EP-HU-10	In cooperation with willing landowners, restore and maintain historical tidal areas, backwater channels and salt marsh.	**Potential Lead:** CDFG **Others:** Coastal Commission, Landowners	Interim/ Continual	*EP-HU-06d*
5	D	EP-HU-11	Maintain and protect channel conditions important for all life stages of coho salmon.	**Potential Lead:** CDFG **Others:** Landowners	Interim/ Continual	*EP-HU-06e*
5	D	EP-HU-12	Restore channel conditions important for all life stages of coho salmon.	**Potential Lead:** CDFG **Others:** Landowners	Interim/ Continual	*EP-HU-06e*
5	D	EP-HU-13	Identify and maintain reaches where naturally functioning channel and flood plain conditions exist.	**Potential Lead:** CDFG **Others:** Landowners	Interim/ Continual	*EP-HU-06f*
5	D	EP-HU-14	Restore a functioning flood plain and natural channel processes where practicable.	**Potential Lead:** CDFG **Others:** Landowners	Interim/ Continual	*EP-HU-06f*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
EUREKA PLAIN HU – Eureka Plain HSA (continued)						
5	E	EP-HU-15	Identify impacted reaches where a functioning flood plain could be re-established: a. Prioritize areas that are not naturally functioning for restoration potential; and b. Develop site specific project objectives to protect and restore naturally functioning channel and flood plain conditions where feasible.	**Potential Lead:** CDFG **Others:** Landowners	Interim/ Continual	*EP-HU-06g*
5	E	EP-HU-16	Conduct hydrologic analysis for all Humboldt Bay tributaries.	**Potential Lead:** CDFG **Others:** NOAA Fisheries	Interim	*EP-HU-06h*
5	E	EP-HU-17	Establish access for both adult and juvenile coho salmon to suitable habitat where practicable.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim/ Ongoing	*EP-HU-06i*
5	E	EP-HU-18	Prioritize and upgrade for repair all county culverts already identified as coho salmon passage barriers.	**Potential Lead:** CDFG **Others:** County, Landowners	Interim/ Ongoing	*EP-HU-06j*
5	E	EP-HU-19	Conduct an inventory and prioritize for treatment migration barriers other than county culverts (private roads, tide gates), including Rocky and Washington gulches.	**Potential Lead:** CDFG **Others:** Landowners, Coastal Commission, NOAA Fisheries	Interim	*EP-HU-06k*
5	D	EP-HU-20	Conduct LWD surveys and identify locations of existing LWD structures and areas for potential recruitment and/or placement of LWD structures.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim/ Continual	*EP-HU-06m*
5	D	EP-HU-21	Protect and maintain habitat associated with instream LWD.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim/ Continual	*EP-HU-06m*
5	D	EP-HU-22	Increase the amount of LWD in rearing reaches.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim/ Continual	*EP-HU-06m*
5	D	EP-HU-23	Establish adequate streamside buffer areas that are protected from vegetation removal ensuring retention of mature trees in the riparian corridor	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim/ Continual	*EP-HU-06m*
5	D	EP-HU-24	Increase canopy by planting appropriate conifer and hardwood species composition along the stream where the canopy is not at acceptable levels. In many cases, planting will need to be coordinated to follow bank stabilization or upslope erosion control projects.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim/ Continual	*EP-HU-06m*
5	D	EP-HU-25	Map areas where large conifer riparian habitat exists for future recruitment.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim/ Continual	*EP-HU-06m*
5	D	EP-HU-26	Maintain functional riparian habitat.	**Potential Lead:** CDFG **Others:** CDF, County, Landowners	Interim/ Ongoing	*EP-HU-06n*
5	D	EP-HU-27	Conduct assessment of historic and present riparian conditions	**Potential Lead:** CDFG **Others:** CDF, County, Landowners	Interim/ Ongoing	*EP-HU-06n*
5	E	EP-HU-28	Develop site specific riparian restoration plans to: a. Restore degraded riparian habitat; and b. Establish a monitoring program to evaluate success of restoration projects.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim	*EP-HU-06*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
EUREKA PLAIN HU – Eureka Plain HSA (continued)						
5	D	EP-HU-29	Prioritize and implement the site specific riparian restoration plans.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim	*EP-HU-06o*
5	D	EP-HU-30	Establish a monitoring program to identify turbidity and suspended sediment levels outside the beneficial range for all life stages of coho salmon.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim/ Continual	*EP-HU-06p*
5	E	EP-HU-31	Reduce input of fine sediments into stream systems by: a. Conducting comprehensive road inventory; b. Carry out priority road related sediment reduction; c. Implement priorities for road-related sediment reduction projects identified in existing road inventories projects; d. Identify areas still needing road/erosion inventories; e. Identify on-going road maintenance needs; f. Identify landslide hazard areas such as steep unstable slopes, stream crossings,(other than those identified in the road inventory) and inner gorge area; g. Implement pre-project geological surveys and/or reducing management activities within these areas, especially road construction, grading, intensive timber harvests; and h. Identify and treat bank erosion sites.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim	*EP-HU-06q*
5	D	EP-HU-32	Establish temperature parameters beneficial to coho salmon during all life stages by: a. Evaluating temperature ranges in all tributaries; b. Review of existing temperature data; c. Identifying data gaps and establish a watershed-wide temperature monitoring program; and d. Determining if temperatures are a concern for coho salmon.	**Potential Lead:** CDFG **Others:** Landowners	Interim	*EP-HU-06r*
5	D	EP-HU-33	Prevent point and non-point source pollution (e.g., septic systems, livestock, household chemicals, petrol-chemicals, herbicides, fertilizer and other pollutants); identify priorities for pollution reduction and strategy to be pursued.	**Potential Lead:** RWCQB **Others:** Landowners, CDFG	Interim/ Continual	*EP-HU-06t*
5	E	EP-HU-34	Determine and maintain adequate flows for migrating juvenile and adult coho salmon by developing an inventory of current water rights, and conduct a field survey of water withdrawals in main-stem and tributaries.	**Potential Lead:** CDFG **Others:** SWRCB	Interim	*EP-HU-06v*
5	C	EP-HU-35	Maintain open space lands (e.g., agriculture, forestland) for water retention and limiting addition of impervious surfaces in the watershed.	**Potential Lead:** County **Others:** Coastal Commission, Landowners, CDFG	Interim/ Ongoing	*EP-HU-06w*
5	C	EP-HU-36	Identify socioeconomic impacts of watershed management and future possible solutions.	**Potential Lead:** County **Others:** Coastal Commission, CDF, Landowners	Interim	*EP-HU-06x*
5	D	EP-HU-37	Facilitate and sustain a well informed watershed community with regards to coho salmon habitat issues.	**Potential Lead:** RCDs, Watershed Groups **Others:** CDFG, NOAA Fisheries	Interim/ Continual	*EP-HU-06y*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
EUREKA PLAIN HU – Eureka Plain HSA (continued)						
5	C	EP-HU-38	Ensure that there are adequate incentives for landowners who choose to protect and/or restore watershed processes.	**Potential Lead:** CDFG **Others:** NOAA Fisheries	Interim/ Continual	*EP-HU-06z*
5	C	EP-HU-39	Continue urban stream day-lighting efforts in Arcata and Eureka to reconnect and restore coho salmon habitat.	**Potential Lead:** City of Arcata, City of Eureka **Others:** NOAA Fisheries, CDFG	Interim/ Ongoing	*EP-HU-28*
EEL RIVER HU						
	C	ER-HU-01	Support the existing watershed cooperative working groups and the formation of new groups where necessary.	**Potential Lead:** CDFG **Others:** RCDs, Watershed Groups	Interim/ Ongoing	*ER-HU-01*
	E	ER-HU-02	Acknowledge that the pike minnow is a problem and support efforts to control it.	**Potential Lead:** CDFG, NOAA Fisheries	Interim/ Ongoing	*ER-HU-02*
	D	ER-HU-03	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Improvement of existing riparian zones through plantings, release of conifers, and manage alders, blackberries, and other competitors; and c. Bank stabilization and fencing projects.	**Potential Lead:** CDFG **Others:** California Conservation Corps, CDF, USFS, DPR, Landowners	Ongoing	*ER-HU-03*
	E	ER-HU-04	Recommend that the SWRCB make a high priority the identification of unauthorized diversions and enforcement actions to stop them.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners	Interim/ Continual	*ER-HU-05*
	D	ER-HU-05	Encourage CHERT to incorporate coho salmon-friendly measures.	**Potential Lead:** CDFG **Others:** CHERT, NOAA Fisheries, USACE	Interim/ Continual	*ER-HU-07*
	E	ER-HU-06	Develop a plan to restore an adequate migration corridor in the mainstem Eel River.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, State Lands Commission	Interim	*ER-HU-08*
	D	ER-HU-07	Implement the plan to restore an adequate migration corridor in the mainstem Eel River.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, State Lands Commission	Interim	*ER-HU-08b*
	E	ER-HU-08	Assess and prioritize sediment sources, including roads.	**Potential Lead:** CDFG **Others:** Landowners, Watershed Groups, RCD, NOAA Fisheries	Interim/ Ongoing	*ER-HU-09*
	D	ER-HU-09	Treat prioritized sediment sources, including roads.	**Potential Lead:** CDFG **Others:** Landowners, Watershed Groups, RCD, NOAA Fisheries	Interim/ Ongoing	*ER-HU-10*
	C	ER-HU-10	Identify coho salmon rearing impacts from Van Arsdale out-planting site.	**Potential Lead:** CDFG	Interim/ Ongoing	*ER-HU-11*
	D	ER-HU-11	In cooperation with agencies and landowners, plan to re-establish estuarine function, restore and maintain historical tidal areas, backwater channels and salt marsh.	**Potential Lead:** CDFG **Others:** Coastal Commission, Landowners	Interim/ Continual	*ER-HU-12*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
EEL RIVER HU (continued)						
	E	ER-HU-12	Request that Caltrans assess, prioritize, and treat culverts that are barriers to passage on Highway 101. Identify barriers to passage and prioritize them for removal, through collaborative efforts with other agencies.	**Potential Lead:** Caltrans **Others:** County, Landowners, California Conservation Corps, CDFG	Interim	*ER-HU-13*
Ferndale HSA						
3	E	ER-FE-01	Develop the Salt River Local Implementation Plan to incorporate coho salmon-friendly measures, in cooperation with the agencies.	**Potential Lead:** USACE, CDFG **Others:** RCD, Watershed Group, City of Ferndale NOAA Fisheries, Humboldt County, NRCS	Interim	*ER-FE-01*
3	E	ER-FE-02	Complete the assessment and prioritization of the sediment sources in the watershed.	**Potential Lead:** USACE, CDFG **Others:** RCD, Watershed Group, City of Ferndale NOAA Fisheries, Humboldt County, NRCS	Interim	*ER-FE-01b*
3	D	ER-FE-03	Treat the sediment sources in the watershed.	**Potential Lead:** USACE, CDFG **Others:** RCD, Watershed Group, City of Ferndale NOAA Fisheries, Humboldt County, NRCS	Interim	*ER-FE-01c*
3	C	ER-FE -04	Acquire conservation easements as an incentive for landowners to conserve and enhance habitat.	**Potential Lead:** CDFG **Others:** Land Conservancies, Landowners	Interim/ Ongoing	*ER-FE -02*
Van Duzen River HSA						
3	E	ER-VD-01	Develop a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage. The plan should a. Evaluate management techniques; b. Implement the identified strategy; and c. Address permitting complexity for identified implementation measures.	**Potential Lead:** CDFG, NOAA Fisheries, Landowners	Long-term	*ER-VD-01*
3	D	ER-VD-02	Implement the plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho salmon passage.	**Potential Lead:** CDFG, NOAA Fisheries, Landowners	Long-term	*ER-VD-02*
3	D	ER-VD-03	Recommend that CHERT incorporate coho salmon-friendly measures.	**Potential Lead:** CDFG **Others:** CHERT, NOAA Fisheries, USACE	Interim/ Continual	*ER-VD-03*
3	D	ER-VD-04	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; and b. Improvement of existing riparian zones through plantings, release and recruitment of conifers, and control of alders, blackberries, and other competitors.	**Potential Lead:** USFS **Others:** NOAA Fisheries, CDFG, CDF, Landowners	Interim/ Ongoing	*ER-VD-04*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Van Duzen River HSA (continued)						
3	E	ER-VD-05	Assess and prioritize sediment sources including roads.	**Potential Lead:** CDFG **Others:** Landowners, Watershed Groups, RCD, NOAA Fisheries	Interim/ Ongoing	*ER-VD-05*
3	D	ER-VD-06	Treat sediment sources including roads.	**Potential Lead:** CDFG **Others:** Landowners, Watershed Groups, RCD, NOAA Fisheries	Interim/ Ongoing	*ER-VD-06*
Scotia HSA						
3	C	ER-SC-01	Evaluate the benefits to coho salmon of removing the barrier on Bridge Creek.	**Potential Lead:** CDFG	Interim	*ER-SC-02*
South Fork Eel River HA						
	C	ER-SF-01	Explore opportunities to acquire conservation easements with conditions that provide benefits to coho salmon.	**Potential Lead:** CDFG	Interim/ Ongoing	*ER-SF-01*
Weott HSA						
5	C	ER-WE-01	Complete storm proofing of the Bull Creek watershed.	**Potential Lead:** DPR **Others:** CDFG	Interim/ Ongoing	*ER-WE-01*
5	C	ER-WE-02	Continue to implement the planting of trees and other habitat enhancement as necessary in the Bull and Salmon creek watersheds.	**Potential Lead:** DPR, Landowners **Others:** CDFG	Interim/ Ongoing	*ER-WE-02*
5	E	ER-WE-03	Assess and prioritize culverts that are barriers to coho salmon passage along Avenue of the Giants through collaborative efforts with other agencies.	**Potential Lead:** Caltrans **Others:** CDFG, County, Landowners, California Conservation Corps	Interim	*ER-WE-03*
5	D	ER-WE-04	Treat the prioritized culverts that are barriers to coho salmon passage along Avenue of the Giants, through collaborative efforts with other agencies.	**Potential Lead:** Caltrans **Others:** CDFG, County, Landowners, California Conservation Corps	Interim	*ER-WE-03b*
Benbow HSA						
5	D	ER-BE-01	Support a watershed assessment.	**Potential Lead:** CDFG **Others:** CDF, Counties, Landowners, NOAA Fisheries	Interim	*ER-BE-01*
5	C	ER-BE-02	Request that the CDF monitor Non-industrial Timber Management Plans to ensure that they are properly implemented.	**Potential Lead:** CDFG **Others:** CDF, Landowners	Interim	*ER-BE-04*
Laytonville HSA						
5	D	ER-LA-01	Continue watershed restoration efforts, including measures to reduce temperatures in Ten-mile Creek.	**Potential Lead:** CDFG **Others:** Watershed Groups, Landowners, California Conservation Corps	Interim/ Ongoing	*ER-LA-01*
5	E	ER-LA-02	Prioritize culverts on county roads that are coho salmon barriers.	**Potential Lead:** County **Others:** CDFG	Interim/ Ongoing	*ER-LA-02*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Laytonville HSA (continued)						
5	D	ER-LA-03	Treat culverts on county roads that are coho salmon barriers.	**Potential Lead:** County **Others:** CDFG	Interim/ Ongoing	*ER-LA-02b*
5	E	ER-LA-04	Work with the county to coordinate with landowners on the removal of coho salmon barriers on private property.	**Potential Lead:** CDFG **Others:** County, CDF, Landowners	Interim/ Ongoing	*ER-LA-03*
5	C	ER-LA-05	Support efforts by the county sheriff to enforce laws against illegal dumping and the Department of Health to clean up dumped materials.	**Potential Lead:** CDFG **Others:** County Sheriff, Department of Health	Interim/ Ongoing	*ER-LA-04*
5	D	ER-LA-06	Recommend that cities, counties, and Caltrans adopt maintenance manuals that protect coho salmon habitat (e.g., standards for side-casting of spoils and identification of spoils disposal sites).	**Potential Lead:** CDFG **Others:** Cities, Counties, Caltrans	Interim/ Ongoing	*ER-LA-06*
5	E	ER-LA-07	Minimize and reduce the effects of water diversions by addressing the season of diversion, installing off-stream reservoirs, requiring bypass flows protective of coho and natural hydrograph, and avoiding adverse impacts caused by water diversion.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners	Interim	*ER-LA-07*
Outlet Creek HSA						
5	E	ER-OC-01	Prepare a technical assessment and prioritization of the Outlet Creek watershed, developing recommendations to restore long-term function.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, RCD	Interim/ Ongoing	*ER-OC-01*
5	D	ER-OC-02	Work with the City of Willits in coho salmon recovery planning to: a. Assess, prioritize, and treat barriers to passage; b. Address water quality issues; c. Modify facility maintenance practices as necessary; and d. Evaluate land use planning and revise plans as appropriate.	**Potential Lead:** CDFG **Others:** City of Willits	Interim/ Ongoing	*ER-OC-02*
5	D	ER-OC-03	Upgrade the NCRWQCB basin plan to benefit coho salmon.	**Potential Lead:** NCRWQCB **Others:** CDFG	Interim	*ER-OC-03*
CAPE MENDOCINO HU						
	E	CM-HU-01	Supplement on-going efforts to provide short-term and long-term benefits to coho salmon by restoring LWD and shade through: a. LWD placement; b. Improvement of existing riparian zones through plantings, release of conifers, and manage of alders, blackberries, and other competitors; and c. Bank stabilization and fencing projects.	**Potential Lead:** CDFG **Others:** California Conservation Corps, CDF, USFS, DPR, Landowners	Ongoing	*CM-HU-01*
	E	CM-HU-02	Assessment and prioritization of sources of sediment including roads.	**Potential Lead:** CDFG, **Others:** CDF, Landowners, CCC, NCRWQCB, County, Watershed Groups, NOAA Fisheries	Interim/ Ongoing	*CM-HU-02*
	D	CM-HU-03	Treat sources of sediment, including roads.	**Potential Lead:** CDFG, **Others:** CDF, Landowners, CCC, NCRWQCB, County, Watershed Groups, NOAA Fisheries	Interim/ Ongoing	*CM-HU-03*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
CAPE MENDOCINO HU (continued)						
	E	CM-HU-04	Investigate feasibility of restoring estuarine function to maximize habitat for coho salmon.	**Potential Lead:** CDFG **Others:** Coastal Conservancy, NOAA Fisheries, Landowners	Interim/ Ongoing	*CM-HU-04*
	E	CM-HU-05	Prioritize and upgrade all county culverts identified as passage barriers.	**Potential Lead:** CDFG, County **Others:** Landowners	Interim/ Ongoing	*CM-HU-05*
	E	CM-HU-06	Conduct an inventory and prioritize for treatment coho salmon barriers other than county culverts.	**Potential Lead:** CDFG **Others:** Landowners, Coastal Commission, NOAA Fisheries	Interim	*CM-HU-06*
Mattole River HSA – Southern Subbasin						
5	C	CM-MS-01	Promote outreach and education of water and conservation practices to improve stream surface flows and coho salmon habitat.	**Potential Lead:** Watershed Groups, Counties **Others:** CDFG, Landowners, NCRWQCB	Long-term	*CM-MS-01*
5	C	CM-MS-02	Protect the high quality habitat found in the Mattole River Headwaters and historic coho streams.	**Potential Lead:** CDFG **Others:** Landowners, CDF	Interim/ Continual	*CM-MS-02a*
5	C	CM-MS-03	Protect high quality habitat found in the South Fork of Vanauken, Mill, Stanley, Thompson, Yew, and Lost Man creeks, recognizing current and continued land management practices by private landowners.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Watershed Groups	Interim/ Continual	*CM-MS-02b*
5	C	CM-MS-04	Promote a cooperative effort to establish monitoring stations at appropriate locations to monitor in-channel sediment (or turbidity) both in the lower basin and in the lower reaches of major tributaries.	**Potential Lead:** NCRWQCB, CDFG **Others:** CDF, Landowners, Watershed Groups, NOAA Fisheries, Counties	Long-term	*CM-MS-03*
5	C	CM-MS-05	Assess and prioritize sources of excess sediment.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Watershed Groups	Interim/ Continual	*CM-MS-04*
5	C	CM-MS-06	Treat sources of excess sediment.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Watershed Groups	Interim/ Continual	*CM-MS-04b*
5	D	CM-MS-07	Study herbicide use with respect to impacts on coho salmon.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Caltrans, County	Interim	*CM-MS-05*
5	D	CM-MS-08	Urge lead agencies to consider herbicide application in CEQA and NEPA review.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Caltrans, County	Interim	*CM-MS-05b*
5	D	CM-MS-09	Protect water quality from the ground application of pesticides following the NCRWQCB suggested BMPs.	**Potential Lead:** NCRWQCB **Others:** CDF, Watershed Groups, Landowners, Counties	Interim	*CM-MS-06*
5	D	CM-MS-10	Work with University of California Cooperative Extension (UCCE) specialists to monitor summer water and air temperatures and flow in cooperation with landowners using Department-accepted protocols.	**Potential Lead:** CDFG **Others:** UCCE, Landowners, Watershed Groups	Interim/ Ongoing	*CM-MS-07*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Mattole River HSA – Southern Subbasin (continued)						
5	D	CM-MS-11	Continue and expand on-going temperature monitoring efforts.	**Potential Lead:** CDFG **Others:** UCCE, Landowners, Watershed Groups	Interim/ Ongoing	*CM-MS-07b*
5	C	CM-MS-12	Request that Mendocino County evaluate new and existing for their impacts to coho salmon habitat.	**Potential Lead:** CDFG **Others:** Mendocino County, Landowners	Interim	*CM-MS-08*
5	C	CM-MS-13	Promote cluster development away from streams to protect coho salmon.	**Potential Lead:** Watershed Groups, Counties **Others:** NCRWQCB	Long-term	*CM-MS-09*
5	C	CM-MS-14	Provide incentives to landowners to protect coho salmon habitat and reduce water use.	**Potential Lead:** Watershed Groups, Counties, NCRWQCB, CDFG	Long-term	*CM-MS-10*
5	C	CM-MS-15	Develop educational materials for landowners explaining how they can protect coho salmon.	**Potential Lead:** Watershed Groups **Others:** CDFG, Counties, NCRWQCB, NOAA Fisheries	Long-term	*CM-MS-11*
5	E	CM-MS-16	Begin the process of declaring the southern subbasin to be fully appropriated in the spring and summer.	**Potential Lead:** SWRCB **Others:** DWR, CDFG	Interim	*CM-MS-12*
5	D	CM-MS-17	Request that the SWRCB make the enforcement of water rights in this watershed a priority.	**Potential Lead:** CDFG **Others:** SWRCB	Interim	*CM-MS-13*
5	D	CM-MS-18	Pursue opportunities to acquire fee title, easement, and water rights from willing sellers.	**Potential Lead:** CDFG **Others:** Landowners	Interim/ Continual	*CM-MS-14*
5	C	CM-MS-19	Plant trees appropriate to the location in riparian areas where conditions are suitable.	**Potential Lead:** Watershed Groups, Landowners, County **Others:** CDFG, CCC, NOAA Fisheries, CDF	Long-term	*CM-MS-15*
Mattole River HSA – Western Subbasin						
5	D	CM-MW-01	Assess current levels of LWD in the western subbasin, and determine amount necessary for improved flushing, pooling and habitat conditions for coho salmon.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Watershed Groups	Interim	*CM-MW-01*
5	D	CM-MW-02	Facilitate immediate placement of LWD in areas where lacking.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Watershed Groups	Interim	*CM-MW-01b*
5	D	CM-MW-03	Develop and implement a plan for long-term recruitment of LWD.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Watershed Groups	Interim	*CM-MW-01c*
5	D	CM-MW-04	Cooperate in establishing monitoring stations at appropriate locations (e.g., Squaw, Honeydew, and Bear creeks) to monitor in-channel sediment and track aggraded reaches in the lower basin and in the lower reaches of major tributaries.	**Potential Lead:** CDFG **Others:** Landowners, CDF, Watershed Groups	Interim/ Ongoing	*CM-MW-02*
5	C	CM-MW-05	Support the assessment, prioritization, and treatment of sources of excess sediment.	**Potential Lead:** CDFG, NOAA Fisheries Landowners, CDF, Watershed Groups	Interim/ Continual	*CM-MW-03*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Mattole River HSA – Western Subbasin (continued)						
5	C	CM-MW-06	Monitor summer water and air temperatures using Department-accepted protocols. Continue temperature monitoring efforts in Stansberry, Mill (RM 2.8) Clear, Squaw, Woods, Honeydew Bear, North Fork Bear, South Fork Bear, Little Finley, Big Finley, and Nooning creeks, and expand efforts into other subbasin tributaries.	**Potential Lead:** Watershed Groups, CDFG **Others:** NCRWQCB	Interim/ Ongoing	*CM-MW-04*
5	C	CM-MW-07	Develop a plan to manage near-stream buffers to reduce the effects of solar radiation and to moderate air temperatures.	**Potential Lead:** CDFG **Others:** Landowners, RWQCB, Watershed Groups	Interim	*CM-MW-05*
5	C	CM-MW-08	Implement the plan to manage near-stream buffers to reduce the effects of solar radiation and to moderate air temperatures.	**Potential Lead:** CDFG **Others:** Landowners, RWQCB, Watershed Groups	Interim	*CM-MW-05b*
5	C	CM-MW-09	Assess and prioritize the actions needed for restoration and enhancement of riparian habitat.	**Potential Lead:** CDFG, Watershed Groups **Others:** Landowners, NOAA Fisheries	Interim	*CM-MW-06*
5	C	CM-MW-10	Implement the prioritized actions needed for restoration and enhancement of riparian habitat.	**Potential Lead:** CDFG, Watershed Groups **Others:** Landowners, NOAA Fisheries	Interim	*CM-MW-06b*
5	C	CM-MW-11	Recognize and support on-going efforts of landowners, BLM, and others to improve habitat conditions for coho salmon.	**Potential Lead:** Watershed Groups **Others:** CDFG, NOAA Fisheries	Interim/ Ongoing	*CM-MW-07*
5	D	CM-MW-12	Work with the SWRCB to expedite the processing of projects, including 1600 agreements, that are intended to reduce summer diversions.	**Potential Lead:** CDFG, NCRWQCB	Interim	*CM-MW-08*
5	C	CM-MW-13	Develop a public education program to raise awareness of the habitat needs of coho salmon and how the community, especially landowners, can improve coho salmon habitat.	**Potential Lead:** Watershed Groups **Others:** Landowners, CDFG, CCC, NOAA Fisheries, County	Interim/ Continual	*CM-MW-09*
5	D	CM-MW-14	Develop incentives for landowners and communities to reduce summer water withdrawals and enhance habitat.	**Potential Lead:** Watershed Groups **Others:** NCRWQCB, Counties, NOAA Fisheries	Interim	*CM-MW-10*
5	C	CM-MW-15	Develop programs to support continued land-use patterns and discourage conversions and subdivisions.	**Potential Lead:** Counties, NCRWQCB **Others:** CDFG, NOAA Fisheries	Long-term	*CM-MW-11*
5	E	CM-MW-16	Support a plan for mapping unstable soils and use of the information to guide land-use decisions, road design, and other activities that can increase erosion.	**Potential Lead:** NCRWQCB **Others:** CDF, CDFG, CGS, Watershed Groups, NOAA Fisheries	Interim	*CM-MW-12*
Mattole River HSA – Northern Subbasin						
5	C	CM-MN-01	Use tree planting and other vegetation management to improve canopy cover, especially in Conklin, Oil, Green Ridge, Devils, and Rattlesnake creeks.	**Potential Lead:** Watershed Groups **Others:** Landowners, CDFG,CCC, NOAA Fisheries, County	Long-term	*CM-MN-01*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Mattole River HSA – Northern Subbasin (continued)						
5	C	CM-MN-02	Through cooperative efforts, treat stream-bank erosion sites to reduce sediment yield, especially in Sulphur, Conklin, and Oil creeks and the lower reaches of the North Fork Mattole River.	**Potential Lead:** Watershed Groups **Others:** Landowners, NCRWQCB, CDFG, CDF	Long-term	*CM-MN-02*
5	D	CM-MN-03	Due to high incidence of unstable slopes in the northern subbasin, base future permitting of sub-division development proposals on existing county-imposed forty-acre minimum parcel sub-division ordinances.	**Potential Lead:** County **Others:** NCRWQCB	Interim	*CM-MN-03*
Mattole River HSA – Eastern Subbasin						
5	E	CM-ME-01	Continue to conduct road and erosion assessments, especially in Middle, Westlund, Gilham, Sholes, Blue Slide, and Fire creeks.	**Potential Lead:** CDFG **Others:** CDF, Landowners, CCC, NCRWQCB, County, Watershed Groups, NOAA Fisheries	Interim/ Ongoing	*CM-ME-01*
5	D	CM-ME-02	Continue to implement road and erosion assessments, especially in Middle, Westlund, Gilham, Sholes, Blue Slide, and Fire creeks.	**Potential Lead:** CDFG **Others:** CDF, Landowners, CCC, NCRWQCB, County, Watershed Groups, NOAA Fisheries	Interim/ Ongoing	*CM-ME-01b*
5	C	CM-ME-03	Use tree planting and other vegetation management to improve canopy cover, especially in Dry and Blue Slide creeks.	**Potential Lead:** CDFG **Others:** Landowners, CCC, Watershed Groups, NOAA Fisheries, CDF, County	Long-term	*CM-ME-02*
5	C	CM-ME-04	Through cooperative efforts, reduce sediment yield at stream-bank erosion sites, especially in Middle, Westlund, Gilham, North Fork Fourmile, Sholes, Harrow, Little Grindstone, Grindstone, Eubank, and McKee creeks.	**Potential Lead:** Watershed Groups **Others:** Landowners, NCRWQCB, CDFG, CDF	Long-term	*CM-ME-03*

TABLE 9-3: Implementation schedule for the CCC Coho ESU

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
MENDOCINO COAST HU						
	E	MC-HU-01	Update general plans to include measures to protect coho salmon.	**Potential Lead:** Counties **Others:** Watershed Groups, CDFG, NOAA Fisheries	Long-term	*MC-HU-01*
	C	MC-HU-02	Provide technical and staff support to update general plans to include measures to protect coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, SWRCB, RWQCBs	Long-term	*MU-HU-01b*
	D	MC-HU-03	Where development would adversely affect coho salmon, limit development in the 100-year flood plain.	**Potential Lead:** Counties **Others:** CDFG, NOAA Fisheries, USACE	Interim/ Continual	*MC-HU-03*
	C	MC-HU-04	Recommend Mendocino and Sonoma counties to adopt county grading ordinances.	**Potential Lead:** CDFG	Long-term	*MC-HU-04*
	C	MC-HU-05	Adopt county grading ordinances.	**Potential Lead:** Mendocino and Sonoma Counties	Long-term	*MC-HU-04b*
	C	MC-HU-06	Recommend to Mendocino County to expand the CEQA checklist to include coho salmon.	**Potential Lead:** CDFG	Interim	*MC-HU-05*
	C	MC-HU-07	Include coho salmon in CEQA checklist.	**Potential Lead:** Mendocino County	Interim	*MC-HU-05b*
	E	MC-HU-08	Maintain current LWD, boulders, and other structure-providing features to maintain current stream complexity and pool frequency and depth.	**Potential Lead:** Landowners, Counties **Others:** CDFG, NOAA Fisheries, Watershed Groups	Interim/ Continual	*MC-HU-06*
	D	MC-HU-09	Install LWD, boulders, and other features to increase stream complexity and improve pool frequency and depth.	**Potential Lead:** Landowners, Counties, CDFG, NOAA Fisheries, Watershed Groups	Interim/ Continual	*MC-HU-06b*
	D	MC-HU-10	Restore riparian vegetation and promote conifer recruitment for shade and for LWD recruitment to increase stream complexity.	**Potential Lead:** Landowners, Counties, CDFG, NOAA Fisheries, Watershed Groups	Interim/ Continual	*MC-HU-06c*
	E	MC-HU-11	Assess, prioritize, and treat sediment sources at an HSA level.	**Potential Lead:** CDFG, **Others:** Watershed Groups, Landowners, NOAA Fisheries, NCRWQCB, CDF, Counties. BLM, DPR, RCDs, CCC	Interim/ Ongoing	*MC-HU-07*
	E	MC-HU-12	Determine site-specific recommendations, including incentives, to remedy high temperatures.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Landowners, Watershed Groups, Counties	Long-term	*MC-HU-08*
	D	MC-HU-13	Implement recommendations to remedy high temperature.	**Potential Lead:** Landowners, Counties, Watershed Groups **Others:** CDFG, NOAA Fisheries	Long-term	*MC-HU-08b*
	E	MC-HU-14	Map unstable soils.	**Potential Lead:** Counties, CDFG **Others:** Watershed Groups, Landowners, NOAA Fisheries, NCRWQCB, CDF, BLM, RCDs	Long-term	*MC-HU-09*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
MENDOCINO COAST HU (continued)						
	C	MC-HU-15	Use soil mapping to guide land-use decisions, road design, THPs, and other activities that can promote erosion.	**Potential Lead:** Counties, Counties, CDF, RWQCB, CDFG, NOAA Fisheries, Landowners **Others:** Watershed Groups, BLM, RCDs	Long-term	*MC-HU-09b*
	C	MC-HU-16	Provide education and training on water diversion practices.	**Potential Lead:** SWRCB **Others:** CDFG	Interim/ Continual	*MC-HU-10*
	C	MC-HU-17	Ensure compliance with pertinent regulations on water diversion practices (e.g., FGC §1600 *et seq.*, FPR §916.9, California water rights law).	**Potential Lead:** SWRCB **Others:** CDFG	Interim/ Continual	*MC-HU-10b*
	E	MC-HU-18	Continue to treat existing upslope sediment to improve pool frequency and depth and decrease sediment load.	**Potential Lead:** CDFG **Others:** Watershed Groups, Landowners, NOAA Fisheries, NCRWQCB, CDF, Counties BLM, DPR, RCDs, CCC	Interim/ Ongoing	*MC-HU-11*
	E	MC-HU-19	Avoid or minimize land fragmentation or conversion to more intensive uses to maintain pool frequency and depth.	**Potential Lead:** Counties, CDFG **Others:** Watershed Groups, Landowners, CDFG	Long-term/ Continual	*MC-HU-11b*
	C	MC-HU-20	Cooperate with and provide incentives to Landowners to maintain road and trail closures to be effective against trespass and discourage poaching of coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Counties, Landowners, DPR, Public	Interim/ Continual	*MC-HU-12*
	C	MC-HU-21	Monitor road closures to discourage poaching of coho salmon.	**Potential Lead:** County law enforcement, CHP, CDFG, NOAA Fisheries **Others:** Counties, Landowners, DPR, Watershed Groups, Public	Interim/ Continual	*MC-HU-12b*
	C	MC-HU-22	Repair defective or damaged roads to discourage poaching of coho salmon.	**Potential Lead:** Counties, Landowners, DPR **Others:** CDFG, NOAA Fisheries	Interim/ Continual	*MC-HU-12c*
	D	MC-HU-23	Promote CalTIP, especially with regard to coho salmon spawning sites, to discourage poaching of coho salmon.	**Potential Lead:** County law enforcement, CHP, CDFG, NOAA Fisheries **Others:** Counties, Landowners, DPR, Watershed Groups, Public	Interim/ Continual	*MC-HU-12d*
	E	MC-HU-24	Investigate the desirability and feasibility of beaver reintroductions to promote channel complexity and provide rearing habitat.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Academia	Long-term	*MC-HU-13*
	C	MC-HU-25	If appropriate, reintroduce beavers to promote channel complexity and provide rearing habitat.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Counties, Landowners, Watershed Groups	Long-term/ Continual	*MC-HU-13b*
	C	MC-HU-26	Increase efforts to control alders, blackberries, and other competitors to restore LWD recruitment and shade.	**Potential Lead:** CDFG **Others:** CDF, NOAA Fisheries, Counties, Landowners, DPR, RCDs, CCC, Watershed Groups	Interim/ Ongoing	*MC-HU-14*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
MENDOCINO COAST HU (continued)						
	C	MC-HU-27	Provide incentives to landowners, such as technical support, to increase efforts to restore LWD recruitment and shade.	**Potential Lead:** CDFG **Others:** CDF, NOAA Fisheries, Counties, Landowners, DPR, RCDs, CCC, Watershed Groups	Interim/ Ongoing	*MC-HU-14b*
	D	MC-HU-28	Avoid or minimize increases in water use to maintain or improve instream flows.	**Potential Lead:** SWRCB, Counties, Landowners **Others:** CDFG, NOAA Fisheries, RCDs	Interim/ Continual	*MC-HU-15*
	D	MC-HU-29	Provide incentives to remove or convert direct diversions to off-stream storage to maintain or improve instream flow.	**Potential Lead:** SWRCB, CDFG, NOAA Fisheries, Counties **Others:** RCDs, Watershed Groups	Interim/ Continual	*MC-HU-15b*
	C	MC-HU-30	Restrict the season of diversion to December through March to maintain or improve instream flows.	**Potential Lead:** SWRCB, Counties, Landowners, CDFG **Others:** NOAA Fisheries, RCDs	Interim/ Continual	*MC-HU-15c*
	E	MC-HU-31	Cooperatively evaluate the rate, location, and volume of water drafting for dust control in streams or tributaries and where appropriate, minimize water withdrawals that could impact coho salmon.	**Potential Lead:** CDF, SWRCB, CDFG **Others:** Landowners, NOAA Fisheries, Caltrans, RWQCBs	Long-term/ Continual	*MC-HU-16*
	D	MC-HU-32	When feasible, use alternatives to water as a dust palliative that are consistent with maintaining or improving water quality. Consider existing regulations or other mechanisms when evaluating alternative to water as a dust palliative (including EPA certified compounds) that are consistent with maintaining or improving water quality.	**Potential Lead:** Counties, Landowners	Long-term/ Continual	*MC-HU-16b*
	D	MC-HU-33	Maintain or re-establish geographic distribution of coho salmon by allocating substantial improvement efforts towards identified biological refugia, spawning coho salmon populations, suitable habitat accessible to coho salmon.	**Potential Lead:** CDFG **Others:** CDF, NOAA Fisheries, Counties, Landowners, DPR, RCDs, CCC, Watershed Groups	Long-term	*MC-HU-17*
	C	MC-HU-34	Coordinate with RWQCB to implement water quality monitoring of coho salmon habitat restoration projects (RWQCB 401, USACE 404, NOAA Fisheries, and USFWS permitting).	**Potential Lead:** CDFG **Others:** SWQCB, USACE, NOAA Fisheries, USFWS	Interim (Spring 2003-Spring 2004)	*MC-HU-18*
	C	MC-HU-35	Streamline permitting of coho salmon habitat restoration projects (RWQCB 401, USACE 404, NOAA Fisheries, and USFWS permitting).	**Potential Lead:** CDFG **Others:** SWQCB, USACE, NOAA Fisheries, USFWS	Interim (Spring 2003-Spring 2004)	*MC-HU-18b*
	E	MC-HU-36	Encourage funding authorities to allocate adequate resources to prioritize and upgrade culverts to provide coho salmon passage within the range of coho salmon to pass 100-year flows and the expected debris loads.	**Potential Lead:** Federal, State, Local, and Tribal Government; Ranching, Agricultural, Forestry, Fishing, and Conservation Stakeholders	Interim	*MC-HU-19*
	E	MC-HU-37	Adequately fund prioritization and upgrading of culverts to provide coho salmon passage within the range of coho salmon to pass 100-year flows and the expected debris loads.	**Potential Lead:** CDFG, NOAA Fisheries, Counties	Interim/ Continual	*MC-HU-19b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
MENDOCINO COAST HU (continued)						
	E	MC-HU-38	Identify areas of increased risk of mass wasting and fine sediment loads to decrease sediment from transportation projects and land management activities.	**Potential Lead:** CDFG, NCRWCB, Caltrans, Counties, Landowners **Others:** Watershed Groups, CDF, CCC	Interim/ Continual	*MC-HU-20*
	D	MC-HU-39	Implement appropriate measures or mitigation for mass wasting.	**Potential Lead:** CDFG, NCRWCB, Caltrans, Counties, Landowners **Others:** Watershed Groups, CDF, CCC	Interim/ Continual	*MC-HU-20b*
	E	MC-HU-40	Abandon riparian road systems and/or upgrade roads and skid trails that deliver sediment to adjacent watercourses to decrease fine sediment loads.	**Potential Lead:** Counties, NCRWQB, CDFG **Others:** Landowners, Counties, Caltrans, Watershed Groups, RCDs, CDF, CCC, DPR	Interim/ Continual	*MC-HU-21*
	E	MC-HU-41	Limit winter use of unsurfaced roads and recreational trails by unauthorized and impacting uses to decrease fine sediment loads.	**Potential Lead:** Counties, NCRWQB, CDFG **Others:** Landowners, Counties, Caltrans, Watershed Groups, RCDs, CDF, CCC, DPR	Interim/ Continual	*MC-HU-21b*
	E	MC-HU-42	Minimize the density of road and trail crossings of watercourses.	**Potential Lead:** Counties, Landowners, Caltrans, CDF **Others:** CDFG, NCRWQCB, Watershed Groups, RCDs, CCC, DPR	Interim/ Continual	*MC-HU-21c*
	E	MC-HU-43	Wherever feasible, out-slope roads with rolling dips to decrease fine sediment loads.	**Potential Lead:** Counties, Landowners, Caltrans, CDF **Others:** CDFG, NCRWQCB, Watershed Groups, RCDs, CCC, DPR	Interim/ Continual	*MC-HU-21d*
	E	MC-HU-44	Identify and modify road maintenance activities that generate fine sediment to decrease fine sediment loads.	**Potential Lead:** Counties, Landowners, Caltrans, CDF **Others:** CDFG, NCRWQCB, Watershed Groups, RCDs, CDF, CCC, DPR	Interim/ Continual	*MC-HU-21e*
	C	MC-HU-45	Develop erosion control projects similar to the North Fork Ten Mile River erosion control plan.	**Potential Lead:** CDFG, Trout Unlimited, NCRWQCB, NOAA Fisheries, Mendocino County, Landowners	Interim	*MC-HU-22*
Albion River HSA						
5	C	MC-AR-01	Place instream structures to improve gravel retention and habitat complexity.	**Potential Lead:** CDFG **Others:** Landowners, CCC, CDF, Watershed Groups, Mendocino County, RCDs	Interim/ Continual	*MC-AR-01*
5	C	MC-AR-02	Provide technical assistance and incentives to landowners in developing and implementing sediment reduction plans to meet requirements of the CWA TMDL, making watersheds with an implementation schedule the highest priority.	**Potential Lead:** NCRWQCB **Others:** CDFG, EPA, NOAA Fisheries, RCDs, Mendocino County, CDF, DPR	Interim	*MC-AR-02*
5	C	MC-AR-03	Conduct collaborative evaluations of priorities for treatment of coho salmon passage barriers, such as the Fish Passage Forum.	**Potential Lead:** CDFG, NOAA Fisheries, Caltrans, Mendocino County Landowners, Watershed Groups.	Interim/ Continual	*MC-AR-03*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Albion River HSA (continued)						
5	C	MC-AR-04	Where necessary and with willing landowners, protect riparian vegetation buffer zones through conservation planning, acquisition, and easements.	**Potential Lead:** WCB, CDFG, NOAA Fisheries **Others:** Mendocino County, RCDs, Watershed Groups, Counties	Interim/ Ongoing	*MC-AR-7*
5	C	MC-AR-05	Encourage when necessary and appropriate restricted access to unpaved roads in winter to reduce road degradation and sediment release. Where restricting winter access to unpaved roads is not feasible, encourage measures such as rocking to prevent sediment from reaching coho salmon streams.	**Potential Lead:** CDF, CDFG, USFS, Counties, Landowners	Interim/ Continual	*MC-AR-11*
5	D	MC-AR-06	Conduct comprehensive subbasin erosion control "storm proofing," combined with installation of LWD into streams.	**Potential Lead:** CDFG, Mendocino County, RCD, Landowners **Others:** CDF, CCC, DPR	Interim	*MC-AR-12*
5	E	MC-AR-07	Modify stream barriers to allow coho salmon passage while maintaining LWD.	**Potential Lead:** CDFG, Landowners, RCD **Others:** Mendocino County, CCC, DPR	Interim	*MC-AR-13*
Big River HSA						
5	E	MC-BR-01	Coordinate and make recommendations needed to implement provisions of the FGC §1600.	**Potential Lead:** SWRCB **Others:** CDFG, NOAA Fisheries, County, Landowners	Interim/ Continual	*MC-BR-01*
5	E	MC-BR-02	Implement recommendations on provisions of the FGC §1600.	**Potential Lead:** SWRCB **Others:** CDFG, NOAA Fisheries, County, Landowners	Interim/ Continual	*MC-BR-01b*
5	E	MC-BR-03	Identify actions to improve coordination between the agencies and others to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and their habitat including spawning gravel and natural hydrograph, and avoidance of adverse impacts caused by water diversion.	**Potential Lead:** SWRCB **Others:** CDFG, NOAA Fisheries, County, Landowners	Interim/ Continual	*MC-BR-01c*
5	E	MC-BR-04	Implement actions to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and their habitat including spawning gravel and natural hydrograph, and avoidance of adverse impacts caused by water diversion.	**Potential Lead:** SWRCB **Others:** CDFG, NOAA Fisheries, County, Landowners	Interim/ Continual	*MC-BR-01d*
5	E	MC-BR-05	Assess and map water diversions.	**Potential Lead:** SWRCB **Others:** CDFG, NOAA Fisheries, County, Landowners	Interim/ Continual	*MC-BR-01e*
5	E	MC-BR-06	Determine and monitor 1600 compliance related to water diversions.	**Potential Lead:** SWRCB **Others:** CDFG, NOAA Fisheries, County, Landowners	Interim/ Continual	*MC-BR-01f*
5	E	MC-BR-07	Evaluate requests for on-stream dams on streams with coho salmon above coho salmon migratory reaches for the effects on the natural hydrograph and the effects on the supply of spawning gravel for recruitment downstream.	**Potential Lead:** SWRCB **Others:** CDFG, NOAA Fisheries, County, Landowners	Interim/ Continual	*MC-BR-01g*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Garcia River HSA						
4	D	MC-GA-01	Establish connectivity of North Fork Garcia River to the mainstem.	**Potential Lead:** CDFG, Counties, Landowners **Others:** NOAA Fisheries	Long-term	*MC-GA-02*
4	C	MC-GA-02	Provide technical assistance and incentives to Garcia River Landowners for developing and implementing sediment reduction plans to meet the requirements of the CWA TMDL.	**Potential Lead:** NCRWQCB **Others:** CDFG, EPA, NOAA Fisheries, RCDs, Mendocino County, CDF	Interim	*MC-GA-05*
4	C	MC-GA-03	Utilize as a model for erosion reduction and LWD placement the comprehensive approach practiced in the South Fork of the Garcia River.	**Potential Lead:** CDF, NCRQCB, CDFG	Interim	*MC-GA-06*
4	C	MC-GA-04	Investigate stream nutrient enrichment and cycling needs for coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, Academia **Others:** Counties, Landowners, Watershed Groups	Interim	*MC-GA-07*
4	E	MC-GA-05	Apply the Garcia River Estuary Enhancement Feasibility Study Report to investigate coho salmon in the Garcia River estuary, as well as new information, to consider restoring estuary functions that would benefit coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Mendocino County, Landowners, RCD, Academia	Interim	*MC-GA-08*
4	D	MC-GA-06	If appropriate, restore estuary function to benefit coho salmon.	**Potential Lead:** Mendocino County, CDFG	Long-term	*MC-GA-08b*
4	C	MC-GA-07	Coordinate LWD placement in streams with logging operations and road upgrades to maximize size, quality, and efficiency of effort.	**Potential Lead:** CDF **Others:** Landowners, CDFG, NOAA Fisheries, Counties, Caltrans	Interim	*MC-GA-09*
4	D	MC-GA-08	Maintain Hathaway Creek, North Fork Garcia, Rolling Brook, Mill Creek (lower Garcia River), South Fork Garcia, Signal, Mill Creek (upper Garcia River) to continue to provide coldwater input to the mainstem Garcia.	**Potential Lead:** CDF **Others:** Landowners, CDFG, NOAA Fisheries, Counties, Caltrans	Interim/ Continual	*MC-GA-11*
4	C	MC-GA-09	Plant conifers in riparian zone of Blue Waterhole, Inman and Pardaloe creeks to reduce instream temperatures and inputs into the mainstem and conifer LWD recruitment.	**Potential Lead:** Landowners **Others:** CDF, CDFG, RCD	Interim	*MC-GA-12*
4	C	MC-GA-10	Encourage, when necessary and appropriate, restricted access to unpaved roads in winter to reduce road degradation and sediment release. Where restricting winter access to unpaved roads is not feasible, encourage measures such as rocking to prevent sediment from reaching coho salmon streams.	**Potential Lead:** Mendocino County, CDF	Interim/ Continual	*MC-GA-13*
4	D	MC-GA-11	Where necessary and with willing landowners, protect riparian vegetation buffer zones through conservation planning, acquisition, and easements.	**Potential Lead:** WCB, CDFG, NOAA Fisheries **Others:** Mendocino County, RCDs, Watershed Groups, Counties	Interim/ Ongoing	*MC-GA-14*
4	D	MC-GA-12	Excavate a geomorphically designed stream channel in the lower North Fork Garcia River to rectify subsurface flow during summer months and prevent coho salmon stranding.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Mendocino County, Watershed Groups	Long-term	*MC-GA-16*
4	E	MC-GA-13	Rescue juvenile coho salmon until subsurface summer flows are rectified.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Mendocino County, Watershed Groups	Interim	*MC-GA-16b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Garcia River HSA (continued)						
4	C	MC-GA-14	Work with landowners to plant conifers in the lower mainstem Garcia River from Eureka Hill road Bridge to Windy Hollow road with the goal of reducing stream temperature, providing bank stability and long-term LWD.	**Potential Lead:** CDFG, NOAA Fisheries, Landowners **Others:** Mendocino County, Watershed Groups	Interim/ Continual	*MC-GA-17*
4	E	MC-GA-15	Evaluate the value to coho salmon of projects to open logjam migration barriers in the North Fork, South Fork, and Fleming Creek.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Watershed Groups	Interim	*MC-GA-18*
4	D	MC-GA-16	If appropriate, open logjam barriers to coho salmon migration in the North Fork, South Fork, and Fleming Creek.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Watershed Groups	Interim	*MC-GA-18b*
4	C	MC-GA-17	Complete the remaining 25% of erosion control sites, identified in the South Fork Garcia River by the Trout Unlimited North Coast Coho Salmon Project.	**Potential Lead:** CDFG, Landowners, Watershed Groups	Long-term	*MC-GA-19*
4	C	MC-GA-18	Where appropriate and with willing landowners, place LWD in Inman Creek, South Fork Garcia River, Signal Creek, and North Fork Garcia River.	**Potential Lead:** CDFG, NOAA Fisheries, Landowners, Watershed Groups **Others:** Counties	Interim/ Continual	*MC-GA-21*
4	C	MC-GA-19	Where appropriate and with willing landowners, plant redwood trees in the lower seven miles of the Garcia River mainstem between Eureka Hill road and Windy Hollow road to provide for LWD recruitment and bank stability and to reduce instream temperatures.	**Potential Lead:** CDFG, NOAA Fisheries, Landowners, Watershed Groups **Others:** Counties	Interim/ Continual	*MC-GA-22*
Navarro River HSA						
4	C	MC-NA-01	Investigate stream nutrient enrichment and cycling needs for coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, Academia	Interim	*MC-NA-03*
4	D	MC-NA-02	Pay particular attention to Implementing actions regarding LWD and shade that are suggested at the HU level.	**Potential Lead:** CDFG **Others:** CDF, NOAA Fisheries, Mendocino County, Landowners, CCC, RCDs	Interim	*MC-NA-04*
4	C	MC-NA-03	Prioritize enforcement of pertinent laws concerning illegal and unpermitted dams and diversions.	**Potential Lead:** SWRCB, CDFG, NOAA Fisheries	Interim/ Continual	*MC-NA-06*
4	C	MC-NA-04	Conserve water by providing land-owners education, incentives, and technical assistance.	**Potential Lead:** SWRCB, CDFG, NOAA Fisheries **Others:** RWQCBs, Watershed Groups, RCDs, UCCE	Ongoing/ Continual	*MC-NA-06b*
4	E	MC-NA-05	Implement comprehensive, subbasin-wide erosion control and LWD installation for Flynn, Dutch Henry, John Smith, Minnie, Horse Camp and German creeks such as is being implemented on Little North Fork.	**Potential Lead:** MRC, CDFG **Others:** NOAA Fisheries, CDF, NCRWQCB	Interim	*MC-NA-07*
4	C	MC-NA-06	Provide technical assistance and incentives to Navarro River landowners for developing and implementing sediment reduction plans to meet the requirements of the CWA TMDL.	**Potential Lead:** NCRWQCB **Others:** CDFG, EPA, NOAA Fisheries, RCDs, Mendocino County, CDF	Interim	*MC-NA-08*
4	C	MC-NA-07	Coordinate LWD placement in streams with logging operations and road upgrades to maximize size, quality, and efficiency of effort.	**Potential Lead:** CDF **Others:** CDFG, Landowners, NOAA Fisheries, Mendocino County, Caltrans	Interim/ Continual	*MC-NA-09*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Navarro River HSA (continued)						
4	C	MC-NA-08	Where necessary and with willing landowners, protect riparian vegetation buffer zones through conservation planning, acquisition, and easements.	**Potential Lead:** WCB, CDFG, NOAA Fisheries **Others:** Mendocino County, RCDs, Watershed Groups, Counties	Interim/ Ongoing	*MC-NA-10*
4	C	MC-NA-09	Where restricting winter access to unpaved roads is not feasible, encourage measures such as rocking to prevent sediment from reaching coho salmon streams.	**Potential Lead:** CDF, CDFG, USFS, Counties, Landowners	Interim/ Continual	*MC-NA-11*
Noyo River HSA						
4	E	MC-NO-01	Investigate the role of the Pudding Creek Dam impoundment in coho migration and freshwater survival rate.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Academia, Landowners	Interim	*MC-NO-02*
4	C	MC-NO-02	If appropriate, repair the Pudding Creek Dam.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Academia, Landowner	Long-term	*MC-NO-02b*
4	C	MC-NO-03	Implement actions of a sediment reduction plan to improve water quality.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Mendocino County, NCRWCB	Interim	*MC-NO-04*
4	E	MC-NO-04	Fund activities to address barriers to coho salmon passage on the California Western Railway right-of-way.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Mendocino County	Interim	*MC-NO-05*
4	D	MC-NO-05	Remove barriers to coho salmon passage on the California Western Railway right-of-way.	**Potential Lead:** CDFG, NOAA Fisheries, Mendocino County	Interim	*MC-NO-05b*
4	C	MC-NO-06	Evaluate the biological justification for the egg-taking station on the South Fork Noyo River.	**Potential Lead:** CDFG NOAA Fisheries **Others:** Academia	Interim	*MC-NO-06*
Ten Mile River HSA						
4	E	MC-TM-01	Complete erosion control on the North Fork Ten Mile River.	**Potential Lead:** Hawthorne-Campbell Company, CDFG **Others:** Trout Unlimited, NCRWQCB, NOAA Fisheries, Mendocino County, Landowners	Interim	*MC-TM-01*
4	C	MC-TM-02	Where necessary and with willing landowners, protect riparian vegetation buffer zones through conservation planning, acquisition, and easements.	**Potential Lead:** WCB, CDFG, NOAA Fisheries **Others:** Mendocino County, RCDs, Watershed Groups, Counties	Interim/ Ongoing	*MC-TM-02*
4	C	MC-TM-03	Where restricting winter access to unpaved roads is not feasible, encourage measures such as rocking to prevent sediment from reaching coho salmon streams.	**Potential Lead:** CDF, CDFG, USFS, Counties, Landowners	Interim/ Continual	*MC-TM-03*
4	C	MC-TM-04	Provide technical assistance and incentives to Ten Mile River landowners for developing and implementing sediment reduction plans to meet the requirements of the CWA TMDL.	**Potential Lead:** NCRWQCB **Others:** CDFG, EPA, NOAA Fisheries, RCDs, Mendocino County, CDF	Interim	*MC-TM-05*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Ten Mile River HSA (continued)						
4	C	MC-TM-05	Coordinate LWD placement in streams with logging operations and road upgrades to maximize the size, quality, and efficiency of effort.	**Potential Lead:** CDF **Others:** Landowners, CDFG, NOAA Fisheries, Counties	Interim/ Continual	*MC-TM-06*
Gualala River HSA						
2	E	MC-GU-01	Complete comprehensive assessment/implementation of erosion control measures in the entire North Fork River basin.	**Potential Lead:** CDFG, NCRWQCB **Others:** Watershed Groups, Landowners	Interim/ Ongoing	*MC-GU-02*
2	E	MC-GU-02	Enforce existing by-pass flow permit conditions of water diversions on the North Fork Gualala River to protect coldwater input to lower mainstem and estuary.	**Potential Lead:** SWRCB, CDFG	Interim	*MC-GU-03*
2	C	MC-GU-03	Where necessary and with willing landowners, protect riparian vegetation buffer zones through conservation planning, acquisition, and easements.	**Potential Lead:** WCB, CDFG, NOAA Fisheries **Others:** Mendocino County, RCDs, Watershed Groups, Counties	Interim/ Ongoing	*MC-GU-04*
2	C	MC-GU-04	Coordinate LWD placement in streams with logging operations and road upgrades to maximize size, quality, and efficiency of effort.	**Potential Lead:** CDF **Others:** CDFG, NOAA Fisheries, Counties, Caltrans	Interim/ Continual	*MC-GU-05*
2	C	MC-GU-05	Explore acquisition or conservation easements from willing land-owners of sections of stands of old-growth Redwood along Haupt Creek.	**Potential Lead:** WCB, CDFG **Others:** Mendocino County, Sonoma County	Interim	*MC-GU-07*
2	C	MC-GU-06	If appropriate and from willing land-owners, acquire fee-title or conservation easement to sections of stands of old-growth Redwood along Haupt Creek.	**Potential Lead:** WCB **Others:** Landowners, CDFG, Mendocino County, Sonoma County	Long-term	*MC-GU-07b*
2	D	MC-GU-07	Restore all tributaries that historically contained coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, Landowners **Others:** Mendocino County, Sonoma County	Interim/ Continual	*MC-GU-09*
2	C	MC-GU-08	Enforce all pertinent laws relating to summer dams and water diversions to provide adequate year round flows and coho salmon passage.	**Potential Lead:** SWRCB, CDFG **Others:** NOAA Fisheries, RWQCB, Mendocino County, Sonoma County	Interim	*MC-GU-11*
2	C	MC-GU-09	Study baseline flow of Gualala River basin.	**Potential Lead:** SWRCB, CDFG **Others:** NOAA Fisheries, RWQCB, Mendocino County, Sonoma County Watershed Groups	Interim	*MC-GU-11b*
2	C	MC-GU-10	Where necessary and with willing landowners, protect riparian vegetation buffer zones through conservation planning, acquisition, and easements.	**Potential Lead:** WCB, CDFG, NOAA Fisheries **Others:** Mendocino County, RCDs, Watershed Groups, Counties	Interim/ Ongoing	*MC-GU-12*
2	E	MC-GU-11	Investigate effects to coho salmon of conversion of timberland and oak woodlands in the Gualala River.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** CDF, Mendocino County, Sonoma County Watershed Groups	Interim	*MC-GU-13*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
RUSSIAN RIVER HU						
	C	RR-HU-01	Upgrade the Russian River Basin Plan to benefit coho salmon.	**Potential Lead:** RWQCB **Others:** CDFG, NOAA Fisheries	Interim	*RR-HU-02*
	E	RR-HU-02	Identify water diverters.	**Potential Lead:** RWQCB **Others:** SWRCB, Counties	Interim	*RR-HU-03*
	C	RR-HU-03	Review, and modify if necessary, water use based on the needs of coho salmon and authorized diverters.	**Potential Lead:** RWQCB, SWRCB **Others:** CDFG, NOAA Fisheries, Counties, Landowners	Long-term	*RR-HU-03b*
	E	RR-HU-04	Assess, prioritize, and develop plans to treat barriers to coho salmon passage in all HSAs.	**Potential Lead:** CDFG, Counties **Others:** NOAA Fisheries, USFWS, Landowners	Interim	*RR-HU-04*
	D	RR-HU-05	Treat barriers to coho salmon passage.	**Potential Lead:** CDFG, Counties **Others:** NOAA Fisheries, USFWS, Landowners	Long-term	*RR-HU-04b*
	E	RR-HU-06	Assess riparian canopy and impacts of exotic vegetation (e.g., *Arundo donax*), prioritize, and develop riparian habitat reclamation and enhancement programs.	**Potential Lead:** RCDs, CDFG **Others:** Landowners, Counties	Interim/ Continual	*RR-HU-06*
	C	RR-HU-07	If appropriate, control exotic vegetation (especially *Arundo donax*).	**Potential Lead:** RCDs, CDFG **Others:** Landowners, Counties	Long-term	*RR-HU-06b*
	C	RR-HU-08	Restore and enhance priority riparian habitat.	**Potential Lead:** RCDs, CDFG **Others:** Landowners, Counties	Long-term	*RR-HU-06c*
	C	RR-HU-09	Implement the Sotoyome Resource Conservation District's Fish Friendly Farming Program within Sonoma and Mendocino counties.	**Potential Lead:** Sotoyome RCD **Others:** Landowners, CDFG, Counties	Interim/ Continual	*RR-HU-07*
	E	RR-HU-10	Continue genetic analysis of source stocks for coho salmon broodstock.	**Potential Lead:** Bodega Marine Lab, CDFG **Others:** NOAA Fisheries	Interim/ Ongoing	*RR-HU-08*
	D	RR-HU-11	Stock first priority streams missing coho salmon, including Felta and Mill creeks (tributary to Dry Creek west of Healdsburg), Freezeout, Willow and Sheephouse creeks (near Duncans Mills), and Ward Creek (tributary to Austin Creek). Identify additional streams that may be suitable for stocking as restoration occurs	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Watershed Groups	Interim	*RR-HU-08b*
	E	RR-HU-12	Identify additional streams that may be suitable for stocking coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Academia	Interim	*RR-HU-08c*
	C	RR-HU-13	Develop and implement a monitoring and evaluation program to adaptively manage the coho salmon broodstock program and meet high and medium priority monitoring objectives as outlined in the coho salmon HGMP.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Academia	Interim/ Continual	*RR-HU-08d*
	C	RR-HU-14	Develop, implement, and evaluate experimental release protocols for the captive broodstock program.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Academia	Interim/ Continual	*RR-HU-08e*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
RUSSIAN RIVER HU (continued)						
	C	RR-HU-15	Review and revise long-term hatchery program goals based on results of the monitoring and evaluation program implemented in the experimental captive broodstock program.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, Academia	Long-term	*RR-HU-08f*
	C	RR-HU-16	Develop and implement protocols for controlling Pierce's Disease to maintain a native riparian corridor.	**Potential Lead:** RCDs, Counties **Others:** Landowners, CDFG, NCRWQCB, NOAA Fisheries, USFWS	Interim/ Continual	*RR-HU-09*
	C	RR-HU-17	Develop an outreach program for controlling Pierce's Disease.	**Potential Lead:** RCDs, Counties **Others:** Landowners, CDFG, NCRWQCB, NOAA Fisheries, USFWS	Interim/ Continual	*RR-HU-09b*
	E	RR-HU-18	Evaluate recommendations to offset impacts from county policies and operations, as developed by the FishNet 4C program in their report, Effects of County Land Use Policies and Management Practices on Anadromous Salmonids and Their Habitat.	**Potential Lead:** Sonoma County **Others:** CDFG, NCRWQCB, NOAA Fisheries, Landowners	Interim	*RR-HU-10*
	C	RR-HU-19	Implement appropriate recommendations to offset impacts from county policies and operations, as developed by the FishNet program.	**Potential Lead:** Sonoma County, Landowners **Others:** CDFG, NCRWQCB, NOAA Fisheries	Long-term	*RR-HU-10b*
	E	RR-HU-20	Evaluate recommendations to offset impacts from county policies and operations, as developed by the Five County effort.	**Potential Lead:** Mendocino County **Others:** CDFG, NCRWQCB, NOAA Fisheries, Landowners	Interim	*RR-HU-10c*
	C	RR-HU-21	Implement appropriate recommendations to offset impacts from county policies and operations, as developed by the Five County effort.	**Potential Lead:** Mendocino County, Landowners **Others:** CDFG, NCRWQCB, NOAA Fisheries	Long-term	*RR-HU-10d*
	C	RR-HU-22	Develop a grading ordinance and grading and erosion control standards to minimize sediment impacts to coho salmon habitat.	**Potential Lead:** Sonoma and Mendocino Counties **Others:** Caltrans, CDF, CDFG, NOAA Fisheries	Long-term	*RR-HU-11*
	E	RR-HU-23	Restore coho salmon passage at county structures on all streams inhabited by coho salmon, as identified in the Russian River Fish Passage Assessment report.	**Potential Lead:** Counties **Others:** CDFG, NOAA Fisheries, Landowners	Interim	*RR-HU-12*
	E	RR-HU-24	Expand coho salmon passage barrier inventories as needed to use a comprehensive watershed approach improving coho salmon passage.	**Potential Lead:** Counties **Others:** CDFG, NOAA Fisheries, Landowners	Interim	*RR-HU-12b*
	C	RR-HU-25	Integrate coho salmon passage projects at county facilities with coho salmon passage improvements involving other Landowners, throughout targeted coho salmon watersheds.	**Potential Lead:** Counties, CDFG, NOAA Fisheries, Watershed Groups **Others:** Landowners	Interim	*RR-HU-12c*
	E	RR-HU-26	Review and, if appropriate, approve Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance (FishNet 4C 2004).	**Potential Lead:** State Agencies	Interim	*RR-HU-13*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
RUSSIAN RIVER HU (continued)						
	C	RR-HU-27	Implement any best management practices pertinent to coho salmon recovery in Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance (FishNet 4C 2004).	**Potential Lead:** Sonoma County Public Works and Parks	Long-term	*RR-HU-13b*
	E	RR-HU-28	Review the Five County Roads manual.	**Potential Lead:** State agencies	Interim	*RR-HU-13c*
	C	RR-HU-29	Implement any practices pertinent to coho salmon recovery in the Five County Roads manual.	**Potential Lead:** Mendocino County	Long-term	*RR-HU-13d*
	D	RR-HU-30	Reduce native riparian vegetation clearing and sediment removal adjacent to and in anadromous coho streams.	**Potential Lead:** Sonoma and Mendocino County Public Works, Water Agencies, Flood Control Districts **Others:** CDFG, NOAA Fisheries	Interim/ Continual	*RR-HU-14*
	D	RR-HU-31	Retain LWD within streams to the extent possible.	**Potential Lead:** Sonoma and Mendocino County Public Works, Water Agencies, Flood Control Districts **Others:** CDFG, NOAA Fisheries	Interim/ Continual	*RR-HU-14b*
	C	RR-HU-32	Store and make available woody material removed from streams for stream enhancement projects benefiting coho salmon.	**Potential Lead:** Sonoma and Mendocino County Public Works, Water Agencies, Flood Control Districts **Others:** CDFG, NOAA Fisheries	Interim/ Continual	*RR-HU-14c*
	C	RR-HU-33	Promote alternatives to conventional bank stabilization for public and private projects, including bioengineering techniques.	**Potential Lead:** Sonoma and Mendocino County Planning and Public Works Departments **Others:** Landowners, CDFG, NCRWQCB, RCDs	Interim/ Continual	*RR-HU-15*
	E	RR-HU-34	Review development set-backs for adequacy in protecting key streams inhabited by coho salmon.	**Potential Lead:** Sonoma and Mendocino Counties, Incorporated Areas **Others:** CDFG, NOAA Fisheries, Landowners, NCRWQCB	Interim	*RR-HU-16*
	E	RR-HU-35	If appropriate, revise development set-backs to adequately protect key streams inhabited by coho salmon.	**Potential Lead:** Sonoma and Mendocino Counties, Incorporated Areas **Others:** CDFG, NOAA Fisheries, Landowners, NCRWQCB	Interim	*RR-HU-16b*
	E	RR-HU-36	Promote streamside conservation measures, including conservation easements, setbacks, and riparian buffers.	**Potential Lead:** Sonoma and Mendocino Counties, Incorporated Areas **Others:** CDFG, NOAA Fisheries, Landowners, NCRWQCB	Interim/ Continual	*RR-HU-16c*
	D	RR-HU-37	Implement streamside conservation measures, including conservation easements, setbacks, and riparian buffers.	**Potential Lead:** Landowners, Sonoma and Mendocino Counties, Incorporated Areas **Others:** CDFG, NOAA Fisheries, NCRWQCB	Interim/ Continual	*RR-HU-16d*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
RUSSIAN RIVER HU (continued)						
	E	RR-HU-38	Inventory, evaluate, and prioritize problem roads which contribute sediment to streams inhabited by coho salmon.	**Potential Lead:** Sonoma and Mendocino County Public Works Departments, Caltrans, Open Space Districts **Others:** CDFG, NCRWQB, Landowners, RCDs, NOAA Fisheries	Interim	*RR-HU-17*
	D	RR-HU-39	Fix problem roads which contribute sediment to streams inhabited by coho salmon.	**Potential Lead:** Counties, Caltrans **Others:** CDFG, NCRWQB, Landowners, RCDs, NOAA Fisheries	Long-term	*RR-HU-17b*
	E	RR-HU-40	Support efforts and develop county, city, and other local programs to protect and increase instream flows for coho salmon.	**Potential Lead:** SWRCB, CDFG, NCRWQCB **Others:** Counties, Landowners, RCDs	Interim	*RR-HU-18*
	D	RR-HU-41	Develop and implement programs to protect and increase instream flows for coho salmon.	**Potential Lead:** Sonoma and Mendocino Counties, RCDs, Landowners **Others:** SWRCB, CDFG, NCRWQCB	Long-term	*RR-HU-18b*
	C	RR-HU-42	Participate in regional water management planning through the general plan process and in other venues as appropriate.	**Potential Lead:** Sonoma and Mendocino Counties, SWRCB, NCRWQCB	Interim	*RR-HU-18c*
Russian River Mainstem (various HSAs)						
	E	RR-MS-01	Manage summer flows in the mainstem Russian River to benefit rearing coho salmon and the estuary, while ensuring that all existing legal water uses and rights are accounted for.	**Potential Lead:** Sonoma County Water Agency (SCWA), USACE, NOAA Fisheries, SWRCB **Others:** CDFG, Landowners, Sonoma County	Interim/ Continual	*RR-MS-01*
	E	RR-MS-02	Evaluate operating the estuary as a natural system to benefit coho salmon rearing and migration.	**Potential Lead:** SCWA, USACE, NOAA Fisheries, CDFG **Others:** Academia, Landowners, Sonoma County, SWRCB	Interim	*RR-MS-02*
	C	RR-MS-03	If appropriate, operate the estuary as a natural system to benefit coho salmon rearing and migration.	**Potential Lead:** SCWA, USACE, NOAA Fisheries **Others:** CDFG, Landowners, Counties, SWRCB	Long-term/ Continual	*RR-MS-02b*
	D	RR-MS-04	Evaluate adjusting the operation of Mirabel Dam, within existing water rights and legal uses, to improve passage of downstream migrants.	**Potential Lead:** SCWA, SWRCB **Others:** CDFG, NOAA Fisheries	Interim	*RR-MS-03*
	C	RR-MS-05	If appropriate, adjust the operation of Mirabel Dam, within existing water rights and legal uses, to improve passage of downstream coho salmon migrants.	**Potential Lead:** SCWA, SWRCB **Others:** CDFG, NOAA Fisheries	Long-term	*RR-MS-03b*
	E	RR-MS-06	Evaluate the feasibility of bypassing large dams.	**Potential Lead:** SCWA, USACE, NOAA Fisheries, CDFG **Others:** Landowners, Counties, Watershed Groups	Interim	*RR-MS-04*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Russian River Mainstem (various HSAs) (continued)						
	C	RR-MS-07	If feasible, bypass large dams.	**Potential Lead:** SCWA, USACE, Counties, Watershed Groups **Others:** CDFG, Landowners, Counties, NOAA Fisheries	Long-term	*RR-MS-04b*
	E	RR-MS-08	Update temperature analyses below Coyote Dam and Warm Springs Dam and review dam management.	**Potential Lead:** SCWA, USACE, NOAA Fisheries **Others:** CDFG, Landowners, Counties	Interim	*RR-MS-05*
	C	RR-MS-09	If appropriate, revise management of Coyote and Warm Springs dams to benefit coho salmon recovery.	**Potential Lead:** SCWA, USACE, NOAA Fisheries **Others:** CDFG, Landowners, Counties	Long-term	*RR-MS-05b*
	E	RR-MS-10	In upper mainstem, prioritize and plan coho salmon habitat restoration programs and projects.	**Potential Lead:** CDFG, SCWA, Mendocino County, NOAA Fisheries **Others:** Landowners, USACE, RCDs	Interim	*RR-MS-06*
	C	RR-MS-11	Implement high-priority coho salmon habitat restoration programs and projects.	**Potential Lead:** CDFG, SCWA, Mendocino County, NOAA Fisheries, Landowners **Others:** USACE, RCDs	Long-term	*RR-MS-06b*
Guerneville HSA						
5	C	RR-GU-01	Encourage local agencies to implement recommendations of completed non-point source sediment assessments.	**Potential Lead:** EPA, SWRCB, RWQCB, NOAA Fisheries, CDFG	Interim	*RR-GU-01*
5	C	RR-GU-02	Implement recommendations of completed non-point source sediment assessments.	**Potential Lead:** Sonoma County **Others:** EPA, SWRCB, NCRWQCB, NOAA Fisheries, CDFG	Interim/ Continual	*RR-GU-01a*
5	E	RR-GU-03	Assess and prioritize sources of excess sediment.	**Potential Lead:** CDFG, RCDs, NCRWQCB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Interim	*RR-GU-02*
5	C	RR-GU-04	Treat priority sources of excess sediment.	**Potential Lead:** Landowners, Sonoma County, RCDs, NCRWQB **Others:** CDFG, USFWS, NOAA Fisheries	Long-term	*RR-GU-02b*
5	C	RR-GU-05	Stock Willow, Sheephouse, Freezeout, Dutchbill and Green Valley creeks as part of the coho salmon broodstock program.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** SCWA, Landowners, Sonoma County	Interim	*RR-GU-03*
5	C	RR-GU-06	From willing Landowners, acquire conservation easements or fee-title of habitat essential for coho salmon.	**Potential Lead:** WCB, CDFG, NOAA Fisheries, **Others:** RCDs, Landowners, Sonoma County	Interim/ Continual	*RR-GU-04*
5	E	RR-GU-07	Identify water diverters.	**Potential Lead:** SWRCB, NCRWQCB **Others:** Sonoma County, RCDs, Landowners	Interim	*RR-GU-06*
5	E	RR-GU-08	Request that the SWRCB review and/or modify water use based on the needs of coho salmon and authorized diverters.	**Potential Lead:** SWRCB, NCRWQCB **Others:** SWRCB, NCRWQCB, Sonoma County, RCDs, Landowners	Interim	*RR-GU-06b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Guerneville HSA (continued)						
5	E	RR-GU-09	Monitor, identify problems, and prioritize needs for changes to water diversion on current or potential coho streams that go dry in some years, in particular Green Valley and Dutchbill creeks.	**Potential Lead:** SWRCB, NCRWQCB, CDFG, NOAA Fisheries, **Others:** Sonoma County, RCDs, Landowners	Interim	*RR-GU-06c*
5	C	RR-GU-10	Remedy priority water diversion problems for current or potential coho streams that go dry in some years.	**Potential Lead:** SWRCB, NCRWQCB, CDFG, NOAA Fisheries **Others:** Sonoma County, RCDs, Landowners	Long-term	*RR-GU-06d*
Austin Creek HSA						
3	C	RR-AC-01	Encourage local agencies to implement recommendations of completed non-point source sediment assessments.	**Potential Lead:** EPA, SWRCB, RWQCB, NOAA Fisheries, CDFG	Interim	*RR-AC-01*
3	C	RR-AC-02	Implement recommendations of completed non-point source sediment assessments.	**Potential Lead:** Sonoma County **Others:** EPA, SWRCB, NCRWQCB, NOAA Fisheries, CDFG	Interim/ Continual	*RR-AC-01a*
3	E	RR-AC-03	Assess and prioritize sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Interim	*RR-AC-02*
3	E	RR-AC-04	Treat high-priority sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Long-term	*RR-AC-02a*
3	E	RR-AC-05	Stock high-priority barren streams, including Ward Creek, with the coho salmon broodstock program.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** SCWA, Landowners, Sonoma County	Long-term	*RR-AC-03*
Warm Springs HSA						
3	E	RR-WS-01	Develop plans to improve riparian vegetation in Dry Creek and its tributaries.	**Potential Lead:** CDFG, Sotoyome RCD **Others:** Landowners, SCWA, USACE	Interim	*RR-WS-01*
3	C	RR-WS-02	Implement riparian vegetation improvement plans.	**Potential Lead:** Landowners, SCWA, Sotoyome RCD **Others:** CDFG, USACE	Long-term/ Continual	*RR-WS-01b*
3	C	RR-WS-03	Implement Sotoyome Resource Conservation District's Fish Friendly Farming Program.	**Potential Lead:** Landowners, SCWA, Sotoyome RCD **Others:** USACE	Interim/ Continual	*RR-WS-01c*
3	C	RR-WS-04	Use land-use planning and conservation easements with willing landowners, to protect riparian vegetation.	**Potential Lead:** CDFG, Sotoyome RCD **Others:** Landowners, SCWA, USACE	Interim/ Continual	*RR-WS-01d*
3	C	RR-WS-05	Support implementation of measures to modify flows in Dry Creek to provide summer rearing habitat for coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, SWRCB, NCRWQCB	Interim	*RR-WS-02*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Warm Springs HSA (continued)						
3	D	RR-WS-06	Modify flows in Dry Creek to provide summer rearing habitat for coho salmon.	**Potential Lead:** Mendocino and Sonoma Counties, SWRCB, NCRWQCB **Others:** CDFG, NOAA Fisheries, Landowners, RCDs	Long-term	*RR-WS-02b*
3	C	RR-WS-07	Stock high-priority barren streams, such as Mill and Felta creeks, as part of the coho salmon broodstock program.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** SCWA, Landowners, Sonoma County	Long-term	*RR-WS-03*
3	C	RR-WS-08	Review and develop preferred protocols for Pierce's Disease Control that would maintain a native riparian corridor and develop an outreach program.	**Potential Lead:** RCDs, Counties **Others:** Landowners, CDFG, NCRWQCB, NOAA Fisheries, USFWS	Interim/ Continual	*RR-WS-04*
3	E	RR-WS-09	Assess, prioritize, and develop plans to treat sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Interim	*RR-WS-06*
3	C	RR-WS-10	Treat high-priority sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Long-term	*RR-WS-06b*
3	D	RR-WS-11	Increase habitat structure and complexity in Dry Creek to enhance habitat diversity, including depositional areas for spawning gravels for coho salmon (e.g., place LWD or large boulders).	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County	Interim	*RR-WS-07*
Mark West HSA						
4	C	RR-MW-01	Use land-use planning and conservation easements, from willing landowners, to reduce habitat fragmentation and improve riparian vegetation.	**Potential Lead:** Sonoma County **Others:** Landowners, CDFG, NOAA Fisheries, Watershed Groups	Interim/ Continual	*RR-MW-01*
4	E	RR-MW-02	Develop plans to improve instream coho salmon habitat conditions.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Landowners, Sotoyome RCD, Sonoma County	Long-term	*RR-MW-02*
4	D	RR-MW-03	Implement measures to improve instream coho salmon habitat conditions.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Landowners, Sotoyome RCD, Sonoma County	Long-term	*RR-MW-02b*
4	E	RR-MW-04	Assess, prioritize, and develop plans to treat sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Interim	*RR-MW-04*
4	C	RR-MW-05	Treat high-priority sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Long-term	*RR-MW-04b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Santa Rosa Creek HSA						
3	C	RR-SR-01	Encourage Sonoma County and the City of Santa Rosa to reduce habitat fragmentation and implement riparian improvements through land-use planning and use of conservation easements.	**Potential Lead:** CDFG, NOAA Fisheries	Interim	RR-SR-01
3	C	RR-SR-02	Use land-use planning and conservation easements, from willing landowners, to reduce habitat fragmentation and improve riparian vegetation.	**Potential Lead:** Sonoma County, City of Santa Rosa **Others:** CDFG, NOAA Fisheries, Watershed Groups	Long-term/ Continual	RR-SR-01b
3	E	RR-SR-03	Evaluate, and develop solutions, to problems for coho salmon caused by channelization.	**Potential Lead:** SCWA, USACE, Sonoma County, UCCE **Others:** CDFG, NOAA Fisheries	Interim	RR-SR-02
3	D	RR-SR-04	Implement solutions to problems for coho salmon caused by channelization.	**Potential Lead:** SCWA, USACE, Sonoma County **Others:** CDFG, NOAA Fisheries, UCCE	Interim	RR-SR-02b
3	E	RR-SR-05	Assess, prioritize, and develop plans to treat sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Interim	RR-SR-03
3	C	RR-SR-06	Treat high-priority sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCDs, NCRWQB, Landowners, Sonoma County **Others:** CDFG, USFWS, NOAA Fisheries	Long-term	RR-SR-03b
Forsythe Creek HSA						
2	C	RR-FO-01	Restore riparian vegetation to improve migration and summer/overwintering habitat for coho salmon.	**Potential Lead:** CDFG, Mendocino RCD, NCRWQB **Others:** Landowners, Mendocino County, USFWS, NOAA Fisheries	Interim/ Continual	RR-FO-01
2	C	RR-FO-02	Control erosion to improve migration and summer/over-wintering habitat for coho salmon.	**Potential Lead:** CDFG, Mendocino RCD, NCRWQB **Others:** Landowners, Mendocino County, USFWS, NOAA Fisheries	Interim/ Continual	RR-FO-01b
2	E	RR-FO-03	Assess, prioritize, and develop plans to treat sources of excess sediment.	**Potential Lead:** CDFG, Mendocino RCD, NCRWQB **Others:** Landowners, Mendocino County, USFWS, NOAA Fisheries	Interim	RR-FO-02
2	D	RR-FO-04	Treat high-priority sources of excess sediment.	**Potential Lead:** CDFG, Mendocino RCD, NCRWQB **Others:** Landowners, Mendocino County, USFWS, NOAA Fisheries	Long-term	RR-FO-02b

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Geyserville HSA						
3	C	RR-GE-01	Use land-use planning and conservation easements, from willing landowners, to maintain and improve riparian vegetation condition and water temperature.	**Potential Lead:** WCD, CDFG, Sonoma County **Others:** NOAA Fisheries, Landowners, Watershed Groups	Interim/ Continual	*RR-GE-01*
3	E	RR-GE-02	Assess, prioritize, and develop plans to treat sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Interim	*RR-GE-03*
3	D	RR-GE-03	Treat high-priority sources of excess sediment.	**Potential Lead:** CDFG, Sotoyome RCD, NCRWQB **Others:** Landowners, Sonoma County, USFWS, NOAA Fisheries	Long-term	*RR-GE-03b*
BODEGA/MARIN COASTAL HUs						
	E	BM-HU-01	Implement BMPs for road projects maintaining environmentally sound upgrades, modifications, and new construction of road projects, including culverts and stream crossings.	**Potential Lead:** Counties, Caltrans **Others:** CDFG, NOAA Fisheries	Interim	*BM-HU-01*
	C	BM-HU-02	Support local agencies, Caltrans, and others in implementing and maintaining environmentally sound upgrades, modifications, and new construction of road projects, including culverts and stream crossings.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Counties, Caltrans	Interim	*BM-HU-01b*
	E	BM-HU-03	Continue to implement erosion control projects that were assessed and inventoried in sediment assessment plans.	**Potential Lead:** CDFG **Others:** Landowners, RCDs, Counties, NCRWQCB, NPS, DPR, CCC, USFWS, NOAA Fisheries	Interim/ Continual	*BM-HU-02*
	E	BM-HU-04	Avoid and/or minimize the adverse effects of water diversion on coho salmon by establishing: a more natural hydrograph, by-pass flows, season of diversion, and off-stream storage.	**Potential Lead:** CDFG, SWRCB **Others:** Landowners, NOAA Fisheries, USFWS	Interim	*BM-HU-03*
	C	BM-HU-05	Work with local governments to incorporate protection of coho salmon in any flood management activities.	**Potential Lead:** CDFG **Others:** Counties	Interim	*BM-HU-04*
	C	BM-HU-06	Implement performance standards in Stormwater Management Plans.	**Potential Lead:** NCRWQCB, Counties	Long-term	*BM-HU-05*
	C	BM-HU-07	Address issues of low flow on private and public lands by increasing riparian protection, restoration, and sediment control, and employing BMPs for permeability and infiltration.	**Potential Lead:** Counties, NPS, DPR, RCDs **Others:** Landowners, CDFG, NCRWQCB	Long-term	*BM-HU-06*
	C	BM-HU-08	Continue outreach, education, and enforcement related to household hazardous waste and hazardous materials spills in creeks.	**Potential Lead:** NCRWQCB, Counties	Long-term	*BM-HU-07*
	C	BM-HU-09	Encourage the cultivation and availability of locally indigenous native plants for use in restoration and bank stabilization.	**Potential Lead:** CDFG, Counties **Others:** CCC, RCDs, Watershed Groups, NPS, DPR	Long-term	*BM-HU-08*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
BODEGA/MARIN COASTAL HUs (continued)						
	E	BM-HU-10	Investigate opportunities for restoring historic runs in identified watersheds.	**Potential Lead:** CDFG, NOAA Fisheries	Interim	*BM-HU-09*
	E	BM-HU-11	Continue to support landowners and the Marin RCD to restore riparian zones and manage livestock to increase stream protection and soil retention.	**Potential Lead:** CDFG, County **Others:** Marin RCD, Landowners	Interim/ Ongoing	*BM-HU-10*
	E	BM-HU-12	Continue sustainable land management practices and control of sediment sources in agricultural zones.	**Potential Lead:** CDFG, County **Others:** Marin RCD, Landowners	Interim/ Ongoing	*BM-HU-10a*
	C	BM-HU-13	Continue to support the active watershed groups, encouraging a focus on coho salmon restoration where appropriate.	**Potential Lead:** CDFG, RCDs, Counties	Interim/ Ongoing	*BM-HU-11*
	E	BM-HU-14	Implement coho salmon passage improvements as identified in inventories conducted by the Salmon Protection and Watershed Network (SPAWN), Taylor and Associates, Trout Unlimited and the NPS. Expand inventories as needed for a comprehensive watershed approach for coho salmon passage.	**Potential Lead:** CDFG, NOAA Fisheries, Counties **Others:** NPS, DPR, Landowners, Caltrans, USFWS, NOAA Fisheries	Interim	*BM-HU-12*
	D	BM-HU-15	County planning, public works, open space, and fire departments should continue to implement FishNet 4C priority goals for this region.	**Potential Lead:** Counties **Others:** Landowners, Local Agencies, CDFG, NOAA Fisheries, USFWS	Interim/ Ongoing	*BM-HU-13*
	D	BM-HU-16	Enact and enforce the Marin County Streamside Conservation Area Ordinance.	**Potential Lead:** Counties **Others:** Landowners, Local Agencies, CDFG, NOAA Fisheries, USFWS	Long-Term/ Continual	*BM-HU-13a*
	D	BM-HU-17	Adopt and implement Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance (FishNet 4C 2004).	**Potential Lead:** Counties **Others:** Landowners, Local Agencies, CDFG, NOAA Fisheries, USFWS	Long-Term	*BM-HU-13b*
	E	BM-HU-18	Systematically work to restore coho salmon passage at county facilities.	**Potential Lead:** Counties **Others:** Landowners, Local Agencies, CDFG, NOAA Fisheries, USFWS	Interim	*BM-HU-13c*
	E	BM-HU-19	Address issues of sediment from roads through restoration and education.	**Potential Lead:** Counties, Caltrans **Others:** Landowners, Local Agencies, CDFG, NOAA Fisheries, USFWS	Interim	*BM-HU-13d*
	C	BM-HU-20	Monitor the effectiveness and maintenance of watershed restoration projects and augment inventories as needed.	**Potential Lead:** CDFG, Watershed Groups, RCDs, NPS, DPR **Others:** NOAA Fisheries, NCRWCB, Landowners	Interim/ Continual	*BM-HU-14*
Salmon Creek HSA						
3	C	BM-SA-01	Coordinate efforts of involved agencies in review of plans for timber harvest and vineyard conversion.	**Potential Lead:** CDF, Sonoma County, NCRWQCB **Others:** CDFG, Landowners, Gold Ridge RCD	Interim	*BM-SA-01*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Salmon Creek HSA (continued)						
3	C	BM-SA-02	Develop standards and BMPs for agriculture to reduce pathogen, nutrient, and sediment loadings to creeks.	**Potential Lead:** CDF, Sonoma County, NCRWQCB **Others:** CDFG, Landowners, Gold Ridge RCD	Interim	*BM-SA-01b*
3	C	BM-SA-03	Implement standards and BMPs for agriculture to reduce pathogen, nutrient, and sediment loadings to creeks.	**Potential Lead:** CDF, Sonoma County, NCRWQCB **Others:** CDFG, Landowners, Gold Ridge RCD	Interim/ Continual	*BM-SA-01c*
3	E	BM-SA-04	Monitor effectiveness and maintenance of past and current watershed restoration projects. Augment surveys as necessary.	**Potential Lead:** CDFG, Gold Ridge RCD **Others:** Landowners, Sonoma County, NCRWQCB, NOAA Fisheries, USFWS	Interim/ Continual	*BM-SA-02*
3	C	BM-SA-05	Continue to fund and support landowners to restore riparian zones and manage livestock to increase stream protection and soil retention. Encourage sustainable land management practices and control sediment sources in agricultural zones.	**Potential Lead:** CDFG, CDF, Sonoma County, NCRWQCB **Others:** Landowners, Gold Ridge RCD	Interim/ Continual	*BM-SA-03*
3	E	BM-SA-06	Implement recommendations of watershed or restoration plans within the range of coho salmon and implement actions consistent with priority recommendations of the coho salmon recovery strategy.	**Potential Lead:** CDFG, Gold Ridge RCD **Others:** Landowners, Sonoma County, NCRWQCB, NOAA Fisheries, USFWS	Interim	*BM-SA-04*
3	C	BM-SA-07	Design vineyard operations to ensure adequate protection of coho salmon habitat attributes, including riparian corridors, instream flow, and water quality.	**Potential Lead:** Sonoma County **Others:** CDFG, Gold Ridge RCD, Landowners, NCRWQCB, NOAA Fisheries, USFWS	Interim	*BM-SA-05*
3	C	BM-SA-08	Assess limiting factors on coho salmon in the Salmon Creek estuary.	**Potential Lead:** CDFG, NOAA Fisheries, DPR **Others:** Sonoma County, Academia	Interim	*BM-SA-06*
Walker Creek HSA						
2	C	BM-WA-01	Address water quality and nutrient loading issues by encouraging sustainable land management practices, controlling sediment sources, protecting riparian zones and employing BMPs that encourage permeability and infiltration.	**Potential Lead:** CDFG, NCRWQCB **Others:** Marin RCD, NOAA Fisheries, Landowners, Marin County	Interim	*BM-WA-01*
2	C	BM-WA-02	Assess the water temperature regime during the summer season for three to five years to determine the role of water temperature as a limiting factor in coho salmon production.	**Potential Lead:** Marin County, Marin RCD, NCRWCB **Others:** CDFG, Landowners, Watershed Groups, NOAA Fisheries	Interim	*BM-WA-03*
2	C	BM-WA-03	Support landowners and the Marin RCD in projects to improve channel conditions and restore natural channel geomorphology, including side channels and dense contiguous riparian vegetation.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Watershed Groups, Marin RCD, Landowners, NCRWQCB, Marin County	Interim/ Continual	*BM-WA-04*
2	C	BM-WA-04	Implement high priority coho salmon enhancement projects for the reduction of sediment delivery and the restoration of riparian corridors as listed in the Walker Creek Enhancement Plan (2001).	**Potential Lead:** CDFG, NCRWQCB **Others:** Watershed Groups, Marin RCD, NOAA Fisheries, Landowners, Marin County	Interim	*BM-WA-05*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Walker Creek HSA (continued)						
2	c	BM-WA-05	Look for opportunities to increase LWD retention and recruitment.	**Potential Lead:** Marin RCD, Watershed Groups, CDFG **Others:** NOAA Fisheries, Landowners, NCRWQCB, Marin County/MMWD	Interim	*BM-WA-07*
2	C	BM-WA-06	Continue to assess the release of water from Soulejule Reservoir to develop the optimum release for coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, NCRWCB, **Others:** CDFG, Marin County/MMWD	Interim/ Ongoing	*BM-WA-07*
2	C	BM-WA-07	Support a coho salmon limiting factors assessment in Keys Estero and Tomales Bay.	**Potential Lead:** CDFG, NOAA Fisheries, Marin County/MMWD	Interim	*BM-WA-08*
Lagunitas Creek HSA						
5	E	BM-LA-01	Use recommendations of existing sediment source surveys to restore habitat of coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries, Marin County/MMWD **Others:** NPS, DPR, Landowners, Marin RCD	Interim	*BM-LA-01*
5	E	BM-LA-02	Expand inventories as needed for a comprehensive watershed approach for coho salmon passage.	**Potential Lead:** CDFG, NOAA Fisheries, Marin County/MMWD **Others:** NPS, DPR, Landowners, Marin RCD	Interim	*BM-LA-01a*
5	D	BM-LA-03	Coordinate with appropriate agencies to restore coho salmon passage at barriers identified by Ross Taylor, SPAWN, and others.	**Potential Lead:** CDFG, NOAA Fisheries, Marin County/MMWD **Others:** Landowners, Marin RCD, SPAWN, NPS, DPR, Caltrans	Interim	*BM-LA-03*
5	D	BM-LA-04	Complete any needed surveys of migration barriers that were not Identified by Ross Taylor, SPAWN, and others.	**Potential Lead:** CDFG, NOAA Fisheries, Marin County/MMWD **Others:** Landowners, Marin RCD, SPAWN, NPS, DPR, Caltrans	Interim	*BM-LA-03b*
5	C	BM-LA-05	Investigate opportunities for restoring historic runs of coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries	Interim	*BM-LA-04*
5	C	BM-LA-06	Continue ongoing efforts and support of stewardship in the basin to include riparian enhancement and protection, sediment source reduction, habitat typing and surveying, coho salmon surveys and counts, water conservation, outreach and education, effectiveness monitoring of projects, and planning and assessment of potential restoration projects to benefit coho salmon.	**Potential Lead:** CDFG, SWRCB **Others:** MMWD	Interim	*BM-LA-05*
5	C	BM-LA-07	Provide incentives for septic inspection, repair, and replacement to reduce aquatic pollution.	**Potential Lead:** Marin County, NCRWQCB **Others:** Landowners, CDFG	Interim	*BM-LA-06*
5	C	BM-LA-08	Assess and evaluate habitat restoration actions in Nicasio Creek.	**Potential Lead:** CDFG, SWRCB, Marin County/MMWD **Others:** Landowners, Marin RCD	Interim	*BM-LA-07*
5	C	BM-LA-09	Implement habitat restoration actions in Nicasio Creek.	**Potential Lead:** CDFG, SWRCB, Marin County/MMWD **Others:** Landowners, Marin RCD	Interim	*BM-LA-07a*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Lagunitas Creek HSA (continued)						
5	C	BM-LA-10	Develop a monitoring and assessment program for the estuarine reaches of Lagunitas Creek and inter-tidal reaches of Tomales Bay, looking at impacts to coho salmon rearing and emigration.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Landowners, NPS, DPR, Academia	Interim/ Continual	*BM-LA-08*
5	C	BM-LA-11	Restore Olema Marsh, Bear Valley Creek, and the mouth of Olema Creek, to benefit coho salmon. The restoration should provide rearing habitat refuge during high flows, habitat protection, and hydrologic connectivity between marshes.	**Potential Lead:** NPS, CDFG **Others:** Landowners, Marin RCD	Long-term	*BM-LA-09*
5	D	BM-LA-12	Work with private landowners to encourage biotechnical bank stabilization, riparian protections, woody debris retention, and timing of water withdrawals to help protect coho salmon.	**Potential Lead:** Marin RCD, Marin County, CDFG **Others:** Landowners, NPS, DPR	Long-term/ Continual	*BM-LA-11*
5	C	BM-LA-13	In the San Geronimo Creek sub-watershed, continue public outreach and education for private landowners, residents, commercial, public utility and county workers regarding best management practices to control erosion, protect riparian vegetation, retain LWD, and minimize disturbance to coho salmon from domestic animals.	**Potential Lead:** Marin RCD, Marin County, Watershed Groups **Others:** SPAWN, Landowners	Long-term	*BM-LA-12*
5	D	BM-LA-14	In the San Geronimo Creek sub-watershed, work with stock pond owners to remove non-native fish species where they are a threat to coho salmon.	**Potential Lead:** Watershed Groups, CDFG, Marin RCD	Long-term/ Continual	*BM-LA-13*
5	D	BM-LA-15	Marin County should develop a policy for reviewing the impacts of new development projects and how new well construction effects the streams. The County should consider adopting recommendations for well developments from the local coastal plan.	**Potential Lead:** Marin County **Others:** Landowners, CDFG, SWRCB	Interim	*BM-LA-14*
5	C	BM-LA-16	Recommend the NPS continue practices to benefit coho salmon, which include restoration projects, sediment control projects, locating fences out of riparian zones, repairing headcut gullies as possible, and implementing rotational grazing in locations to minimize erosion and impacts to the creek.	**Potential Lead:** NOAA Fisheries **Others:** CDFG, NPS	Interim/ Ongoing	*BM-LA-15*
5	C	BM-LA-17	Continue to implement and coordinate the the Watershed Protection Agreement Program for additional water hook-ups in Nicasio and San Geronimo creek watersheds.	**Potential Lead:** Marin MMWD, County **Others:** NOAA Fisheries, CDFG	Interim	*BM-LA-16*
5	C	BM-LA-18	Look for opportunities to restore natural channel form and function in the upper watershed to protect summer flows into San Geronimo Creek.	**Potential Lead:** Marin County, CDFG **Others:** Landowners, NPS, DPR, NOAA Fisheries, USFWS	Interim	*BM-LA-17*
5	C	BM-LA-19	Continue riparian protection and sediment control projects with a focus on working with landowners to manage livestock to protect riparian areas, and to implement erosion control projects on State and Federal park and private lands (e.g., Devil's Gulch).	**Potential Lead:** DPR, NPS **Others:** Landowners, CDFG, NOAA Fisheries	Interim/ Ongoing	*BM-LA-18*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Lagunitas Creek HSA (continued)						
5	C	BM-LA-20	Continue public outreach and education for private landowners, residents, commercial, public utility and county workers regarding best management practices to control erosion, protect riparian vegetation, retain woody debris, and minimize disturbance to coho salmon from pets.	**Potential Lead:** CDFG, Watershed Groups **Others:** County	Interim/ Continual	*BM-LA-21*
5	C	BM-LA-21	Determine policy for reviewing new development projects and well construction. Consider adopting recommendations for well developments from the Coastal Plan.	**Potential Lead:** CDFG, County, Watershed Groups	Interim	*BM-LA-23*
Bolinas HSA						
5	E	BM-BO-01	Implement recommendations of completed sediment source surveys and supplement surveys as necessary.	**Potential Lead:** Marin County, CDFG, Marin RCD **Others:** NPS, DPR, Landowners, USFWS, NOAA Fisheries	Long-term	*BM-BO-01*
5	D	BM-BO-02	Continue restoration efforts on Bolinas and Big lagoons to benefit coho salmon during all life phases and seasons.	**Potential Lead:** NPS **Others:** CDFG, Marin County, Landowners, NOAA Fisheries, USFWS	Interim/ Ongoing	*BM-BO-02*
5	E	BM-BO-03	Work with landowners through outreach and education and appropriate agencies to manage summer flows for coho salmon, on a watershed basis. Provide support and incentives to protect both fisheries flows and agriculture by timing of withdrawals, construction of off-site storage facilities, water conservation practices, and riparian zone protections. Conduct outreach and education for landowners on these practices.	**Potential Lead:** SWRCB, CDFG, NOAA Fisheries **Others:** Watershed Groups	Interim	*BM-BO-03*
5	C	BM-BO-04	Look for opportunities to increase LWD recruitment and retention.	**Potential Lead:** CDFG	Long-term	*BM-BO-04*
5	C	BM-BO-05	Provide incentives for septic inspection, repair and replacement to improve water quality in both streams and lagoons.	**Potential Lead:** Marin County, NCRWQCB	Long-term	*BM-BO-05*
5	C	BM-BO-06	Encourage the National Park Service to provide additional space for Stinson Beach Water District for off-stream storage to protect coho salmon in Easkoot Creek.	**Potential Lead:** NOAA Fisheries, Stinson Beach Water District **Others:** CDFG, SWRCB, Marin County, USFWS	Interim	*BM-BO-06*
5	D	BM-BO-07	Identify and prioritize coho salmon passage barriers in the Redwood Creek drainage.	**Potential Lead:** DPR, County **Others:** CDFG	Interim	*BM-BO-07*
5	D	BM-BO-08	Treat coho salmon passage barriers in the Redwood Creek drainage.	**Potential Lead:** DPR, County **Others:** CDFG	Interim	*BM-BO-07b*
5	C	BM-BO-09	Identify and prioritize problems related to roads and trails in these watersheds, including location of trails and access for construction and maintenance of roads and trails.	**Potential Lead:** NPS **Others:** DPR, CDFG, NOAA Fisheries, USFWS	Long-term	*BM-BO-08*
5	C	BM-BO-10	Treat problems related to roads and trails in these watersheds, including location of trails and access for construction and maintenance of roads and trails.	**Potential Lead:** NPS **Others:** DPR, CDFG, NOAA Fisheries, USFWS	Long-term	*BM-BO-08b*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
SAN FRANCISCO BAY AREA HU						
	C	SF-HU-01	Include coho salmon in habitat suitability evaluations in the San Francisco Bay Area.	**Potential Lead:** CDFG **Others:** Counties, Watershed Groups, NOAA Fisheries, Landowners	Long-term	*SF-HU-01*
	C	SF-HU-02	Where appropriate, apply range-wide recommendations to suitable streams in the San Francisco Bay.	**Potential Lead:** CDFG, Counties, NOAA Fisheries	Long-term	*SF-HU-02*
San Rafael HSA						
2	C	SF-SR-01	Work to restore coho salmon habitat, especially in Arroyo Corte Madera del Presidio and Corte Madera Creek.	**Potential Lead:** Marin County, Watershed Groups, CDFG **Others:** Landowners, NOAA Fisheries, USACE	Long-term	*SF-SR-01*
SAN MATEO HU						
	E	SM-HU-01	Reduce the effects of water diversions, by assisting the SWRCB's coordination with other agencies in addressing season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and natural hydrograph.	**Potential Lead:** CDFG **Others:** SWRCB, Landowners, USFS, RWQCB, Watershed Groups	Interim	*SM-HU-02*
	D	SM-HU-02	Develop legislation that will fund county planning for environmentally sound growth and water supply. Work in coordination with the California Department of Housing and Community Development (CDHCD), Association of Bay Area Governments (ABAG), and other government associations.	**Potential Lead:** CDFG **Others:** Counties, CDHCD, ABAG, RWQCB, Landowners, Watershed Groups, NOAA Fisheries	Long-term	*SM-HU-03*
	C	SM-HU-03	Continue to protect riparian zones on streams inhabited by coho salmon within the coastal zone according to the local coastal plan and THP prescriptions.	**Potential Lead:** Counties **Others:** CDFG, CDF, Landowners, Watershed Groups, Caltrans, NOAA Fisheries, RWQCB	Interim	*SM-HU-04*
	C	SM-HU-04	Evaluate the need to apply coastal zone protections to streams inhabited by coho salmon that are not in the coastal zone.	**Potential Lead:** Counties **Others:** CDFG, CDF	Interim	*SM-HU-04b*
	C	SM-HU-05	Develop written standards for routine operations and maintenance.	**Potential Lead:** Counties **Others:** CDFG, CDF	Interim	*SM-HU-04c*
	C	SM-HU-06	Implement written standards for routine operations and maintenance, and train staff in best management practices.	**Potential Lead:** Counties **Others:** CDFG, CDF	Interim	*SM-HU-04d*
	D	SM-HU-07	Assess and prioritize coho salmon passage barriers to coho salmon habitat.	**Potential Lead:** Counties, CDFG	Interim	*SM-HU-04e*
	D	SM-HU-08	Restore coho salmon passage to coho salmon habitat by using the prioritized list.	**Potential Lead:** Counties, CDFG	Interim	*SM-HU-04f*
	D	SM-HU-09	Conduct road assessments and address issues of sedimentation from county public works and parks roads and trails.	**Potential Lead:** Counties, DPR **Others:** CDFG	Interim	*SM-HU-04g*
	C	SM-HU-10	Promote alternatives to conventional bank stabilization for public and private projects.	**Potential Lead:** Counties, CDFG **Others:** Landowners	Interim	*SM-HU-04h*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
SAN MATEO HU (continued)						
	C	SM-HU-11	Establish adequate spoils storage sites throughout the counties so that material from landslides and road maintenance can be stored safely away from streams inhabited by coho salmon. Coordinate these efforts with Caltrans.	**Potential Lead:** Caltrans, Counties **Others:** CDFG	Interim	*SM-HU-04i*
	C	SM-HU-12	Work to increase county enforcement of permit conditions and erosion control plans on development.	**Potential Lead:** Counties, CDFG **Others:** NOAA Fisheries	Interim	*SM-HU-04j*
	C	SM-HU-13	Support continued economically sustainable management of forest and agricultural lands in the range of coho salmon to reduce the potential for conversion to residential or commercial development.	**Potential Lead:** CDF, Landowners **Others:** CDFG, BLM NPS, Watershed Groups	Interim	*SM-HU-05*
San Gregorio Creek and Pescadero Creek HSAs						
4	E	SM-SG-01	Minimize take attributable to diversion of stream flow through alternatives, such as the operation of off-stream reservoirs, development of infrastructure necessary for conjunctive use of stream flow, and use of desalinated ocean water.	**Potential Lead:** RWQCB **Others:** CDFG, Landowners, Watershed Groups, Counties	Interim	*SM-SG-01*
4	D	SM-SG-02	Conduct a watershed assessment in San Gregorio Creek that addresses impacts to coho salmon.	**Potential Lead:** CDFG **Others:** Watershed Groups, Landowners	Interim	*SM-SG-02*
4	E	SM-SG-03	Conduct a comprehensive assessment of watershed processes (e.g., hydrology, geology, fluvial-geomorphology, water quality, and vegetation), instream habitat, and factors limiting coho salmon production.	**Potential Lead:** CDFG **Others:** Watershed Groups, Landowners	Interim	*SM-SG-03*
4	D	SM-SG-04	Use the assessment results to develop a plan for restoration of coho salmon passage, instream habitat, and upslope erosion control, for implementation by cooperating landowners/managers.	**Potential Lead:** CDFG **Others:** Watershed Groups, Landowners	Interim	*SM-SG-03b*
4	C	SM-SG-05	Implement BMPs designed to reduce erosion and sediment from roads into instream habitat (e.g., practices described in the California Salmonid Stream Habitat Restoration Manual).	**Potential Lead:** Landowners, County **Others:** CDFG, Caltrans, Watershed Groups	Interim	*SM-SG-04*
4	D	SM-SG-06	Improve riparian areas by implementing BMPs designed to reduce bank erosion, water temperature, and the removal of LWD. These BMPs should include livestock exclusion fencing, reclamation and reconstruction of flood plain, and active revegetation.	**Potential Lead:** CDFG **Others:** Cattlemen's Association, Farm Bureau, Landowners, Watershed Groups, Counties, RWQCB	Interim	*SM-SG-05*
4	E	SM-SG-07	Encourage funding authorities to allocate adequate resources to prioritize and upgrade culverts to provide fish passage within the range of coho salmon to pass 100-year flows and the expected debris loads (e.g. LWD that might be mobilized).	**Potential Lead:** Federal, State, Local, and Tribal Government; Ranching, Agricultural, Forestry, Fishing, and Conservation Stakeholders	Interim	*SM-SG-06*
4	E	SM-SG-08	Request that the SWRCB declare critical tributaries to San Gregorio and Pescadero creeks fully appropriated during summer and fall months.	**Potential Lead:** CDFG **Others:** SWRCB, RWQCB	Interim	*SM-SG-07*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Año Nuevo (Gazos Creek) HSA						
5	D	SM-AN-01	Implement the projects recommended as high priority for coho salmon in the Gazos Creek watershed restoration plan.	**Potential Lead:** CDFG, Watershed Groups, Counties	Interim	*SM-AN-01*
BIG BASIN HU						
	E	BB-HU-01	Continue to operate MBSTP Kingfisher Flat Hatchery as a conservation hatchery, following the guidelines of the Department and NOAA Fisheries.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Watershed Groups, Counties, Landowners	Interim/ Ongoing	*BB-HU-01*
	C	BB-HU-02	Provide education and training on water diversion practices to facilitate compliance.	**Potential Lead:** CDFG **Others:** Watershed Groups	Interim/ Continual	*BB-HU-02*
	E	BB-HU-03	Assess and prioritize culverts to provide coho salmon passage within the range of coho salmon, and to pass expected high flow debris loads (e.g. mobilized LWD).	**Potential Lead:** County **Others:** CDFG	Interim	*BB-HU-03*
	D	BB-HU-04	Allocate adequate resources to prioritize and upgrade culverts providing coho salmon passage within the range of coho salmon and to pass expected high flow debris loads (e.g. mobilized LWD).	**Potential Lead:** County, CDFG **Others:** NOAA Fisheries	Interim	*BB-HU-03b*
	E	BB-HU-05	Develop and apply bypass stream flow requirements on all existing and future structures in streams inhabited by coho salmon.	**Potential Lead:** CDFG **Others:** SWQCB, Landowners, CDF, Caltrans, Watershed Groups	Interim/ Continual	*BB-HU-04*
	D	BB-HU-06	Implement the highest priority restoration projects in the watershed plans that address coho salmon habitat. Adjust on-going efforts based on results.	**Others:** CDFG, Watershed Groups, Counties, Santa Cruz County Resource Conservation District, Coastal Conservancy	Interim/ Continual	*BB-HU-05*
	D	BB-HU-07	Complete a broad conjunctive use feasibility study focusing on creative ways of managing existing surface and groundwater resources in Santa Cruz County, with the intent to increase base flow at critical times.	**Potential Lead:** CDFG, SWQCB **Others:** Water Districts, Counties, Landowners, Watershed Groups	Interim	*BB-HU-06*
	C	BB-HU-08	Develop a lagoon management plan that addresses the needs of coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, SWQCB, Academia, Santa Cruz County Resource Conservation District, Coastal Conservancy	Interim	*BB-HU-07*
	C	BB-HU-09	Implement the lagoon management plan that addresses the needs of coho salmon.	**Potential Lead:** CDFG **Others:** NOAA Fisheries, RWQCB, Academia, Santa Cruz County Resource Conservation District, Coastal Conservancy	Interim	*BB-HU-07b*
Davenport HSA						
5	E	BB-DA-01	Work with the SWRCB to develop and enforce stream flow bypass requirements for diversions in Waddell Creek, mainstem Scott Creek, Big Creek, Mill Creek, and San Vicente Creek.	**Potential Lead:** CDFG, SWRCB **Others:** Watershed Groups, Landowners	Interim/ Long-term	*BB-DA-01*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
Davenport HSA (continued)						
5	E	BB-DA-02	Petition the SWRCB to declare Scott Creek and San Vicente Creek fully appropriated during summer and fall months.	**Potential Lead:** CDFG **Others:** SWRCB	Interim	*BB-DA-02*
5	D	BB-DA-03	Improve riparian vegetation by implementing established BMPs designed to reduce bank erosion, temperature, and removal of LWD; also include livestock fencing where needed, reclamation or reconstruction of flood plains, and active revegetation (this recommendation applies especially to Scott Creek).	**Potential Lead:** CDFG **Others:** Cattlemen, Farm Bureau, Landowners, Watershed Groups, Counties, RWQCB, Santa Cruz County Resource Conservation District, Coastal Conservancy	Interim/ Continual	*BB-DA-03*
5	C	BB-DA-04	Reduce sediment from road erosion using established BMPs (this recommendation applies especially to Scott Creek).	**Potential Lead:** Counties, Caltrans **Others:** CDFG, Watershed Groups, Santa Cruz County Resource Conservation District, Coastal Conservancy	Interim/ Continual	*BB-DA-04*
5	C	BB-DA-05	Investigate suspect log jams in Waddell Creek to determine if passage issues for coho salmon exist and should be modified if absolutely necessary.	**Potential Lead:** CDFG, DPR **Others:** Watershed Groups, CCC, Counties, Landowners	Interim	*BB-DA-05*
5	C	BB-DA-06	Develop a log-jam management plan.	**Potential Lead:** DPR	Interim	*BB-DA-05b*
5	D	BB-DA-07	Develop stream flow bypass requirements for diversions on the mainstem San Vicente and Mill creeks.	**Potential Lead:** CDFG, SWQCB **Others:** Watershed Groups	Interim	*BB-DA-07*
5	D	BB-DA-08	Implement stream flow bypass requirements for diversions on the mainstem San Vicente and Mill creeks.	**Potential Lead:** CDFG, SWQCB **Others:** Watershed Groups	Interim	*BB-DA-07b*
5	D	BB-DA-09	Enforce stream flow bypass requirements for diversions on the mainstem San Vicente and Mill creeks.	**Potential Lead:** SWQCB, CDFG **Others:** Landowners	Interim	*BB-DA-07c*
San Lorenzo River HSA						
3	C	BB-SL-01	Reduce sediment from road erosion using established BMPs accounting for public safety standards; this applies especially to San Lorenzo River.	**Potential Lead:** Counties, Caltrans **Others:** CDFG, Watershed Groups, Santa Cruz County Resource Conservation District, Coastal Conservancy	Interim	*BB-SL-01*
3	E	BB-SL-02	Develop and enforce stream flow bypass requirements for diversions in the San Lorenzo River and its tributaries Zayante, Fall, Bear, Boulder, and Branciforte creeks.	**Potential Lead:** CDFG, SWRCB **Others:** Watershed Groups, Landowners	Interim	*BB-SL-02*
3	D	BB-SL-03	Evaluate the Felton Diversion Dam for impacts to coho salmon.	**Potential Lead:** CDFG, NOAA Fisheries **Others:** Watershed Groups	Interim	*BB-SL-03*
3	C	BB-SL-04	Improve adult coho salmon passage at locations named in the San Lorenzo River Enhancement Plan, the Santa Cruz Road Crossing and Salmonid Passage Assessment (Taylor 2003) and those identified by the Department as being problematic.	**Potential Lead:** CDFG, Counties, FishNet 4C, Watershed Groups, Landowners, Caltrans	Interim	*BB-SL-04*

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ORIGINAL IDENTIFIER
San Lorenzo River HSA (continued)						
3	C	BB-SL-05	Implement the portions of the San Lorenzo River Enhancement Plan, and the areas identified as problematic by the Department that are consistent with the coho salmon recovery strategy.	**Potential Lead:** CDFG, Counties, FishNet 4C, Watershed Groups, Landowners, Caltrans	Interim	*BB-SL-04b*
Aptos-Soquel HSA						
3	E	BB-AP-01	Implement elements of the Soquel Creek Watershed Assessment and Enhancement Project Plan that are consistent with the coho salmon recovery strategy. Specifically focusing on preservation of base flow, restoration of flood plains, improvements to coho salmon passage, BMPs to reduce sedimentation of instream habitat.	**Potential Lead:** Counties, Landowners, Santa Cruz County RCD, Coastal Conservancy **Others:** CDFG, FishNet 4C, Watershed Groups, Caltrans,	Interim/ Continual	*BB-AP-01*
3	E	BB-AP-02	Maintain year round instream flows for coho salmon by amendments to the adjudication, water conservation, shallow recharge opportunities, shallow-well gauging, deep-well gauging, stream-gauging, self-monitoring of diversions, and conjunctive water management for recovery of groundwater levels.	**Potential Lead:** CDFG **Others:** SWQCB, Watershed Groups, Santa Cruz County Resource Conservation District, Coastal Conservancy	Interim/ Continual	*BB-AP-02*

10 Shasta-Scott Pilot Program

In accordance with the direction of the Commission, the Department established the Shasta-Scott Pilot Program (SSPP) to address coho salmon recovery issues associated with agriculture and agricultural water use in the Shasta and Scott river valleys in Siskiyou County (i.e., Shasta Valley and Scott River recovery units), and established the Shasta-Scott Recovery Team (SSRT) to advise the Department on these issues. All other issues within these two recovery units were addressed by the CRT. Both the SSRT and CRT aided the Department in the development of the Pilot Program.

10.1 FRAMEWORK FOR AGRICULTURAL ISSUES

The SSRT has reached preliminary agreement on the recommendations included in the Pilot Program. However, the SSRT intends to consider the recommendations in another round of review before finalizing the recommendations. The SSRT also intends to establish the framework for an implementation and permitting strategy (including appropriate Streambed Alteration Agreements and Incidental Take Permits).

Recommendations addressing agriculture and agricultural water use in the Shasta and Scott river valleys were developed in eight action categories. Recommendations for implementation and administration are introduced in Section 10.2. Recommendations for the following seven categories are presented in Section 10.3:

1. *Water Management*. Recommendations in this category include the following topics: preparation of a Dry Year Water Plan, verification of water use and water rights, ramped flows for diversions, pulse flows, interim instream flows, irrigation rotation, installation and maintenance of headgates and measuring devices for diversions, better water forecasting, groundwater studies, and instream flow/habitat/temperature modeling studies.
2. *Water Augmentation*. Recommendation topics are formation of water trusts, development of additional surface water storage, small storage opportunities, conjunctive groundwater use, conveyance from the main Klamath, as well as buying or leasing water rights.
3. *Habitat Management*. These recommendations are presented separately for the two watersheds.
   a. Scott River. Recommendations for habitat management focus on improvement of rearing habitat (habitat restoration, flow connectivity, temperature), valley and low-gradient tributary channel structure and function, fish passage (low flow, structures at private road crossings, remediation of mine tailings), and spawning gravels.
   b. Shasta Valley. Recommendations address rearing habitat (identification of current rearing habitat and efforts to maintain it; enhancement of rearing habitat; identification and remediation of various dams and impoundments, high temperatures, and structures at road crossings that are barriers to fish passage), management of spawning gravel, management of riparian vegetation, and water temperatures.

4. *Water Use Efficiency*. Topics in this category include development of alternative stock water systems, workshops in water use efficiency for landowners, ditch lining and piping, ditch repair and cleaning, irrigation system efficiency, cropping changes, tailwater reclamation, BMPs, and implementing the California Irrigation Management Information System (CIMIS) program in the two watersheds.
5. *Protection*. This category includes screening diversions and screen maintenance, protection of riparian zones, fish rescue, and barrier removal.
6. *Assessment and Monitoring*. The recommendations are presented in two categories: habitat monitoring and fish population monitoring. The goals are to collect data that will be needed for both the Federal and State recovery programs as they evaluate progress toward recovery and to support an adaptive management program for the measures in the other categories. One key issue is obtaining access from landowners.
7. *Education and Outreach*. Education efforts will target not only landowners, but also legislators (Federal, State, and local), and local schools. Handbooks, newsletters, a website, active engagement with the local press, demonstration projects, and special events are proposed.

10.2 ADMINISTRATION AND IMPLEMENTATION

Acceptance of the SSPP by the local agricultural community is inextricably linked to development of a programmatic implementation framework which covers normal ranching and farming activities consistent with the Pilot Program. The Department is committed to working with the SSRT to develop this framework. This framework should include necessary Streambed Alteration Agreements for water diversion and other instream work, as well as coverage for any unavoidable incidental take of coho salmon or other listed species.

The implementation schedule is dependent on funding. Quantitative estimates of both the fiscal cost and socioeconomic impacts of implementing the SSPP have been developed in conjunction with the economic analysis presented in Chapter 11. For a more detailed analysis, refer to the complete economic report in Appendix I.

Historically, funding for salmon restoration has been available from a variety of sources including State and Federal agencies and from various restoration grant opportunities with cost sharing by local landowners. The current economic downturn and State budget crisis could jeopardize funding from one or more of these sources. The Department recognizes that adequate funding is essential to successful implementation of the Pilot Program.

The Department is committed to working with the SSRT, other State and Federal agencies, and with various interest groups to ensure the SSPP is implemented in an economically reasonable manner with an equitable apportionment of public and private obligations. The Department continues to believe that an incentive-based approach to implementation is the most viable option for agricultural areas of the Shasta and Scott valleys.

10.3 SHASTA-SCOTT RECOMMENDATIONS AND IMPLEMENTATION SCHEDULE

The recommendations developed by the SSRT[1] to deal with agricultural water and land-use issues are presented in seven solution categories. They are water management, water augmentation, habitat management, water use efficiency, protection, assessment and monitoring, and education and outreach (Table 10-1). Brief issue and solution statements that provide context are provided within the list of recommendations.

[1] The SSRT has reached conceptual agreement (termed "preliminary favorable regard") on the recommendations within the first seven action areas. This is a status short of "final approval." The SSRT intends to continue its work following approval of the Recovery Strategy and pursue the establishment of an implementation and permitting framework necessary to allow their final approval of the recommendations.

TABLE 10-1: Recovery recommendations and implementation schedule for the Shasta-Scott Pilot Program

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER MANAGEMENT – SHASTA VALLEY HSA, SCOTT BAR HSA, AND SCOTT VALLEY HSA						
WATER MANAGEMENT: DRY YEAR WATER PLAN						
ISSUES: Low instream flows, especially in drought and dry years, limit habitat for coho salmon and other salmonids. There are no comprehensive plans to deal with supplying instream flows for coho salmon.						
SOLUTIONS: Develop a comprehensive, community-based plan that identifies progressive steps to take to obtain, manage, or deal with low water conditions in advance of the event.						
4	E	WM-1a	Ask Scott River Watershed Council (SRWC) to develop a Dry Year Water Plan for the Scott. Components would include predetermined funding and prioritized actions for implementation, with identification of who, what, where, when, and how. **Short-term:** Seek funding and proceed with plan development. **Long-term:** Use plan to coordinate actions during low-water periods. Plan will define "low-water."	SRWC, Siskiyou RCD, CDFG, DWR	Interim	$40,000.
4	E	WM-1b	Ask the Shasta Coordinated Resources Management Planning (CRMP) to develop a Dry Year Water Plan for the Shasta. Components would include predetermined funding and prioritized actions for implementation, with identification of who, what, where, when, and how. **Short-term:** Seek funding and proceed with plan development. **Long-term:** Use plan to coordinate actions during low water periods. Plan will define "low-water."	CRMP, Shasta Valley RCD, CDFG, DWR	Interim	$40,000.
WATER MANAGEMENT: VERIFICATION OF WATER DIVERSIONS WITH WATER RIGHTS						
ISSUES: Currently the Shasta River and five creeks in the Scott Watershed are under State Watermaster Service. The main Scott River and other tributaries, while under decree, are not under either State or private watermaster service. Watermasters allocate and manage water diversions so that each diverter receives water according to his or her right as defined in the decree. In the non-watermastered areas, diverters may not be diverting their correct allotment and there is no verification that diverters are correctly following their adjudicated right; if diverters are taking more than their right, it may be impacting instream flows, coho salmon habitat, and water-right holders.						
SOLUTIONS: Careful management and verification of diversion amounts according to existing decrees may increase flows. Recent DWR efforts to more precisely manage diversions on the watermastered streams have produced prolonged higher instream flows in the summer season. Watermasters also are able to manage volunteered or dedicated instream flows.						
4	E	WM-2a	Add additional oversight and provide more people to verify water use and better manage water in current watermaster service areas (Shasta and Scott). **Short-term:** Seek and support additional funding and authorization to add one additional person to work in the area already watermastered by DWR. Include verification data in the annual report. **Long-term:** Continue oversight and verification and improve as necessary.	DWR, RCDs	Interim/ Continual	$350,000-$500,000 per yr.
4	D	WM-2b	Work with diverters covered by the Scott River Decree to confirm they know exactly their rights. **Short-term:** Hold voluntary one-on-one meetings with diverters and conduct a diverters' workshop for each schedule. **Long-term:** Continue periodic diverters' workshops.	DWR, SWRCB	Interim/ Continual	$20,000.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER MANAGEMENT: VERIFICATION OF WATER DIVERSIONS WITH WATER RIGHTS (continued)						
ISSUES: Lack of prediction of water-year type limits opportunities for water management. Lack of short-term predictions similarly constrains planning for mid-season water use.						
SOLUTIONS: Forecasting stream flows for the water year based on snow surveys, precipitation, and aquifer condition within the season could aid water management techniques, such as irrigation rotation and harvesting, and thereby provide additional instream flows and habitat.						
4	E	WM-2c	Provide assistance for voluntary flow measurement of current non-watermastered diversions on the Scott. **Short-term:** DWR staff can continue to provide service as needed. DWR can train others (SRWC, RCD staff) on flow measuring techniques. **Long-term:** Continue to provide service and training as needed.	DWR, SRWC, Siskiyou RCD	Interim/ Ongoing	$20,000.
4	E	WM-2d	Verify compliance with water rights as contained in the Scott River Decree using a phased implementation period for currently un-watermastered areas. 100 percent verification is the goal. **Short-term:** 1. During 2003 and early 2004, diverters on a given reach will choose to have usage verified under one of the following options: a. Independent and accountable private watermaster, who coordinates with DWR; b. Allow DWR to access sites for compliance (individual); c. Watermaster by DWR with no fee; or d. Other mechanisms to be determined. 2. After 7/1/04, DWR will assess and report on the adequacy of the verification efforts. If sufficient, continue. If not sufficient (not enough volunteers or inadequate results), solicit water users for adoption of Watermaster Service. (Fifteen percent of the diverters within the decree can request State Watermaster Service.)	DWR, Siskiyou County, SRWC, Siskiyou RCD	Interim/ Continual	$250,000/yr (approximate cost of two additional watermasters).
WATER MANAGEMENT: RAMPED FLOWS FOR DIVERSIONS						
ISSUES: Especially at the beginning of the irrigation season, a significant number of irrigators often begin diverting at the same time. This action may severely lower water levels almost instantaneously, causing fish stranding or other impacts.						
SOLUTIONS: Institute a cooperative agreement between diverters to stage their irrigation starts and completions to gradually change flows over several days.						
4	D	WM-3a	On the Shasta River, through Shasta CRMP, DWR and irrigators' cooperation, establish a voluntary program to stagger or rotate irrigation starts and completions (ramped flows). Monitor success. **Short-term:** Continue and expand this effort. **Long-term:** Continue appropriate implementation, monitor and adaptively manage. Develop a long-term plan for implementation.	DWR, CDFG, Shasta Valley RCD, CRMP	Interim/ Ongoing	Little or no incremental cost.
4	C	WM-3b	On the Scott River, investigate if ramping would be beneficial or necessary. **Short-term:** Survey water users, CDFG, and watermaster staff. Publish results. Begin implementation if appropriate. **Long-term:** Continue appropriate implementation. Monitor and adaptively manage. Develop a long-term plan for implementation.	SRWC, Siskiyou RCD, DWR, CDFG	Interim/ Continual	$20,000.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER MANAGEMENT: PULSE FLOWS						
ISSUES:			Juvenile outmigrants or other life stages may have difficulty migrating during some periods.			
SOLUTIONS:			Produce a pulse of flow, which will aid in migration.			
4	D	WM-4a	On the Shasta River, the CRMP and CDFG, through voluntary participation and compensation, develop an agreement under which landowners pull diversions for a limited period to allow a resulting pulse flow to travel downstream. **Short-term:** On the Shasta River, implement voluntary program among diverters to create pulse flows; augment with cost funding as needed. Monitor both flow and fish distribution results. Integrate findings of flow-temperature model in planning. Establish a monitoring protocol. **Long-term:** Reduce and eliminate barriers and water quality problems that create need for it in the first place. Integrate this effort with TMDL process.	CRMP, Shasta Valley RCD, DWR, CDFG, NCRWQCB	Interim/ Ongoing	$3,000/yr.
4	C	WM-4b	On the Scott River, CDFG should research with the SRWC and RCD to determine if some streams could benefit from a pulse flow. **Short-term:** Implement research recommendations.	CDFG, SRWC, Siskiyou RCD	Interim/ Ongoing	$20,000.
WATER MANAGEMENT: USING UNUSED WATER AND WATER RIGHTS FOR INSTREAM FISH FLOWS						
ISSUES:			Low instream flows limit habitat for coho salmon and other salmonids.			
SOLUTIONS:			Some water rights are currently not being exercised under existing decrees. Work within the water rights process to allow water rights holders to temporarily dedicate currently unused rights to instream flow.			
4	E	WM-5a	DWR and SWRCB should outline the procedure for developing instream flow dedications and develop incentives for acquiring instream flow. **Short-term:** Watermasters will continue and expand opportunities to help manage flows on some streams; develop an informational report to describe the process and incentives; identify potential for future measures; and develop guidelines to protect water users, inform funders, and ensure that water is used for instream flows.	DWR, SWRCB	Interim/ Continual	See text regarding instream flow.
4	D	WM-5b	On the Scott River, SRWC and DWR should determine unused diversion rights and approach those diverters about providing flows for instream use without affecting the water rights of others. **Short-term:** Once agreements are reached, work to inform other downstream users as to water amounts to be left in the stream. Oversee and shepherd those flows. **Long-term:** Acquire flows for permanent dedication.	SRWC, Siskiyou RCD, DWR, CDFG	Interim/ Ongoing	Little or no incremental cost.
4	D	WM-5c	On the Shasta River, the CRMP and DWR should determine unused diversion rights and approach those diverters about providing flows for instream use without affecting the water rights of others. **Short-term:** Once agreements are reached, work to inform other downstream users as to water amounts to be left in the stream. Oversee and shepherd those flows. **Long-term:** Acquire flow for permanent dedication. Include options for Dwinnell, Greenhorn, and other storage reservoirs.	CRMP, DWR, CDFG	Interim/ Ongoing	$50,000 for study. See text regarding instream flow.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER MANAGEMENT: IRRIGATION ROTATION PROGRAM						
ISSUES:			Low instream flows limit habitat for coho salmon and other salmonids and inhibit movement of coho salmon juveniles to secure rearing habitat.			
SOLUTIONS:			For certain stream and river reaches, diverters could rotate irrigations so not all users are on line at the same time when flows are critical for fish. This would leave additional flow in the stream to maintain or enhance habitat at critical times.			
4	D	WM-6a	Within watermastered areas, DWR watermasters could work closely with irrigators to develop creative water management techniques to benefit coho salmon. Develop incentives. Focus on key areas. **Short-term:** CDFG should identify critical habitat reaches and times that might benefit from this activity. DWR should continue pilot program. On the Shasta River, demand on river is variable and coordination among users might help avoid accidental problems.	DWR, Shasta Valley RCD	Interim/ Ongoing	Little or no incremental cost.
4	D	WM-6b	On non-watermastered reaches of the Scott River HA, develop a test rotation program with tributary groups. **Short-term:** Contact various tributary or ditch groups to assess willingness and difficulty. Execute pilot program. Write up results. **Long-term:** Continue to work with groups on irrigation coordination and other water management; expand as warranted.	SRWC, Siskiyou RCD, DWR	Interim/ Continual	$50,000.
WATER MANAGEMENT: INSTALL HEAD GATES AND MEASURING DEVICES ON DIVERSIONS						
ISSUES:			Low instream flows limit habitat for coho salmon and other salmonids and inhibit movement of coho salmon juveniles to secure rearing habitat. Many diversions do not have flow control devices or ways to measure discharges into the diversion. Without control structures and accurate measurements, diversions cannot be managed easily for changing stream flows and some users could be diverting more than their proper allotments. (See also WM-2 for verification.)			
SOLUTIONS:			Provide head gates and measuring devices for diversions.			
4	E	WM-7a	Within watermastered areas, continue DWR's program of constructing head gates and measuring devices on diversions. **Short-term:** Seek additional funding for these structures to help encourage timely installation. Install on all watermastered diversions by 2006.	DWR, RCDs	Interim/ Ongoing	Installing 50 devices will cost approximately $300,000/yr for 2 yrs, or $600,000.
4	D	WM-7b	Seek additional funds to provide structures for willing irrigators in non-water-mastered areas; CDFG, DWR, SRWC or RCD could participate. **Short-term:** Seek funding to provide measuring weirs and devices to willing irrigators. Install weirs and measuring devices as requested. (See recommendation WM-7a.) **Long-term:** Continue program until all diversions have gates and are measurable.	DWR, CDFG, SRWC, Siskiyou RCD	Interim	Little or no incremental cost.
4	D	WM-7c	On Shasta River, riparian users should participate. **Short-term:** Provide devices to riparian users. Set up voluntary diversion reporting process so the Watermaster knows what riparian users are doing.	DWR, CRMP, Shasta Valley RCD	Interim	Little or no incremental cost.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER MANAGEMENT: WATER AVAILABILITY PROJECTIONS AND FORECASTS						
ISSUES: Lack of prediction of water-year type limits opportunities for water management. Lack of short-term predictions similarly constrains planning for mid-season water use.						
SOLUTIONS: Forecasting stream flows for the water year based on snow surveys, precipitation, and aquifer condition within the season could aid water management techniques, such as irrigation rotation and harvesting, and thereby provide additional instream flows and habitat.						
4	D	WM-8a	On the Scott River, DWR, SRWC, USFS, and other partners should study the correlation of stream flow with other parameters to closely predict weekly flow rates (cfs). **Short-term:** Develop work/study plan. Collect additional data. Hire consultant /team. Implement. Seek additional funding to initiate and implement a predictive program. **Long-term:** Continue implementation.	DWR, SRWC, Siskiyou RCD, USFWS	Interim	$176,000 (see text).
4	D	WM-8b	On the Shasta River, DWR, USFS, CRMP and other partners should study the correlation of stream flow with other parameters to closely predict weekly flow rates (cfs). **Short-term:** Develop a work/study plan. Collect additional data. Hire consultant or team. Implement. Seek additional funding to initiate and implement a predictive program. **Long-term:** Continue implementation.	DWR, USFWS, Shasta Valley RCD, CRMP, NCRWQCB	Interim	$176,000 (see text).
WATER MANAGEMENT: INSTREAM FLOW STUDIES AND RECOMMENDATIONS						
ISSUES: Flow-habitat relationships for coho salmon have not been established and the amount of habitat required for coho salmon recovery has not yet been identified.						
SOLUTIONS: Conduct an instream flow study to develop the relationship between flows and habitat. Develop the relationship between flow and habitat availability for the different life stages of coho salmon.						
4	E	WM-9	CDFG and USFWS in cooperation with the community should seek funding to conduct instream flow studies on the Scott River and Shasta River to determine flow-habitat relationships. Establish a broad-based technical advisory group. Quantify how much, where, and when stream flow is needed for coho salmon rearing life stages. **Short-term:** As an interim measure and in coordination with the Emergency Water Plan and other recommended water management measures, identify target minimum instream flows for the tributaries that provide coho salmon summer rearing habitat. Use the best, scientifically valid method suitable for the analysis. Seek funding and carry out study. Explore different instream flow assessment methods including, 1D and 2D modeling, microhabitat mapping, hydrologic modeling and others. Use Water Balance information, including feasibility aspects. Evaluate potential for implementation in conjunction with applicable Reasonable and Prudent Measures required in NOAA Fisheries' Biological Opinion for the Klamath Project. **Long-term:** Integrate findings into watershed planning processes.	CDFG, NOAA Fisheries, USFWS, USFS, RCDs, CRMP, SRWC, NCRWQCB	Interim	$2,075,250 for Shasta, $2,132,250 for Scott, or $4,207,500 for both rivers.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER MANAGEMENT: GROUNDWATER STUDIES						
ISSUES:			Low instream flows limit habitat for coho salmon and other salmonids and inhibit movement of coho salmon juveniles to secure rearing habitat. Some groundwater withdrawals appear to be linked to surface flows, but effects are not conclusive given other factors (climate change, precipitation variations, upland vegetation changes and removed barriers).			
SOLUTIONS:			Study groundwater availability in the Scott and Shasta Valley to determine groundwater status and potential needs and opportunities regarding groundwater management.			
4	E	WM-10a	DWR, the CRMP, and other partners should seek funding and cooperators to conduct a comprehensive groundwater study of the Shasta Valley. **Short-term:** Seek funding; conduct the study; make recommendations that would help preserve or enhance instream flows. Look at using groundwater from wells not connected with the river during low-flow periods and effect of infiltration from unlined ditches. Lead agencies will apply for funds for 2-year study by May 2004. **Long-term:** Implement recommendations as applicable. Coordinate results with water supply augmentation options.	DWR, CDFG, CRMP, NCRWQCB Shasta Valley RCD, Siskiyou County	Interim	$176,000 (see text).
4	E	WM-10b	Prepare a comprehensive study updating previous work by USGS (Seymour Mack 1958) and DWR to determine the current status of groundwater in the Scott Valley and its relationship to surface flows. Studies should include factors such as climate change, adjudications/decree verification, precipitation variability, changes in upland vegetation and removal of diversions and natural dams (e.g. beaver dam) that would have elevated groundwater levels. **Short-term:** Obtain funding to update the study. Find additional wells and cooperative landowners to measure monthly groundwater levels and develop current groundwater contours. Analyze data to assess management options. Look at using groundwater from wells not connected with the river during low flow periods. Lead agencies will apply for funds for 2-year study by May 2004. **Long-term:** Coordinate results with water supply augmentation options.	DWR, Siskiyou County, SRWC, NCRWQCB, Siskiyou RCD	Interim	$176,000 (see text).
4	D	WM-10c	Prior to groundwater study completion, recommend County establish process for developing groundwater management plans. If the comprehensive groundwater study shows the necessity, the County should initiate a basin-specific groundwater plan to protect the resource of groundwater for all users, including fish. **Short-term:** Review results of groundwater study and previous county work. Recommend that by 2005, the County appoint a broadly representative, community based steering committee to develop the idea. Formalize the process for preparing basin-wide plans using groundwater study results. Implement plan. Beginning in 2006, review and analyze study results and determine thresholds and actions to protect resource for all users.	Siskiyou County, RCDs, SRWC, NCRWQCB, CRMP, DWR, CDFG	Interim	$200,000 (see text).

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER MANAGEMENT: WATER BALANCE STUDY						
ISSUES:	The connection between surface water and groundwater and the sources and sinks of water are poorly understood. This lack of knowledge limits the ability to take actions to increase instream flow and maintain the groundwater levels necessary to support riparian vegetation.					
SOLUTIONS:	Conduct studies that will provide the missing information and use that information to guide water management, water augmentation, and habitat enhancement.					
4	D	WM-11a	Support completion of the Scott River Water Balance Study to learn how water behaves in the river; in particular establish the fate of water added to the Scott River to increase instream flow. The study should identify the best locations to augment flow and predict the impact of the additional water at downstream locations. Apply the results of the completed Water Balance Study to water management, water augmentation, and habitat enhancement recommendations. **Short-term:** Obtain funds to complete Water Balance Study. Use results to guide projects that will support improvement to coho salmon habitat. **Long-term:** Continue implementation.	SRWC, Siskiyou RCD, DWR, NCRWQCB	Interim/ Ongoing	$60,000 for study.
4	D	WM-11b	Support preparation of a water balance study for the Shasta River to learn how water behaves in the river, in particular establish the fate of water added to the river to increase instream flow. The study should identify the best locations to augment flow and predict the impact of the additional water at downstream locations. Apply the results of the completed study to water management, water augmentation, and habitat enhancement recommendations. **Short-term:** Obtain funds to prepare Water Balance Study. Use results to guide projects that will support improvement to coho salmon habitat.	CRMP, Shasta Valley RCD, DWR, NCRWQCB	Interim	$100,000 for study.
WATER AUGMENTATION – SHASTA VALLEY HSA, SCOTT BAR HSA AND SCOTT VALLEY HSA						
WATER AUGMENTATION: WATER TRUST (WATER LEASING)						
ISSUES:	Low stream survival and growth during some coho salmon life stages.					
SOLUTIONS:	Provide a structured process for willing participants to donate, sell, or lease water or water rights to provide improved stream flow for coho salmon and habitat at critical periods.					
4	E	WA-1a	Support the ongoing efforts of the Scott River Water Trust to create an endowment that will support the Trust as a non-permanent agent for buying water to augment instream flows. **Short-term:** Complete the Phase 1 study funded by CDFG grant; Phase 2, implementation of the Water Trust, will occur no later than 2006 if Phase 1 supports feasibility of the process. Verification of the adjudication should be a concurrent activity to use of the Water Trust to ensure that legal use of water is addressed and that flows reflect this. **Long-term:** Continue as needed with the expectation that instream flow issues will be addressed and remedied, making this function less important.	SRWC, Siskiyou RCD, DWR, CDFG	Interim/ Ongoing	Little or no incremental cost.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER AUGMENTATION: WATER TRUST (WATER LEASING) (continued)						
4	E	WA-1b	Promote the establishment of a Shasta River Water Trust. **Short-term:** Explore options to create the Shasta River Water Trust and implement as applicable. Identify willing participants in the short term until longer-range solutions are available or in place. **Long-term:** Continue as needed with the expectation that instream flow issues will be addressed and remedied, making this function less important.	CRMP, Shasta Valley RCD, DWR, CDFG	Interim	Little or no incremental cost.
4	D	WA-1c	Create an endowment to provide funding for water leasing and purchase. **Short-term:** Find commitment for funding a water leasing or purchase program. Solicit agency support. Evaluate potential for implementation in conjunction with applicable Reasonable and Prudent Measures required in NOAA Fisheries' Biological Opinion for the Klamath Project.	SRWC, CRMP, RCDs, CDFG	Interim	See text regarding instream flow.
4	D	WA-1d	Initiate measures to create or enhance instream flows by reducing irrigation starting in September to promote access and connectivity of existing spawning areas; capitalize on available adult returns. Where this applies to rearing areas, it would also benefit juveniles. **Short-term:** (1) Prioritize streams where benefit will be greatest; (2) Solicit cooperation from water users; (3) Develop a contact list; (4) Acquire funding; (5) Form a water management group to manage the money and develop an implementation strategy, including long-range planning for growers. Implementation in Summer 2004. Investigate option for participators to not irrigate after September 1 (e.g., a fourth alfalfa crop) with this water dedicated to instream flows in exchange for appropriate reimbursement. **Long-term:** Continue as necessary.	DWR, RCDs, SRWC, CRMP	Interim	$30,000 for study. Other costs addressed in WA-1. See text regarding instream flow.
WATER AUGMENTATION: STUDY ADDITIONAL LARGE SURFACE WATER STORAGE						
ISSUES:	Low instream flows limit survival and growth during some coho salmon life stages. Winter runoff once out of the system cannot be recovered to provide year round flows at critical times to benefit coho salmon.					
SOLUTIONS:	Study the feasibility of building storage reservoirs to capture excess winter runoff and manage stream flows more for the benefit of coho salmon. Implement if feasible and acceptable. The intent of the stored water would be to benefit coho salmon, not to increase the irrigation acreage or volume.					
4	C	WA-2a	Initiate reconnaissance level studies to identify possible surface storage opportunities and possible fatal flaws for those alternatives in the Shasta River watershed. Off-stream reservoirs may provide storage yet maintain current or improved fish habitat. The study should identify management alternatives. **Short-term:** Identify environmental concerns for additional water storage, including those on steelhead and Chinook and develop proposal to alleviate. Initiate reconnaissance level study of increasing storage at Lake Shastina and opportunities for use of water from Greenhorn Reservoir. **Long-term:** Seek funding for and implement feasible projects.	DWR, CRMP, Shasta Valley RCD, USFS	Interim	$176,000 for study.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER AUGMENTATION: STUDY ADDITIONAL LARGE SURFACE WATER STORAGE (continued)						
4	D	WA-2b	Initiate reconnaissance level studies to identify possible surface storage opportunities and possible fatal flaws for those alternatives in the Scott River watershed. Off-stream reservoirs may provide storage yet maintain current or improved fish habitat. The study should identify management alternatives. **Short-term:** Look into historical and proposed water storage reservoirs; expedite the process at the elected official and agency levels. Consider potential impacts on Chinook and steelhead. Consider Noyes Valley, Wildcat Creek, Kidder Valley off-stream and other off-stream and upslope sites. Consider option of ditching or pumping water to storage area. Determine how to avoid usual problems with water storage, such as infilling of the storage structure with sediment, address channel maintenance flows, etc. **Long-term:** Seek funding for and implement feasible projects.	DWR, USFS, SRWC, Siskiyou RCD		$176,000 for study.
WATER AUGMENTATION: SMALL STORAGE OPPORTUNITIES (OFF-STREAM OR HIGH MOUNTAIN LAKES)						
ISSUES:	Low instream flows limit survival and growth during some coho salmon life stages. Winter runoff once out of the system cannot be recovered to provide year round flows at critical times to benefit coho salmon.					
SOLUTIONS:	Raise the levels of existing small lakes or create storage using small off-stream reservoirs rather than one large reservoir.					
4	D	WA-3a	Study raising additional mountain lakes in a reconnaissance level effort. **Short-term:** Support current partnership effort to rehabilitate Cliff Lake to provide 150 acre-feet of water for coho salmon rearing and migration; Identify USFS small storage locations that have not been maintained. **Long-term:** Seek funding for and implement feasible projects.	DWR, USFS, CDFG	Interim/ Ongoing	$176,000 for study. Approximately $300,000 to implement.
4	D	WA-3b	Study using small, off-stream ponds for increased storage. **Short-term:** Identify options for off-stream storage on public and private lands. **Long-term:** Seek funding for and implement feasible projects.	DWR, CDFG, SRWC, CRMP	Interim	$176,000 for study. Approximately $1,750,000 to create 10 ponds.
WATER AUGMENTATION: STORE WATER WITH A CONJUNCTIVE GROUNDWATER USE PROGRAM AND GROUNDWATER RECHARGE PONDS						
ISSUES:	Low instream flows limit survival and growth during some coho salmon life stages.					
SOLUTIONS:	Initiate reconnaissance level study of operating surface storage in conjunction with groundwater storage. Establish groundwater recharge ponds that receive and capture high winter river and stream flows and allow that water to percolate and recharge the aquifer. Recharging/maintaining the groundwater may be used to increase stream flows (e.g., recharging groundwater that is connected to the surface flows or using the groundwater to replace surface diversions).					
4	D	WA-4a	Along with general groundwater investigation on the Shasta (see WM-10a), include coordinating groundwater storage with operation of Lake Shastina. **Short-term:** Conduct Shasta River Groundwater Study to obtain basic data. Evaluate potential for implementation in conjunction with applicable Reasonable and Prudent Measures required in NOAA Fisheries' Biological Opinion for the Klamath Project. **Long-term:** Look at options for conjunctive use in specific study.	DWR, Shasta Valley RCD, Siskiyou County, CRMP	Interim	$176,000 for study.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER AUGMENTATION: STORE WATER WITH A CONJUNCTIVE GROUNDWATER USE PROGRAM AND GROUNDWATER RECHARGE PONDS (continued)						
4	D	WA-4b	On the Scott River, as part of both the general groundwater investigation and the surface reservoir investigation (see WM-10b), include conjunctive groundwater operation. **Short-term:** Find funding and implement reconnaissance level study. Evaluate potential for implementation in conjunction with applicable Reasonable and Prudent Measures required in NOAA Fisheries' Biological Opinion for the Klamath Project. **Long-term:** Pursue feasibility study and implement if warranted.	DWR, Siskiyou RCD, Siskiyou County, SRWC	Interim	$176,000 for study.
4	D	WA-4c	On both the Scott and Shasta, investigate the most efficient ways to recharge groundwater. Mechanisms could include recharge ponds, unlined ditches, or others. Evaluate pre-season flooding of agricultural land for groundwater recharge. **Short-term:** Find funding and initiate groundwater and hydrologic studies, develop groundwater management criteria (yield and withdrawal criteria), identify possible recharge locations, and conduct reconnaissance level studies, which include legal aspects. Evaluate potential for implementation in conjunction with applicable Reasonable and Prudent Measures required in NOAA Fisheries' Biological Opinion for the Klamath Project. **Long-term:** Pursue feasibility study and implement if warranted.	DWR, UC Davis Cooperative Extension, Siskiyou County, SRWC, CRMP, NRCS, RCDs	Interim	$300,000 for study. Approximately $1,000,000 to implement.
WATER AUGMENTATION: SCOTT VALLEY TAILINGS WATER STORAGE						
ISSUES: Low instream flows limit survival and growth during some coho salmon life stages.						
SOLUTIONS: On the Scott River, reshape dredge tailings to provide additional water storage within the remaining tailings.						
4	D	WA-5	Initiate reconnaissance-level study on options for a tailings rehabilitation and water storage project. Pursue viable options; coordinate water storage with restoration. **Short-term:** Find funding and implement reconnaissance level study. **Long-term:** Pursue feasibility study and implement if warranted.	SRWC, USFWS, CDFG, Siskiyou County	Interim	$250,000 for study. Long-term costs covered by other recovery actions.
WATER AUGMENTATION: WATER CONVEYANCE TO SHASTA VALLEY FROM MAIN KLAMATH						
ISSUES: High water temperatures and low instream flows limit survival and growth during some coho salmon life stages.						
SOLUTIONS: A water diversion of between 100 and 200 cfs from the mainstem Klamath River above Iron Gate Reservoir could provide irrigation water to the Shasta Valley greatly reducing the need for water diversions and ground water pumping for agricultural purposes. The majority of the low temperature, high quality water from the Shasta River would then be left instream to the benefit of spawning and rearing coho salmon.						
4	E	WA-6a	Study the legality of a Klamath-to-Shasta diversion. **Short-term:** Verify the legal status of the several reserved water rights for the Shasta Valley, and map out the best strategy to exercise them. Coordinate with the relicensing before FERC.	Siskiyou County, USBR, SWRCB, CRMP, DWR	Interim	$6,000-$7,000.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER AUGMENTATION: WATER CONVEYANCE TO SHASTA VALLEY FROM MAIN KLAMATH (continued)						
4	D	WA-6b	Conduct Feasibility Study **Short-term:** Study engineering and environmental considerations of the various point-of-diversion possibilities, including capital and operation costs and biological and ecological considerations. Select most promising approach. Determine how much water is needed in Shasta Valley with Dwinnell Dam intact and without Dwinnell Dam.	DWR, Siskiyou County, USBR, SWRCB, CRMP	Interim	$200,000.
WATER AUGMENTATION: ACQUIRING WATER RIGHTS						
ISSUES:			Low instream flows limit survival and growth during some coho salmon life stages			
SOLUTIONS:			Acquire water rights that shall be dedicated to instream flow.			
4	E	WA-7a	Conduct reconnaissance-level investigations. **Short-term:** Conduct cost-benefit analysis that includes socioeconomic effects to community and legal considerations; Present options and survey public support. Proceed as warranted.	DWR, CDFG, SRWC, CRMP	Interim	$200,000.
4	D	WA-7b	Depending upon study, engage and support projects **Short-term:** Solicit interest from willing participants. Evaluate potential for implementation in conjunction with applicable Reasonable and Prudent Measures required in NOAA Fisheries' Biological Opinion for the Klamath Project. **Long-term:** Continue short-term actions.	DWR, CDFG, SRWC, CRMP	Interim/ Continual	See text regarding instream flow.
4	D	WA-7c	Apply the results of appropriate studies (e.g., water balance, instream flow, coho salmon population surveys) to prioritize the purchase of water rights. **Short-term:** Complete and synthesize studies; fund implementation.	DWR, CDFG, SRWC, CRMP	Interim/ Continual	See text regarding instream flow.

HABITAT MANAGEMENT AND RESTORATION – SCOTT BAR HSA AND SCOTT VALLEY HSA

HABITAT MANAGEMENT AND RESTORATION: IMPROVEMENT OF SUMMER AND WINTER REARING HABITAT

ISSUES: Lack of Habitat Complexity. The Scott River watershed has experienced a loss of summer and winter rearing habitat for juvenile coho salmon. Juvenile coho salmon naturally move throughout the year looking for suitable temperature, cover, flow velocity, and food supply. Large logs, small woody debris, boulders, pools, side channels, beaver ponds, springs, and accessible wetlands provide habitat complexity and are "safe havens" for coho salmon juveniles. Protection from high flows, such as can be found around large structures in the stream or in backwaters connected to the stream, is necessary for over-wintering survival of juvenile coho salmon. Riparian vegetation provides habitat complexity and is an important element supporting juvenile rearing habitat for coho salmon. Riparian vegetation has been reduced for a variety of reasons, including lowering of the water table and channel destabilization. Current information shows a positive relationship between coho salmon presence and beaver ponds. The valley was historically heavily populated with beaver until mid-1800s. Today small populations exist. The rather stable ponds created by these animals, especially on valley tributaries, likely created year round fish rearing habitat, including the period of low stream flow. Changes in stream channel form and function may have limited riparian restoration potential. Changes in hydrologic conditions, such as changes in groundwater and water use may also limit riparian restoration potential. The loss of off-channel habitat results in a loss of productive rearing and over-wintering areas, often favored by species such as the coho salmon.

SOLUTIONS: Identify and conserve existing rearing habitat. Restore lost rearing habitat where possible. In locations where there are problems, increase habitat complexity. Find new ways to increase riparian vegetation in addition to continuing current efforts.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
HABITAT MANAGEMENT AND RESTORATION: IMPROVEMENT OF SUMMER AND WINTER REARING HABITAT (continued)						
4	E	Scott HM-1-1a	Study the habitat needs of rearing coho salmon in the Scott River watershed. Identify critical existing coho salmon rearing habitat. For the protection of riparian habitat, see recommendation P-2. **Short-term:** Secure funding; work with landowners to gain access; explore methods to obtain the necessary data to implement the appropriate coho salmon recovery projects; develop an action plan to prioritize projects. Coordinate with other ongoing agreements and scheduling. **Long-term:** Implement and evaluate projects.	CDFG, Siskiyou RCD, SRWC, USFS, NOAA Fisheries	Interim	$300,000 for study. See text regarding habitat restoration.
4	D	Scott HM-1-1b	Identify methods for increasing habitat complexity and appropriate locations for instream habitat structures to create pools, increase habitat complexity, and improve bank stabilization. All bank stabilization projects should be done in a fish-friendly manner. **Short-term:** Research and quantify locations and develop restoration plans for them. Define what constitutes fish-friendly bank stabilization. Evaluate existing alternative bank stabilization methods. Continue to seek funding and carry out specific projects. **Long-term:** Assess and monitor activities to determine whether or not instream structures are working properly and doing no harm. There should be a decreasing need to install instream structures as natural river channel processes (channel meander, riparian vegetation recruitment, reduced sedimentations, etc.) are improved.	CDFG, Siskiyou RCD, SRWC, USFS, NOAA Fisheries	Interim	See text regarding habitat restoration.
4	D	Scott HM-1-1c	Encourage riparian restoration projects using locally native vegetation. Project implementation should consider if: 1) the site previously supported riparian vegetation and still has the soil and hydrologic characteristics to support it; 2) the native plants selected are likely to flourish; 3) the width of the planted riparian zone is appropriate for the hydrologic regime at the site; and 4) the plan includes effectiveness monitoring using approved protocols. Establish procedures for recommending appropriate plant materials where natural conditions are significantly compromised. **Short-term:** Support ongoing riparian restoration efforts and continue to seek funding and carry out projects with an emphasis on the tributaries, especially those identified as potentially major coho salmon streams. Evaluate outcomes of replanting and research causes of riparian planting outcomes, appropriate width of planted areas, and new strategies for restoration. Monitor past projects to secure updated information on most effective techniques. **Long-term:** Assure implementation monitoring with emphasis on protecting the coho salmon refugia.	Siskiyou RCD, SRWC, NCRWQCB, CDFG	Interim/ Ongoing	See text regarding habitat restoration.
4	D	Scott HM-1-1d	Continue riparian easement programs. **Short-term:** Seek cooperation from local landowners. Compensate land-owners for short- or long-term protection of their riparian property.	NRCS, Landowners, RCDs	Interim/ Ongoing	See text regarding habitat restoration.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
HABITAT MANAGEMENT AND RESTORATION: IMPROVEMENT OF SUMMER AND WINTER REARING HABITAT (continued)						
4	D	Scott HM-1-1e	Evaluate the use of beaver ponds and other efforts that contain similar benefits to increase habitat complexity. **Short-term:** Review literature (studies done in Washington and Oregon). Hold workshops and publish newsletters as appropriate. Investigate projects in prioritized areas to support beaver activity if appropriate. Coordinate with related projects to improve stream complexity and habitat. If projects are planned, ensure that riparian growth is adequate or provide materials for beaver needs, so that appropriate riparian cover is maintained. **Long-term:** Include implementation monitoring. If beaver reintroduction fails or is found to be inappropriate, consider analogous habitat attribute efforts.	RCDs, CDFG, NOAA Fisheries	Interim	$200,000 for study.
HABITAT MANAGEMENT AND RESTORATION: IMPROVEMENT OF SUMMER AND WINTER REARING HABITAT						
ISSUES:	High Water Temperatures. Water temperatures are influenced by amount of river flow, and river structure (W/D ratios, etc.), air temperature, shading from terrain and vegetation, influx of groundwater, tributary flow and runoff, and other factors, including aggraded streambeds and sedimentation. High water temperatures can stress coho salmon, increasing disease and mortality. Water temperature is listed as a significant problem for the Scott River (303d impaired) and the condition is associated with current summer flow regime and the valley structure of the river (high width to depth ratios). Water temperature influences the development and survival of coho salmon by affecting different physiological processes such as growth and smoltification. Water temperature affects migration timing and the fishes' ability to cope with predation and disease and exposure to contaminants. High water temperatures also create thermal barriers to migration.					
SOLUTIONS:	Identify and remedy conditions that contribute to high water temperatures. Restore structure of river. Modeling water temperature and flow relationships in the mainstem will help guide the timing of water additions to the river and selecting the best locations for restoration of water table, meander pattern, and slope.					
4	E	Scott HM-1-2a	Identify location, timing, frequency and duration of thermal barriers to migration for adult and juvenile coho salmon. Develop habitat improvement measures that address temperature. **Short-term:** Identify and map locations and timing of thermal barriers. Coordinate information and projects to address appropriate solutions in prioritized areas with the most benefit to coho salmon. **Long-term:** Implement projects or measures in coordination with over-all habitat recovery process and monitor for improvements in an adaptive fashion.	CDFG, NOAA Fisheries, Siskiyou RCD, SRWC, NCRWQCB	Interim	$176,000 for study. See text regarding habitat restoration.
4	C	Scott HM-1-2b	Investigate the contribution to stream cooling of the flow of cool water through gravel. Investigate the interference of fine sediment in that process. **Short-term:** Seek funding and carry out study using agreed-upon scientists identified by the Technical Committee of the SRWC. **Long-term:** Use results to plan projects and drive adaptive management.	SWRC, NCRWQCB, Siskiyou RCD	Interim	Little or no incremental cost.
4	D	Scott HM-1-2c	Install systems that treat warm water or percolate it through the ground to cool it. (See also WUE-7b) **Short-term:** Seek funding and carry out projects where appropriate.	Siskiyou RCD, SRWC, NRCS	Interim	$200,000 for approximately two projects.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
HABITAT MANAGEMENT AND RESTORATION: IMPROVEMENT OF SUMMER AND WINTER REARING HABITAT (continued)						
4	D	Scott HM-1-2d	Model the relationship of temperature and flow and use the results to plan the timing and locations of water additions to the river. **Short-term:** Fund and implement temperature studies. Coordinate with the NCRWQCB TMDL process in data collection. **Long-term:** Monitor projects to determine optimum benefits are achieved with implementation of habitat improvement actions.	Siskiyou RCD, CDFG, SRWC, NCRWQCB	Interim	$176,000 for study.
HABITAT MANAGEMENT AND RESTORATION: IMPROVE VALLEY AND LOW-GRADIENT TRIBUTARY CHANNEL STRUCTURE AND FUNCTION						
ISSUES:	Degraded Channel Structure and Function. Historical accounts indicate that in the early 1900s the Scott River in the valley was narrow and deep (with more of a meander pattern) and was more in contact with its flood plain. Today the river is currently a mix of reaches, some are narrow and riprapped, while others are broad and wide. Channel recovery is impeded. Most reaches illustrate large width to depth ratios. This fact, combined with summer low flows and minimal riparian shading, lead to very warm stream temperatures during the summer months. In other reaches, down-cut channel conditions, loss of meander pattern, and increased stream gradient all translate to increased amounts of stream flow (stream power) held within the channel during larger flows resulting in increases stream-bank erosion and the need for riprap. Down-cut channels also act as drains to surrounding land resulting in a lowering of the water table. This has ramifications on water storage, riparian vegetation and stream-bank stabilization.					
SOLUTIONS:	Restore valley river structure to an appropriate meander pattern, decreased channel slope, decreased width-to-depth ratios, proper connections with the flood plain and side channels, where feasible.					
4	D	Scott HM-2a	Evaluate the geomorphology of the Scott River system. Identify all areas of high width-to-depth ratios, with entrenched channels, or other compromised areas. Implement projects that improve stream geomorphology at specific locations in conjunction with system-wide stream channel improvement. Identify and apply consistently a system of stream classification. **Short-term:** Need expert input – understand fluvial processes and formulate plan of recovery. Map areas of unstable banks, high width-to-depth ratios, or entrenched channels. Develop a Request for Proposals for stream channel restoration projects that are based in natural process restoration. **Long-term:** Implement a long-term monitoring program to assess responses to implemented restoration projects, with monitoring sites established to measure, for example, cross-sectional channel profile, substrate composition, stream-bank condition (including riparian vegetation), and photo points.	CDFG, Siskiyou RCD, SRWC, NCRWQCB, NOAA Fisheries	Interim/ Continual	$176,000 for initial study. Approximately $160,000 for monitoring/yr.
4	D	Scott HM-2b	Identify locations where the main channel can be reconnected to its flood plain and historic sloughs to allow formation of side channels without negative impacts to the community. Implementation of this recommendation should be done after remediation of the Callahan Dredger Tailings. **Short-term:** Assess the feasibility of setback levees to restore channel function. Survey with funding. Prioritize projects and solicit buy-in. Utilize information from habitat studies above to select locations for the best cost/benefit to coho salmon. **Long-term:** Implement projects as appropriate. Include appropriate monitoring of this effort.	SRWC, Siskiyou RCD, Landowners, CDFG, NOAA Fisheries	Interim	$200,000 for study. Incremental restoration costs uncertain.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
HABITAT MANAGEMENT AND RESTORATION: IMPROVE VALLEY AND LOW-GRADIENT TRIBUTARY CHANNEL STRUCTURE AND FUNCTION (continued)						
4	E	Scott HM-2c	Restore the Scott River flood plain in the Callahan Dredger Tailings reach, through a community-driven process supported by the SRWC. **Short-term:** Review Tom Hesseldenz and Associates report to USFWS. Secure funding to establish a stakeholder group (including agencies and design consultants) to formulate a process and plan to restore the tailings. **Long-term:** Secure funding and implement tailings restoration.	SRWC, Siskiyou RCD, CDFG, Siskiyou County, USFWS	Interim	$30,000,000.
HABITAT MANAGEMENT AND RESTORATION: BARRIERS TO FISH PASSAGE						
ISSUES:	Juvenile coho salmon need access to rearing habitat that is suitable at different times of the year, however natural and other barriers may prevent them from moving freely. Barriers to juvenile fish movement are found where streamflow goes sub-surface and where impediments in the channel block fish passage. Coho salmon return to the Scott River in November, making their way up through the canyon to spawning grounds. Particularly in drought years, natural and other barriers may delay or prevent coho salmon from reaching spawning areas. Barriers to movement are found where streamflow goes sub-surface and where impediments in the channel block fish passage. Some barriers are the result of human activity and have the potential to be remedied.					
SOLUTIONS:	Continue to investigate and implement fish passage improvement projects and promote the surface connectivity of streams that provide coho salmon habitat.					
4	E	Scott HM-3a	Identify location, timing, duration and frequency of low flows that prevent juvenile access to rearing habitats and adult access to spawning habitats. **Short-term:** Compile information and incorporate into a GIS. **Long-term:** Implement actions to remediate barriers.	CDFG, Siskiyou RCD, SRWC, DWR	Interim/ Ongoing	Little or no incremental cost.
4	C	Scott HM-3b	Identify, prioritize, and treat barriers on private roads, consistent with the Five Counties process for road assessments. Comply with CDFG-NOAA Fisheries passage criteria. **Short-term:** Prioritize projects for benefit to coho salmon and implement with completion dates in the near term (1-3 years). **Long-term:** Implement actions to remediate barriers.	Siskiyou RCD, CDFG, SRWC, Landowners	Interim	See text regarding treatment of barriers to passage.
4	D	Scott HM-3c	Investigate opportunities to construct low-flow channels through alluvial fans to improve fish passage (short- and long-term) in all tributaries from French Creek north. **Short-term:** Compile data describing where barriers are found. Secure funding to formulate a process and plan to restore the aggraded reaches. **Long-term:** Secure funding and implement restoration.	CDFG, Siskiyou RCD, SRWC, NOAA Fisheries	Interim	$1,800,000 assuming treatment of six sites.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
HABITAT MANAGEMENT AND RESTORATION: IMPROVEMENT OF SPAWNING HABITAT						
ISSUES:	Spawning coho salmon require gravel with rocks within a particular size range. They prefer spawning locations with adequate habitat complexity to prevent redds from washing out in floods and provide cover nearby for emerging fry. Moffett Creek has a high sediment load, can run turbid, and contributes a large amount of fine-grained sediment to the Scott River. Large pools in the Canyon Area are reduced in volume due to granitic sand loading. In other locations, aggradations of larger cobbles and boulders have covered or replaced spawning gravels. Erosion from mining tailings affects many tributaries from the South Fork to Scott Bar.					
SOLUTIONS:	Identify and conserve existing spawning habitat. Restore lost spawning habitat where possible. In locations where there are problems, increase habitat complexity and gravel quality.					
4	E	Scott HM-4a	Identify existing coho salmon spawning habitat. Study the habitat needs of spawning coho salmon in the Scott River watershed. Protect and maintain spawning habitat to prevent further loss of the species. **Short-term:** Secure funding. Continue and expand existing surveys. Quantify spawning habitat. Use this information to prioritize projects for habitat restoration and enhancement **Long-term:** Continue to use results to plan projects and drive adaptive management.	SRWC, NCRWQCB, Siskiyou RCD, CDFG, NOAA Fisheries	Interim/ Ongoing	$176,000 for study. See text regarding habitat restoration.
4	D	Scott HM-4b	Improve spawning gravel quantity and quality. **Short-term:** Develop a sediment budget; identify locations with an action plan for desired future conditions; and determine and remediate causes of aggradation. Identify locations that have poor quality or lack adequate spawning gravels but in other respects meet coho salmon spawning requirements. Remove fine sediment from gravels in locations that otherwise meet coho salmon spawning requirements but where gravels are buried. Remove large, aggraded rock from locations that otherwise meet coho salmon spawning requirements but where gravels are buried. Assess gravel recruitment and augmentation locations. **Long-term:** Design, secure funding, and implement projects.	SRWC, NCRWQCB, Siskiyou RCD, CDFG, NOAA Fisheries	Interim	See text regarding habitat restoration.
4	C	Scott HM-4c	Identify and remedy sources of fine sediment within the SSRT area. **Short-term:** Secure funding and conduct surveys. Use this information to implement projects to reduce sediment input. **Long-term:** Continue as needed.	Siskiyou RCD, SRWC, CDFG, NCRWQCB, NRCS, Landowners	Interim	See text regarding treatment of barriers to passage.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
HABITAT MANAGEMENT AND RESTORATION – SHASTA VALLEY HSA						
HABITAT MANAGEMENT AND RESTORATION: IMPROVEMENT OF REARING HABITAT						
ISSUES	Inaccessibility to tributaries, high stream temperatures, low dissolved oxygen levels, and lack of habitat complexity limit coho salmon production within the Shasta River.					
SOLUTIONS	In the short-term identify and maintain existing spawning and rearing habitats. In the long term, create multiple refugia areas, and/or re-link those no longer accessible. Establish recovery goals.					
4	E	Shasta HM-1a	Identify existing areas successfully used for rearing and potential rearing areas by conducting entire mainstem channel-length survey: 1) water temperature/refugia; and 2) habitat suitability based on slope and water velocity. Estimate carrying capacity and fish utilization of rearing habitat. Identify spawning areas and determine accessibility to rearing areas. **Short-term:** Secure funding, conduct habitat, spawning, and rearing surveys, and prepare analysis. **Long-term:** Use results to guide and prioritize projects to insure best benefit to coho salmon and overall restoration of the river.	CDFG, NCRWQCB, Shasta Valley RCD, CRMP, Landowners	Interim	$176,000.
4	D	Shasta HM-1b	Implement habitat protection, restoration, and improvement projects that enhance rearing habitat in high priority areas. **Short-term:** Focus on areas currently accessible to coho salmon or potentially accessible (e.g. below Greenhorn and Dwinnell Dams). Conduct habitat suitability studies (see also Shasta HM-1a) on other streams to guide future actions. Coordinate with long-range planning effort for addressing barriers (Shasta HM-2). Possible projects to include are livestock control or exclusion fencing, tree and emergent planting, bioengineered bank stabilization, and irrigation tailwater reduction. **Long-term:** Continue projects. Monitor for effectiveness over the long term, utilizing adaptive management to fine-tune projects for best benefit to coho salmon.	Shasta Valley RCD, CRMP, CDFG, Landowners	Interim	See text regarding habitat restoration.
HABITAT MANAGEMENT AND RESTORATION: BARRIERS TO FISH PASSAGE						
ISSUES	Juvenile coho salmon need access to rearing habitat that is suitable at different times of the year, however natural and other barriers may prevent them from moving freely. Barriers to juvenile fish movement are found where streamflow goes sub-surface and where impediments in the channel block fish passage. Coho salmon return to the Shasta River in November, making their way up through the canyon to spawning grounds. Particularly in drought years, natural and other barriers may delay or prevent coho salmon from reaching spawning areas. Barriers to movement are found where streamflow goes sub-surface and where impediments in the channel block fish passage. Some barriers are the result of human activity and have the potential to be remedied.					
SOLUTIONS	Continue to investigate and implement fish passage improvement projects and promote the surface connectivity of streams that provide coho salmon habitat.					
4	E	Shasta HM-2a	Identify barriers to fish passage throughout the watershed for adults and juveniles, and work to implement solutions to these barriers. **Short-term:** At each site assess impacts on water quality and assess importance for coho salmon passage at each site. Assign each dam/impoundment a priority for reduction or removal. Work with users to select workable management measures. Implement short term solutions and work towards removal or remediation of passage problems at flashboard dams as soon as possible where feasible; otherwise develop temporary modifications to minimize passage and water quality problems. **Long-term:** Implement removal or remediation of passage problems at flashboard dams where feasible, otherwise modify to minimize passage and water quality problems. Continue to work with affected landowners and implement workable solution. Refine and Implement long-term solutions.	CDFG, NCRWQCB, Shasta Valley RCD, CRMP, Landowners	Interim	See text regarding treatment of barriers to fish passage.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
HABITAT MANAGEMENT AND RESTORATION: BARRIERS TO FISH PASSAGE (continued)						
4	D	Shasta HM-2b	Develop a long-term strategy for improving passage at Greenhorn and Dwinnell dams. **Short-term:** Develop working group to create long-range strategy for Greenhorn and Dwinnell, including assessment of suitability of habitat upstream, options for passage or modification/removal. **Long-term:** Develop a long-term solution and implement that if it is different from short-term outcome.	CDFG, Shasta Valley RCD, CRMP, Landowners	Interim	See Shasta HM-2a.
4	E	Shasta HM-2c	Develop solutions for water quality barrier caused by impoundment at Highway 3. **Short-term:** Provide for passage at Highway 3 as soon as possible; determine impacts on water quality, if any, at all sites. **Long-term:** Develop a plan for complete removal if possible. Implement TMDL plans.	CDFG, NCRWQCB, Shasta Valley RCD, CRMP, Landowners	Interim	See Shasta HM-2a.
4	E	Shasta HM-2d	Provide for passage at impoundment above County Road A-12. **Short-term:** Provide for passage above A-12 to Big Springs refugia area as soon as possible. Determine impacts on water quality, if any. **Long-term:** Develop a plan for complete removal if possible.	CDFG, NCRWQCB, Shasta Valley RCD, CRMP, Landowners	Interim	See Shasta HM-2a.
4	D	Shasta HM-2e	Eliminate barriers caused by high water temperatures throughout the river. **Short-term:** Work with Shasta Temperature model and through TMDL process to establish appropriate targets based on system capability. Provide for passage to safe areas in the short term.	CDFG, Shasta Valley RCD, CRMP, Landowners, RWQCB, NCRWQCB	Interim/ Ongoing	Little or no incremental cost.
4	E	Shasta HM-2f	Eliminate barriers on Parks Creek caused by low water drainage at Interstate 5 and diversion downstream. **Short-term:** Studies/repairs underway. Continue to completion. **Long-term:** Monitor for management, maintenance and effectiveness.	CDFG, Shasta Valley RCD, CRMP, Landowners	Interim/ Ongoing	Little or no incremental cost.
4	E	Shasta HM-2g	Remediate barriers on Parks Creek caused by de-watering. (See WM-9 for flow recommendations.) **Short-term:** Develop target initial instream flows to re-water channel year-round. **Long-term:** Purchase or lease water. Assess appropriateness of flow tested. Adjust.	CDFG, Shasta Valley RCD, CRMP, Landowners	Interim	Little or no incremental cost.
4	E	Shasta HM-2h	Provide fish passage at remaining diversion dam on Little Shasta River. **Short-term:** Develop a plan for the second and seek funding. **Long-term:** Implement barrier modification on second barrier.	CDFG, Shasta Valley RCD, CRMP, Landowners	Interim/ Ongoing	See Shasta HM-2a.
4	D	Shasta HM-2i	Correct fish passage problems associated with road crossings. **Short-term:** Implement results of ongoing study of road barriers on Parks Creek.	CDFG, Shasta Valley RCD, CRMP, Landowners	Interim/ Ongoing	Little or no incremental cost.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
HABITAT MANAGEMENT AND RESTORATION: SPAWNING GRAVEL MANAGEMENT						
ISSUES:			In the Shasta River, severe limits on spawning gravel exist below Dwinnell Dam due to natural geological conditions. Historic in-channel gravel mining in the main-stem, gold mining in Yreka Creek and its subsequent channelization, and the construction of Greenhorn Dam exacerbated that shortage. Greenhorn Dam also blocks the input of gravel to Yreka Creek and Shasta Canyon. Those natural geologic conditions (the filling of the Shasta Valley with volcanic debris approximately 300,000 years ago) make coarse-sediment supply in the Shasta extremely limited and present coarse-sediment transport conditions that probably exist nowhere else on earth. Under current conditions, existing spawning gravel has essentially no way of cleansing or replacing itself, leading to higher mortality of eggs in gravels. Presence of Dwinnell Dam limits peak flows that historically cleaned gravels. Remnant gravels may have substantially less capacity for fine sediment than natural conditions once allowed, due to lack of periodic removal of fines.			
SOLUTIONS:			Improve spawning gravel quality and quantity and reduce input of fine sediment.			
4	E	Shasta HM-3a	Prepare a gravel budget for the watershed. **Short-term:** Continue to submit funding request for study. The gravel budget study will guide implementation of all recommendations in this section. Use this information to develop projects to benefit coho salmon spawning, secure funding, and implement. **Long-term:** Monitor. Continue implementation of plan as hydrologic conditions dictate.	Shasta Valley RCD, CRMP	Interim	$200,000 for study.
4	D	Shasta HM-3b	Determine natural processes that historically maintained spawning gravel. Identify methods of restoring quantity and quality of gravel. **Short-term:** Conduct gravel budget study and apply results of study to needs of coho salmon. **Long-term:** Re-create historic process if feasible; mitigate if not. Artificial supplementation may be necessary due to loss of natural processes and historic removal.	Shasta Valley RCD, CRMP	Interim	$176,000 for study.
4	D	Shasta HM-3c	Identify and map existing and potential spawning gravel locations and sources of gravel. Evaluate suitability for spawning and access to rearing areas for emergent fry. **Short-term:** Conduct Gravel Budget study and apply results of study to needs of coho salmon. **Long-term:** Monitor condition over time and continue to apply results of the study.	Shasta Valley RCD, CRMP	Interim	Little or no incremental cost.
4	D	Shasta HM-3d	Identify and quantify sources of fine sediment and mitigate their effect on spawning gravel quality. **Short-term:** Accelerate restoration measures, especially livestock exclusion fencing and emergent plantings. Investigate role and importance of spawning salmon in maintaining gravel cleanliness under the unique conditions found in the Shasta River. **Long-term:** Establish basin-wide monitoring program to chart changes over time in fine sediment. Develop fine sediment budget for the river. Assess status. Integrate fine sediment problem into long-range planning for Dwinnell Dam, potential use of flushing flows to maintain habitat, and establishing instream flow needs.	Shasta Valley RCD, CRMP	Interim	Little or no incremental cost.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
HABITAT MANAGEMENT AND RESTORATION: RIPARIAN VEGETATION MANAGEMENT						
ISSUES:			Riparian vegetation is an important element supporting juvenile rearing habitat for coho salmon. Riparian trees shade streams, reducing solar heating of the water, provide bank stabilization, woody debris, and drop insects and debris that contribute to the food supply. In the Shasta River vegetation has been reduced for a variety of reasons. Substantial restoration efforts have focused on livestock exclusion fencing and riparian planting, and much has been accomplished in those areas, but significant problems have been discovered that limit the ability to re-create riparian cover.			
SOLUTIONS:			Increase riparian vegetation.			
4	D	Shasta HM-4a	Encourage riparian restoration projects using locally native vegetation including both woody and herbaceous stocks. Project implementation should consider if: 1) the site previously supported riparian vegetation and still has the soil and hydrologic characteristics to support it; 2) the native plants selected are likely to flourish; 3) the width of the planted riparian zone is appropriate for the hydrologic regime at the site; and 4) the plan includes effectiveness monitoring using approved protocols. **Short-term:** Continue riparian planting efforts. Identify natural processes that encourage riparian vegetation recruitment. Establish working relationship/MOU with entities such as U.C. Davis, Humboldt State University, USFS, NRCS, Society for Ecological Restoration, etc. to investigate specifics, test alternatives, and develop broad adaptive management approach. Evaluate outcomes of replanting and research causes of riparian planting outcomes, appropriate width of planted areas, and new strategies for restoration. **Long-term:** Continue.	Shasta Valley RCD, CRMP	Interim/ Ongoing	See text regarding habitat restoration.
4	D	Shasta HM-4b	Establish procedures for recommending appropriate plant materials where natural conditions are significantly compromised and local species are not likely to thrive. **Short-term:** Do search for information on similar conditions elsewhere. Where undocumented, or where realistic remediation does not exist, prepare presentation materials for publication and discussion at restoration conferences (See EO-8). Seek to establish a working group from industry, academia and government to identify specific problem conditions, determine if they can be reduced, or suggest alternative species compatible with local conditions if they cannot be remediated. **Long-term:** Coordinate this discussion with considerations on instream flows, future role of Dwinnell Dam, TMDL temperature targets, fine sediment monitoring in spawning gravels.	CDFG, CRMP, Shasta Valley RCD	Interim	Little or no incremental cost.
4	C	Shasta HM-4c (See also EO-9)	Educate non-agricultural landowners on the importance of not removing riparian vegetation. **Short-term:** Prepare presentation materials with photos, illustrating desired future condition. Create awards and recognition. Since this is primarily an urban problem, work closely with Yreka Creek Committee to develop approach. **Long-term:** Secure ongoing funding for periodic reminders and recognition.	CRMP, Shasta Valley RCD, CDFG	Interim	$60,000/yr.
4	D	Shasta HM-4d	Investigate the establishment of a riparian easement or lease program to compensate landowners for short-term or long-term protection of their riparian property. **Short-term:** Create opportunity, and then gauge acceptability of program from local landowners' response. Review the Buckhorn Conservancy. Find or develop a local entity or process to implement program. **Long-term:** Monitor; utilize adaptive management of program.	Shasta Valley RCD	Interim	See text regarding habitat restoration.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
HABITAT MANAGEMENT AND RESTORATION: WATER TEMPERATURE						
ISSUES:			Water temperatures are influenced by amount of river flow, and river structure (W/D ratios, etc.) air temperature, shading from terrain and vegetation, influx of groundwater, tributary flow and runoff, and other factors. Water temperature is listed as a significant problem for the Shasta River (303d impaired). High water temperatures can stress coho salmon, increasing disease and mortality.			
SOLUTIONS:			Address factors that contribute to high water temperatures. Modeling water temperature and flow relationships in the mainstem will help plan for water management and habitat restoration in the river.			
4	E	Shasta HM-5a	Continue to model the relationship of temperature and flow. Use that information and other habitat variables to plan for water management and habitat restoration in the river. **Short-term:** Fund development of more scenarios to cover a broader array of flows to run through the model. Coordinate with the NCRWQCB in TMDL process. **Long-term:** Use model result to target restoration projects. Expand model to include the rest of the watershed.	CDFG, Shasta Valley RCD, CRMP, NCRWQCB	Interim/ Ongoing	$176,000.
4	D	Shasta HM-5b	Identify location, timing, frequency and duration of thermal barriers to migration for adult and juvenile coho salmon. Develop habitat improvement measures that address temperature. **Short-term:** Identify and map locations and timing of thermal barriers. Coordinate information and projects to address appropriate solutions in prioritized areas with the most benefit to coho salmon. **Long-term:** Implement projects or measures in coordination with over-all habitat recovery process and monitor for improvements in an adaptive fashion.	CDFG, NCRWQCB	Interim	Little or no incremental cost.
WATER USE EFFICIENCY[1] – SHASTA VALLEY HSA, SCOTT BAR HSA AND SCOTT VALLEY HSA						
WATER USE EFFICIENCY: STOCK WATER ALTERNATIVES						
ISSUES:			Active surface diversion for livestock watering in the post-irrigation season may reduce instream flows at a critical time for migrating adult coho salmon.			
SOLUTIONS:			Provide and maintain alternate stock watering facilities through voluntary, incentive-based programs.			
4	C	WUE-1a	Develop the cost and potential stream-flow enhancement if all relevant diversions participated. **Short-term:** Coordinate with implementation of WUE-1b.	SRWC, CRMP, DWR, RCDs	Interim	Little or no incremental cost.
4	D	WUE-1b	Where water losses appear to be significant or where associated benefits can be demonstrated for coho salmon (e.g., fencing of riparian areas), identify and provide alternative stock water systems. **Short-term:** Identify and reprioritize systems needed by Dec 31, 2003. Design approach to individual systems; seek funding. **Long-term:** Install selected systems by Sept. 30, 2007.	SRWC, CRMP, RCDs	Interim	$320,000 for 40 systems.

[1] The following overall goals apply to the entire Water Use Efficiency category:
- Promote water conservation by all water users (both for irrigation and stock water), particularly during low-flow years.
- Promote and assure leaving water savings in the streams.
- Prioritize projects by recognized benefit to coho salmon; conduct cost-benefit analyses, including analysis of watershed volume and the effectiveness of the efficiency program for benefits to coho salmon.
- Research and promote incentives for the efficient use of water, including tax incentives.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER USE EFFICIENCY: STOCK WATER ALTERNATIVES (continued)						
4	C	WUE-1c	Provide improved awareness of needs for fish protection through the non-irrigation season and provide information about costs and benefits of stock-watering alternatives.[2] **Short-term:** Provide education about management changes under ESA.	SRWC, CRMP, RCDs	Interim	$60,000/yr.
WATER USE EFFICIENCY: LANDOWNERS WORKSHOPS						
ISSUES: Water users may lack awareness about the advantages and methods of water use efficiency, including alternate stock-watering methods.						
SOLUTIONS: Educate water users and develop incentives for their participation in water-use efficiency programs.						
4	D	WUE-2	Promote and provide landowner workshops. Work with landowners to develop a method to prioritize efficiency improvements that will yield either increased instream flows or improved water quality. Use to avoid funding projects that would not benefit coho salmon. (See also EO-2.) **Short-term:** Evaluate and provide education as appropriate.	SRWC, CRMP, RCDs	Interim	Little or no incremental cost to WUE-1c.
WATER USE EFFICIENCY: DITCH LINING AND PIPING						
ISSUES: Water losses from surface ditch systems may lead to more water being diverted than is needed at the point of use.[3]						
SOLUTIONS: Identify the advantages and water savings of lining and or piping surface ditch systems. Identify and prioritize ditch systems that have potential water saving benefits to coho salmon. Research possible negative effects to habitat, wildlife, and aquifer recharge from lining and or piping ditches.						
4	D	WUE-3	Identify water savings from lining and/or piping surface ditch systems. Identify and prioritize ditch systems that have potential water-saving benefits to coho salmon. Develop locally specific policies and provide guidance to entities that fund and review these projects. Evaluate potential negative impacts to groundwater, wildlife, and other resources that could result from lining or piping ditch systems. If appropriate, concurrently implement companion planned winter recharge program to maintain system balance. **Short-term:** Map all existing ditches, show season of use, quantity, and determine ditch loss. Prioritize potential ditch lining projects. Collect field data if needed. Consider opportunity for assured, measurable increase in quantity and duration instream flows in spring and fall relative to coho salmon needs for passage, other criteria as developed. Utilize outreach funds to develop appropriate lining projects, especially on shared ditches. Implement where costs, benefits and overall basin priorities coincide. **Long-term:** Continue implementation of high priority projects.	SRWC, RCDs, CRMP, NRCS	Ongoing	$2.2 million See text regarding ditch lining.

2 Realization that fish screens must operate at all times when diverting water (paddle wheel and screens ice up in winter and self destruct) will make efficient livestock watering systems look good. Biggest failure is frost damage and ill thought out tank placement. Once valve freezes or pipe splits, they don't get fixed. This has driven the cost way up. Might be worth documenting causes of failure in order to either upgrade or avoid in future designs. Over the years this problem became in part a justification for removing screens when they would do the most good—when newly emerged fish are in the water column, but also when the risk of damage is greatest (a typical mechanics response to a biological problem—protect the machine) and as a result no effort was made to solve it. There may be a need for a little innovation to take advantage of the fact that liquid water contains a great deal of heat, and that something as simple as an insulated cover might be sufficient to reduce evaporation and trap heat to keep the temperature above freezing, or if not that alone possibly in combination with cups to carry up more water and dump it over the wheel and/or screen to facilitate the heat transfer.

3 Additional Considerations: One or more ditches in the Shasta run continuously all summer, even though the demand doesn't seem to be continuous. Turning them off takes too long (driving time), especially when combined with the time required to re-fill the ditch.

Some ditches in the Scott continue to divert water even though it is not getting to point of use. Users don't take out diversion dams as they are waiting for flows to increase in the fall for stock water. This is not a beneficial use of water and flows should be returned to the stream. It may be possible to return 5-7 cfs to the streams under this scenario for no cost. This is where water verification system is needed.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER USE EFFICIENCY: DITCH REPAIR AND CLEANING						
ISSUES: Lack of ditch maintenance can cause sustained high diversion rates and resulting flow impacts to coho salmon.						
SOLUTIONS: Promote routine and ongoing ditch maintenance. Research funding opportunities and incentives for ditch repair and cleaning.						
4	C	WUE-4	Promote routine and ongoing ditch maintenance for ditches in active use.[4](See also EO-2.) **Short-term:** Educate landowners about the importance of maintaining ditch in active use and the possible need for access for maintenance activities. **Long-term:** Continue education. Discuss purchase of water right if its beneficial use will not support the cost of maintaining its delivery system.	DWR, Landowners	Interim	$60,000/yr.
WATER USE EFFICIENCY: IRRIGATION SYSTEM EFFICIENCY						
ISSUES: Inefficient irrigation systems cause loss of water and potential impacts to both flow and water quality.						
SOLUTIONS: Promote incentives for irrigators to upgrade and maintain the efficiency of existing irrigation systems where there is a benefit to coho salmon.						
4	D	WUE-5a	Evaluate irrigation systems for water use efficiency with assistance from UC Extension Service, NRCS Farm Irrigation Rating Index Model (FIRI) or other available resources. (Flood vs. wheel lines vs. pivots and conversion to low-pressure sprinkler systems.) **Short-term:** Develop prioritization approach for possible projects. Consider soil type, impacts on water quantity and quality, measurable benefits to coho salmon in terms of instream flow or water quality improvement. **Long-term:** Implement projects only where benefits to coho salmon can be demonstrated and secured.	RCDs, NRCS, NCRWQCB, SRWC, CRMP, UC Davis Cooperative Extension	Ongoing	$200,000 for study.
4	C	WUE-5b	Promote maintenance of existing sprinkler systems, such as: replacing gaskets and drains; replacing nozzles and/or heads with crop-specific equipment. **Short-term:** Implement education program through UC Extension.	SRWC, CRMP, RCDs, UC Davis Cooperative Extension, NRCS	Ongoing	$60,000/yr.
4	C	WUE-5c	Develop/disseminate BMPs for each irrigation type (including land leveling) and a corresponding on-farm monitoring system that is easily useable by farmer (e.g. moisture sensors to verify BMP). Encourage UC Extension to serve as a clearinghouse for the data and to evaluate success of the program.	UC Davis Cooperative Extension, NRCS	Ongoing	$200,000 for development $60,000 for outreach.
4	D	WUE-5d	Review existing water delivery pricing arrangements within irrigation districts to see if they are as effective as possible at encouraging efficient use of water. **Short-term:** Conduct an economic study to look at current pricing systems, suggest revenue neutral changes that would enhance conservation and/or dedication to instream flows. Present to each district for consideration and possible action.	UC Davis Cooperative Extension, NRCS	Interim	$200,000.
4	C	WUE-5e	Support DWR in implementing the CIMIS stations that measure evapotranspiration information and make it available over the internet to aid farmers in efficiently irrigating. **Short-term:** Site and install stations, take steps to make information available to irrigators. Hold training programs to show utility.	DWR	Ongoing	$10,000.

[4] Cleaning an unmanaged ditch that gains riparian and aquatic values may require a 1600 agreement. A well maintained ditch will not develop such values and no agreement is likely to be required. The maintenance of a ditch is up to the user. This should not be a burden of the State unless there is mutual benefit through a material change (lining or piping coupled with dedication of portion of the net water to the stream). This may be the most effective way to retire water rights in the future. Certainly a poor cost-benefit ratio has had that effect in the past.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER USE EFFICIENCY: CROPPING CHANGES						
ISSUES:	Lack of stream flows influenced by diversion can impact coho salmon habitat. Certain crops or practices may not be the most efficient use of water.					
SOLUTIONS:	Research and suggest voluntary changes in cropping or practices that reduce water consumption and/or improve yield.					
4	D	WUE-6a	Research and suggest voluntary cropping changes that reduce water consumption and/or improve yield. **Short-term:** Prepare a document reviewing all known crops capable of being grown commercially in this area, showing yield/acre likely, current market price, water requirements, growing season. For any that look promising in terms of water consumption, do further assessment of barriers to their use, including difference in return per acre vs. existing crops, marketing hurdles, processing hurdles, equipment processing and storage hurdles, and market limitations. **Long-term:** Implement if feasible. Periodically review and update crop review document. If deemed feasible, partner with other producers throughout the watershed as appropriate, to establish guidelines for verification and marketing processes. If mechanical barriers are identified to otherwise promising potential changes, develop plans to address those hurdles if local producers can be encouraged to show interest. Where barriers are primarily economic, develop an approach that could subsidize conversion by willing producers.	UC Davis Cooperative Extension, NRCS	Interim	See qualitative discussion of payments for environmental services.
4	D	WUE-6b	Seek more marketing assistance and begin investigation of promoting local processing plants, thereby allowing people to transition to lower water use crops and to gain more income from value added options. Investigate opportunities to embark on strategy of salmon-safe product marketing as a way to boost value of otherwise economically non-competitive crops or growing procedures. **Short-term:** Seek needed assistance; develop a plan to promote project; implement with County support; investigate RAC funding for processing plant options. If deemed feasible, partner with other producers throughout the watershed as appropriate; establish guidelines verification and marketing processes.	Siskiyou County, Siskiyou County EDC, Farm Bureau, Farm Extension	Interim	See qualitative discussion of payments for environmental services.
4	D	WUE-6c	Launch a project to take advantage of changing opportunities in the beef industry for niche markets, which can provide greater financial returns and possible water savings as a result of the value-added option. **Short-term:** Develop a workshop model that addresses risk involved in starting a niche-oriented business; production flow and related issues; product marketing; pricing; applicable State and federal regulations. Proceed with implementing workshops and making available marketing and other support to carry out the program. **Long-term:** Implement this project concurrently with efforts to establish local processing plants.	UC Davis Cooperative Extension, USDA field personnel, RCDs, CRMP, Siskiyou County EDC	Interim	See qualitative discussion of payments for environmental services.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
WATER USE EFFICIENCY: TAILWATER RECLAMATION						
ISSUES: Tailwater (agricultural runoff) may negatively impact coho salmon and coho salmon habitat by returning water that is nutrient rich and/or high temperature.						
SOLUTIONS: Tailwater return systems can provide beneficial impacts and water conservation opportunities.[5]						
4	E	WUE-7a	Conduct basin-wide assessment of irrigation practices to identify opportunities to improve water use efficiency in order to reduce tailwater creation. Identify areas of tailwater inputs that cannot be reduced by improved irrigation practices. **Short-term:** Conduct assessment. Coordinate with TMDL process. **Long-term:** Prioritize remedial measures identified in assessment.	RCDs, SRWC, NCRWQCB, CRMP	Interim	$176,000 for study.
4	D	WUE-7b	Research and promote methods and opportunities to first minimize and then reclaim tailwater where it can be justified and is legally permissible. Priority should be given to shared systems. **Short-term:** Provide agricultural engineering assistance to evaluate irrigation practices, soil depth, costs, and other factors that affect creation of tailwater on a ranch-by-ranch basis. Provide an agricultural waiver to eliminate red tape and permitting hurdles that currently block construction of tailwater systems, while retaining assurances that conditions will not be made worse by system proposed. Formalize local review group and process to assure cost effectiveness and prevent collateral damage **Long-term:** Develop more comprehensive plans to capture and re-use tailwater as efficiently as possible, e.g., possibly build larger systems addressing multiple owners, rather than a cascade of individual ponds.	NRCS, RCDs, NCRWQCB	Interim/ Ongoing	See WUE-7a.
4	C	WUE-7c	Develop a comprehensive evaluation and ranking process to be adopted by funding sources to maximize benefits to coho salmon while minimizing negative impacts possible with tailwater management projects. **Short-term:** Educate funders to understand complexity of this issue via coho salmon process. Strongly advocate the development of a range-wide evaluation process to achieve positive cost/benefit ratio with adequate understanding of effects on instream flows before State or Federal funds are allocated. Implement. **Long-term:** Refine and adaptively manage.	CRMP, DWR, NRCS, Farm Bureau	Interim	See WUE-7a.
WATER USE EFFICIENCY: AGRICULTURAL WATER CONSERVATION BEST MANAGEMENT PRACTICES						
ISSUES: Current farm operations may not employ agricultural BMPs.						
SOLUTIONS: Develop Agricultural Water Conservation BMPs that meet the needs of local landowners, particular with respect to regulatory issues.						
4	D	WUE-8	Develop Agricultural Water Conservation BMPs. **Short-term:** Revive Resource Management Advisory Committee (RMAC)-type planning approach. Get stakeholder agencies (State and Federal) to work with agriculture to develop a BMP/Safe Harbor program.	UC Davis Cooperative Extension, NRCS, DWR, NCRWQCB	Interim	See WUE-7a.

[5] Tailwater capture and reuse projects should only be done after reasonable measures have been taken to minimize its creation in the first place, information has been gathered to quantify magnitude of problem to be solved to assure cost effectiveness of individual project, and adequate assurances are in place to prevent further dewatering of the system as a whole. There is an inherent risk of trading improvements in water quality for losses in water quantity if new land is irrigated with the tailwater, or existing irrigated ground is irrigated more than it previously had been.
Establish prioritization process and guidelines to direct future funding from all agency sources toward those projects that accomplish water quality improvements only where protection is included to assure that it will not be done by sacrificing instream flows, thereby jeopardizing other users and fish.
Reductions in tailwater may contribute to dewatering of system if new land is irrigated.
Efficiency measures may not yield benefits in terms of water quantity if losses are currently either returning to the system, or are used by others who would shift to other surface sources if tailwater were eliminated.
Efficiency measures may not improve quality if tailwater does not reach the stream.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
PROTECTION – SHASTA VALLEY HSA, SCOTT BAR HSA, AND SCOTT VALLEY HSA						
PROTECTION						
ISSUES:	Adult coho salmon migrate upstream and spawn during the winter months, juveniles remain (rear) in the mainstem and tributary streams for one full year before they migrate downstream and out of the watersheds. Throughout the course of that year, there are many activities that take place that could minimize the production of coho salmon.					
SOLUTIONS:	Promote coho salmon recovery by minimizing the potential for entrainment in diversions, protecting riparian vegetation, encouraging effective land-use planning and enforcing of existing regulations.					
4	E	P-1	Screen all diversions in the known and potential range of coho salmon. **Short-term:** Identify funding and complete ongoing screening program within known and potential range of coho salmon. Assess habitat that will be made accessible to coho salmon after completion of scheduled projects. Coordinate between involved Federal and State Agencies, local and private entities to develop a prioritized list of any remaining unscreened diversions and action plans including designs. **Long-term:** Deal with screen maintenance problems. Identify funding and complete ongoing screening program within the known and potential range of coho salmon. Develop protocols for coho salmon trapping and relocation. Establish verification procedures to assure that screens are properly installed and maintained by person(s) benefiting from use of the screened diversion. Support evaluation of, and transition to, less labor intensive designs to minimize future maintenance.	CDFG, SRWC, CRMP, RCDs, Landowners	Interim	Little or no incremental cost.
4	D	P-2	Promote and encourage protection of riparian zones that are important for coho salmon through fencing or other measures. Use grazing management, where appropriate, in association with vegetation utilization monitoring and stream-bank protection. **Short-term:** Identify and continue to develop incentive based programs (e.g., NRCS's CRP) for riparian protection zones. Develop GIS layer for accomplished and needed protection areas. Limit funding to planting of trees from local native stock only. Provide funding for greatly expanded tree re-planting program. Provide protection for remaining large trees along Shasta from beavers. Provide public with visual aids and recognition of achievement of desired future condition. Fund studies to solve regeneration problems as found in Shasta due to altered hydrological cycle and Scott due to drop in groundwater level. All riparian areas within range of coho salmon will be identified and protected within 5 years. **Long-term:** Develop long range riparian protection goals statement and recommendations based on stream meander width (e.g., Rosgen et al.). Continue to emphasize need to establish/protect/maintain desired conditions. If consequences of altered hydrograph in Shasta cannot be overcome with native trees, investigate and develop biologically appropriate recommendations.	Siskiyou County, NRCS, SRWC, NCRWQCB, CRMP, RCDs, Landowners, UC Cooperative Extension	Interim	Little or no incremental cost.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
PROTECTION (continued)						
4	E	P-3	Expand routine/ daily fish screen maintenance program (volunteer and paid) whether installed with grant funds or by the CDFG. **Short-term:** Local groups to work with CDFG and NOAA to develop comprehensive maintenance program by 2005. Work with screen users to develop inspection verification procedure for use after transition period. Use time afforded by grant funds to transition away from non-owner screen maintenance and, where appropriate, transfer screen maintenance to the diverter. Prepare maintenance manual, provide part names, numbers and sources, encourage local hardware or farm supply store to stock parts subject to wear, or make arrangements for CDFG to stock and sell. Use existing grant-funded personnel to assess existing screens (public and private) to identify all normally replaceable parts used, to modify screens where possible to standardize all parts possible, and prepare hardware lists of replacement parts and number of screens needing each. **Long-term:** Long-term procedure should implement inspection/verification, integrated with verification of water use described in WM-2. Provide periodic on-site training on proper screen maintenance and repair.	CDFG, SRWC, CRMP, RCDs, Landowners	Interim	$60,000/yr for outreach. Other costs covered by WM-2.
4	E	P-4	Evaluate fish rescue and relocation program. Make improvements if program is viable, and develop steps to minimize the need for rescue and relocation within 5 years. **Short-term:** CDFG develops a fish rescue plan, which will include identification of areas of suitable habitat for all coho salmon life stages, trapping sites, release sites, responsible parties and effectiveness monitoring. Schedule any additional necessary field surveys, create GIS map of problem areas, assess causes of each, then develop list of actions needed to minimize need for fish rescue. **Long-term:** Work to address problems responsible for bulk of rescue needs.	CDFG	Ongoing	Little or no incremental cost.
4	E	P-5	Develop construction and removal procedures or alternate means of diverting water for irrigation dams (gravel or flashboard) that minimize impacts to coho salmon. **Short-term:** Identify locations of existing structures, assess impacts to coho salmon, and recommend improvements to procedures and individual structure design. Work with diverters to implement these improvements. Determine timing of coho salmon emergence. In Shasta, proceed to implementation phase, complete assessments. Eliminate passage problems wherever possible, install or replace ladders where necessary as short term fix. Provide qualified CDFG engineer for design assistance in retrofitting barriers with ladders or correcting problems with locally produced and installed ladders as short term, temporary fix. Develop BMPs for removal/ replacement/ operation, and include these in 1600 process and monitor for effectiveness for both agriculture and fish. **Long-term:** Work with other agencies to assure that additional barriers are not created in future. Eliminate or reduce passage problems where ladders were used as short-term solutions or mitigation. Fund experimental designs to test approaches under local field conditions.	CDFG, SRWC, CRMP, RCDs, DWR	Interim	Incremental cost is development of BMPs. Approximate cost is $200,000.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
PROTECTION (continued)						
4	C	P-6	Recommend to County to develop agricultural land use policies addressing coho salmon recovery actions, ideas and protections. **Short-term:** Develop agricultural land use policies as appropriate to address coho salmon recovery actions, ideas and protections. **Long-term:** Implement County agricultural land use policies as appropriate.	Siskiyou County	Long-term	See qualitative discussion of land use.
4	E	P-7	Recommend enforcement of existing laws, codes, regulations and existing court decrees that are relevant to coho salmon recovery. **Short-term:** Support adequate funding of agencies with enforcement authority. Develop outreach, information and education program specific to existing laws, codes, regulations and existing court decrees. Recommend to local Fish and Game Commission that fines go to recovery restoration efforts **Long-term:** Continue enforcement.	CDFG	Interim	See qualitative discussion of enforcement.
MONITORING AND ASSESSMENT – SHASTA VALLEY HSA, SCOTT BAR HSA, AND SCOTT VALLEY HSA						
MONITORING AND ASSESSMENT: HABITAT						
ISSUES:			Monitoring and assessment actions are needed in both watersheds to identify and evaluate limiting factors for coho salmon, assist in the prioritization of management alternatives, and evaluate the implementation and effectiveness of individual restoration actions.			
SOLUTIONS:			The SSRT should seek to provide for physical access following acceptable protocols and agreements for community based organizations (SRWC, Shasta River CRMP, SOSS) and public agencies (State, federal, local) to conduct monitoring and assessment activities. To maximize the cost effectiveness of monitoring and assessment work, activities in both HSAs should be closely coordinated with ongoing local and regional monitoring programs. Information collected should be grouped and aggregated for public release so that privacy is not violated and made available through web-based linkages and databases. To evaluate the effectiveness of individual restoration actions, funds should be provided to monitor changes in both habitat parameters and potential response by coho salmon following implementation.			
4	D	MA-1a	Where agricultural roads have a potential effect on coho salmon, conduct roads inventory and assessments including the location of fish barriers and sediment delivery potential. Monitor physical changes to aquatic resources through time. **Short-term:** Identify and prioritize sediment sources and passage problems for correction. **Long-term:** Implement remediation actions and monitor effectiveness over time.	CDFG, SRWC, NCRWQCB, CRMP, RCDs	Interim	
4	D	MA-1b	Identify and assess riparian vegetation coverage and condition and monitor changes through time. **Short-term:** Design and implement assessment and monitoring. **Long-term:** Continue implementation.	CDFG, SRWC, NCRWQCB, CRMP, RCDs	Ongoing	
4	E	MA-1c	Assess baseline physical habitat conditions including but not limited to channel structure, side channel (including beaver ponds), spawning gravel, riparian vegetation, habitat complexity/connectivity, large woody debris recruitment, and monitor changes in habitat quality and quantity including those associated with restoration activities. **Short-term:** Design and implement comprehensive assessment and monitoring incorporating protocols developed in range-wide or regional monitoring programs. **Long-term:** Continue implementation.	CDFG, SRWC, CRMP, RCDs	Ongoing	

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
MONITORING AND ASSESSMENT: HABITAT (continued)						
4	E	MA-1d	Assess water quality/quantity parameters including but not limited to dissolved oxygen, pH, suspended sediment, temperature, turbidity, flow, hyporheic flow, nutrients/pollutants (agricultural return flows, pesticides, herbicides, wastewater) and monitor changes through time. Identify and assess point and non-point pollution sources (e.g., irrigation returns, sediment). Coordinate with the TMDL process. **Short-term:** Design and implement comprehensive assessment and monitoring incorporating protocols developed in range-wide or regional monitoring programs. **Long-term:** Continue implementation.	NCRWQCB, SRWC, CRMP, RCDs	Interim	
4	E	MA-1e	Complete inventory and mapping of surface water diversions within the Scott and Shasta Valleys. **Short-term:** Complete study including QA/QC. **Long-term:** Incorporate into planning process.	CDFG, DWR	Long-term	
4	C	MA-1f	Identify and assess effects of flood control levees on over wintering and other habitat conditions for coho salmon and monitor habitat changes through time. **Short-term:** Find USACE and NRCS records of activity for both HAs. Determine effects of levee system. **Long-term:** Determine feasibility. Develop and implement remediations based on results of assessments.	SRWC, CRMP, RCDs	Ongoing	$200,000.
4	D	MA-1g	Inventory, assess, and monitor effectiveness of water use efficiency/water conservation, water augmentation and water management projects expected to contribute to instream flow. **Short-term:** Design and implement comprehensive monitoring program. Work with DWR to predict effectiveness of the various water use efficiency and conservation practices in both valleys. **Long-term:** Compile results and incorporate into planning.	SRWC, CRMP, RCDs, NRCS	Long-term	
4	D	MA-1h	Inventory, assess, and evaluate instream habitat and riparian restoration project activities and BMPs and monitor effectiveness in improving habitat for coho salmon. **Short-term:** Design and implement comprehensive assessment and monitoring incorporating protocols developed in range-wide or regional monitoring programs. Make sure effectiveness monitoring is a component of future habitat improvement projects. **Long-term:** Continue implementation and incorporate into future management plans or actions.	CDFG, SRWC, CRMP, RCDs	Interim	
4	C	MA-1i	Inventory, evaluate, and monitor changes in land use practices over time including conversion from agriculture to other uses for impacts on coho salmon and their habitat. **Short-term:** Collect baseline data. **Long-term:** Evaluate and incorporate information into the County land use policy.	SRWC, CRMP, RCDs, Siskiyou County, DWR	Interim	
4	D	MA-1j	Conduct adult and juvenile current and potential carrying capacity estimates and monitor changes over time. **Short-term:** Assess and estimate current and potential carrying capacity. Evaluate potential method for predicting carrying capacity. **Long-term:** Apply abundance data to determine realization of carrying capacity.	CDFG, NOAA Fisheries	Interim/ Continual	

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
MONITORING AND ASSESSMENT: HABITAT (continued)						
4	E	MA-1k	Conduct groundwater monitoring in support of the studies referred to in WM-10a and WM-10b. **Short-term:** Support and expand coverage and frequency of current DWR and local group long-term monitoring. If ground water is used to supplement surface water for instream flows, monitor the effects on stream flows and well levels. Collect and distribute monitoring data from additional wells to establish groundwater contours. **Long-term:** Information to be provided to groundwater committee referred to in WM-10c. Continue long-term monitoring.	DWR	Interim/ Ongoing	
MONITORING AND ASSESSMENT: COHO SALMON POPULATIONS						
ISSUES:	Baseline information is needed on the distribution and abundance of coho salmon within both watersheds. Monitoring coho salmon populations over time is necessary to determine long-term trends in abundance, evaluate the effectiveness of coho salmon recovery actions and progress toward meeting recovery goals, and provide data to guide changes in management actions. Availability of baseline information is affected by the difficulty, due to high winter flows, of counting adult salmon.					
SOLUTIONS:	Work with CDFG and other fisheries experts to develop and implement a program to monitor coho salmon abundance and distribution within the Shasta Valley and Scott River HSAs. Integrate this program with existing regional and range-wide monitoring efforts.					
4	E	MA-2a	Conduct limiting factors analysis and monitor changes through time by life stage for coho salmon. **Short-term:** Identify additional data needs to complete both efforts. Assess disease as a limiting factor. **Long-term:** Develop management plans for remediation of limiting factors. Monitor effects to coho salmon populations and habitat.	CDFG, NOAA Fisheries, SRWC, CRMP	Interim/ Ongoing	$176,000.
4	E	MA-2b	Continue to identify the historic and current distributions of coho salmon adults and juveniles within the Scott Bar, Scott Valley, and Shasta Valley HSAs. **Short-term:** Identify, evaluate, and map coho salmon spawning and rearing habitat utilization areas and monitor changes through time. **Long-term:** Monitor and analyze spatial structure and changes in distribution through time. Continue to implement and use results to modify monitoring protocols, and modify restoration techniques.	CDFG, SRWC, CRMP, RCDs, NOAA Fisheries	Interim/ Ongoing	
4	E	MA-2c	Conduct adult and juvenile abundance estimates and monitor changes over time. **Short-term:** Begin abundance surveys. Develop and implement statistical methodology for adult and juvenile salmon. Improve methods for counting adult salmon in the Scott. **Long-term:** Continue and improve abundance surveys. Use data to develop annual adult and outmigrant abundance estimates for both valleys.	CDFG, NOAA Fisheries	Interim/ Continual	
4	D	MA-2d	Conduct analysis of juvenile growth rates and production estimates and monitor changes through time. **Short-term:** Develop and implement a comprehensive study plan with appropriate agencies **Long-term:** Continue studies and apply results as appropriate.	CDFG, NOAA Fisheries	Interim/ Continual	

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
MONITORING AND ASSESSMENT: COHO SALMON POPULATIONS (continued)						
4	C	MA-2e	Conduct standard measurements of trapped spawners and carcasses **Short-term:** Develop egg production estimates and spawner age distribution **Long-term:** Apply data via appropriate agencies.	CDFG, SRWC, CRMP, RCDs	Interim/ Ongoing	$176,000.
4	C	MA-2f	Identify adult and juvenile diversity (genotypic/phenotypic) variations within the Scott and Shasta rivers for comparisons with other populations within the SONCC Coho ESU. **Short-term:** Coordinate with State and Federal agencies in collection of tissues. **Long-term:** Make both phenotypic and genotypic data available to appropriate agencies and public.	CDFG, NOAA Fisheries	Long-term	$176,000.
4	C	MA-2g	To evaluate food availability, conduct macroinvertebrate assessments and monitor changes through time. **Short-term:** Expand studies and analyze results. **Long-term:** Apply results as appropriate.	CDFG, SRWC, CRMP, RCDs, DWR	Long-term	$176,000.
4	E	MA-2h	Assess effectiveness of fish rescue program through monitoring survival of rescued fish. **Short-term:** Support CDFG effort to monitor and assess the survival of the rescued fish. **Long-term:** Provide assistance in monitoring fish survival.	CDFG	Interim/ Ongoing	
EDUCATION AND OUTREACH – SHASTA VALLEY HSA, SCOTT BAR HSA, AND SCOTT VALLEY HSA						
EDUCATION AND OUTREACH						
ISSUES:			1) Coho salmon recovery cannot succeed without buy-in from local people. Education and outreach can help landowners and members of the public understand why restoring coho salmon and their habitat is worthwhile, and how they can help. 2) To improve funding opportunities for restoration, education must also be targeted towards agency and elected officials at the State and Federal levels, to inform them about local efforts and successes in the Shasta and Scott valleys.			
SOLUTIONS:			Use events, workshops, and various forms of media to encourage changes in attitudes and behavior that enhance coho salmon recovery.			
4	D	EO-1	Use existing extension services to inform landowners of funding programs for water conservation, fish habitat restoration, and Best Management Practices (BMPs). **Short-term:** Advertise available funding sources, assist landowners in identifying projects for support (based on CRT recommendations), and provide grant writing resources/ training. Monitor extension effectiveness (# projects funded, # projects implemented) on a routine basis. **Long-term:** Expand extension efforts to include all interested landowners. Insure that all priority projects are funded. Continue to monitor extension effectiveness.	NRCS, UC Davis Cooperative Extension, USFWS, CDFG	Interim/ Continual	**Short-term:** $20,000/year. **Long-term:** $20,000/yr.
4	D	EO-2	Sponsor land stewardship training courses (e.g., ranch planning, road maintenance, alternative stock watering system development and maintenance, irrigation ditch maintenance, and water use efficiency, prioritizing activities that tangibly increase instream flows and improve water quality). **Short-term:** Implement local-adapted land stewardship courses. **Long-term:** Expand locally adapted land stewardship courses and monitor their effectiveness.	SRWC, NCRWQCB, CRMP, RCDs, UC Davis Cooperative Extension, NRCS	Interim/ Continual	**Short-term:** $50,000/yr. **Long-term:** $50,000/yr.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
EDUCATION AND OUTREACH (continued)						
4	C	EO-3	Fund demonstration projects on land with public access, showing fish-friendly BMPs and associated agricultural innovations. **Short-term:** Identify locations for demonstration projects. Undertake integrated restoration efforts at these sites. Organize tours to visit these demonstration projects. Organize tours of successful demonstration projects in other watersheds, to gain inspiration. **Long-term:** Continue to improve demonstration projects, while developing an active research program to assess demonstration project effectiveness.	SRWC, CRMP, RCDs, UC Davis Cooperative Extension, NRCS, USFWS	Interim/ Continual	**Short-term:** $75,000/yr. **Long-term:** $75,000/yr.
4	D	EO-4	Use available outreach resources to inform landowners about existing riparian easement or lease programs and how to participate in them. **Short-term:** Contact landowners and help them identify how riparian easements can assist them in achieving land management objectives. Identify funding sources to help compensate landowners for establishing and maintaining riparian easements. **Long-term:** Expand outreach efforts throughout the Shasta and Scott valleys.	SRWC, CRMP, RCDs,	Interim/ Continual	**Short-term:** $3,000/yr. **Long-term:** $3,000/yr.
4	C	EO-5	Enhance funding for school systems to continue and expand watershed and fisheries education (examples of activities already done in Siskiyou County: aquarium incubators in classrooms; a riparian plant nursery; student participation in spawning survey data gathering). **Short-term:** Increase participation in current programs, and expand them to other agencies and communities. Evaluate program effectiveness and revise as necessary. **Long-term:** Review overall effectiveness of ongoing programs and revise as necessary. Create new watershed and fisheries education programs.	Schools, Tribes, CDFG, SRWC, CRMP, RCDs	Interim/ Continual	**Short-term:** $75,000/yr. **Long-term:** $75,000/yr.
4	C	EO-6	Develop and distribute widely an informational brochure explaining coho salmon life history, habitat requirements, and both its historic and recent distribution. **Short-term:** Develop this brochure and print 10,000 copies. **Long-term:** Revise and reprint the brochure as needed.	CDFG, Private Graphics Consultant	Interim	**Short-term:** $10,000/yr. **Long-term:** $10,000/yr.
4	C	EO-7	Develop and distribute widely a newsletter describing current fisheries restoration efforts, as well as how the public can become involved. **Short-term:** Publish a newsletter (15,000 copies) that is inserted into local newspapers once every six months, beginning in late summer/fall 2003. **Long-term:** Continue to publish a newsletter at least once a year.	SRWC, Siskiyou RCD, CRMP, RCDs, Siskiyou County, CDFG, USFWS, NOAA Fisheries	Interim/ Continual	**Short-term:** $20,000/yr. **Long-term:** $15,000/yr.
4	C	EO-8	Develop and distribute an informational brochure describing plant species recommended for riparian restoration, emphasizing the use of native plant species and matching species to specific stream-bank conditions. Causes of past riparian planting failures and remedies to these will be discussed. **Short-term:** Consult past and continuing local riparian restoration programs to gather information about riparian species nursery management, restoration site selection, outplanting, and plant protection. Use this information to develop the brochure. **Long-term:** Monitor riparian restoration project effectiveness (e.g., plant survival, increased cover, lowered water temperatures, improved bank stabilization, and then revise and reprint the brochure as needed.	Siskiyou County, SRWC, CRMP, RCDs, CDFG	Interim	**Short-term:** $3,500/yr. **Long-term:** $3,500/yr.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
EDUCATION AND OUTREACH (continued)						
4	C	EO-9	Develop and distribute a publication targeting non-agricultural landowners that highlights the importance of not removing riparian vegetation, and the beneficial role of LWD in properly functioning streams. **Short-term:** Publish an annual newsletter (1,000 copies) and distribute via local, State and Federal agencies. Offer incentives to participate in riparian protection/enhancement programs (free workshops on riparian restoration, free riparian species seedlings, etc.). Provide recognition and awards to exemplary non-agricultural land-owners, highlighting their riparian protection/restoration efforts. Coordinate with the Yreka Creek Committee in designing complementary riparian protection programs. **Long-term:** Continue to publish a newsletter at least once a year. Expand initiatives that enhance protection and recovery of riparian areas, especially where beneficial to coho salmon.	SRWC, Siskiyou RCD, CRMP, RCDs, Siskiyou County	Interim/ Continual	**Short-term:** $2,500/yr. **Long-term:** $5,000/yr.
4	C	EO-10	Based on a literature review of beaver-salmon interactions, publish a brochure to educate the public about the impacts of beavers and their dams on coho salmon and coho salmon recovery. **Short-term:** Review beaver-salmon interaction literature to provide a basis for brochure content. **Long-term:** Revise and republish brochure as necessary.	CDFG	Long-term	**Short-term:** $1,000/yr. **Long-term:** $1,000/yr.
4	C	EO-11	Produce a locally oriented fish-friendly road and stream care handbook for free distribution. **Short-term:** Develop this handbook and print 1,000. **Long-term:** Update every two years, or as needed.	SRWC, CRMP, RCDs, CDFG, Tribes, Siskiyou County	Interim	**Short-term:** $25,000. **Long-term:** $7,500 every two yrs.
4	D	EO-12	Produce a brochure targeted at prospective landowners, real estate agents, and title companies that describes adjudicated water rights, irrigation ditch easements, and the requirements and responsibilities associated with them. The brochure should emphasize that access to ditches with easements must be granted to allow for ditch maintenance and repair.	DWR, Siskiyou County	Interim	$500.
4	C	EO-13	Recruit local media and media personalities to inform the public about restoration efforts. Develop and submit Opinion-Editorial pieces related to local coho salmon restoration efforts/issues. **Short-term:** Interview local people spearheading fish restoration efforts for radio, newspapers, and cable TV. Do this quarterly. **Long-term:** Continue to produce interviews and reports for local radio, newspapers, and cable TV every three months.	SRWC, CRMP, RCDs, Schools, Siskiyou County, Tribes, CDFG	Interim/ Continual	**Short-term:** $5,000/yr. **Long-term:** $5,000/yr.
4	C	EO-14	Use media professionals to create informational videos that are local in context, to be shown to schools, service clubs, county fair-goers, etc. **Short-term:** Shoot informational video during 2003-2004 (during all four seasons). Edit video during latter portion of 2004. Begin using video in early 2005.	SRWC, CRMP, RCDs, Tribes, USFWS, CDFG	Interim	**Short-term:** $25,000.
4	C	EO-15	Establish a web site with coho salmon biology information, up-to-date restoration grant funding, and examples of projects. Ask local websites to provide a link to this coho salmon site. **Short-term:** Create website and make operational by the end of 2003. Provide for monthly website maintenance and updates. **Long-term:** Continue to maintain and update website monthly.	CDFG	Interim/ Continual	**Short-term:** $5,000. **Long-term:** $1,000/yr.

HSA PRIORITY	TASK LEVEL	TASK NUMBER	TASK DESCRIPTION **Short-term Action** (if stated), **Long-term Action** (if stated)	IDENTIFIED ACTION ENTITIES	ESTIMATED DURATION	ESTIMATED COST
EDUCATION AND OUTREACH (continued)						
4	C	EO-16	Develop an informational PowerPoint presentation on coho salmon recovery and provide this to local groups (service organizations, county fair, local extension offices, etc.). **Short-term:** Develop PowerPoint presentation, send to other agencies/groups for review, then revise and distribute. **Long-term:** Update every two years, or as needed.	CDFG, SRWC, CRMP, RCDs, and other agencies to provide review.	Interim	**Short-term:** $1,000. **Long-term:** $1,000 every two yrs.
4	D	EO-17	Establish contacts and organize events that bring resource-dependent people from throughout the Klamath Basin together, and that foster communication, friendship, and cooperation. **Short-term:** Organize an event/gathering that people throughout the Klamath Basin might want to attend (SSRT brainstorming needed). **Long-term:** Continue to organize basin wide gatherings regularly, and publicize these gatherings widely.	CDFG, USFWS, NOAA Fisheries, Tribes, and the public.	Interim/ Continual	**Short-term:** $10,000/yr. **Long-term:** $7,500/yr.
4	C	EO-18	Organize an annual (coho) salmon festival, inviting the general public. Put on a mini version of this festival at the county fair, to help advertise the event. **Short-term:** Select an optimal season (fall?) and date, and organize a salmon festival at this time every year. **Long-term:** Continue to organize annual salmon festivals.	SRWC, CRMP, RCDs, Siskiyou County, Tribes, and all agencies.	Interim/ Continual	**Short-term:** $5,000/yr. **Long-term:** $5,000/yr.
4	C	EO-19	Provide the public with information about the California Irrigation Management Information System (CIMIS) **Short-term:** Produce CIMIS informational materials for circulation through a variety of media. Update CIMIS informational materials every two years and re-circulate.	DWR	Interim/ Continual	**Short-term:** $1,000/year **Long-term:** $1,000 every two yrs.
4	D	EO-20	For each of the Shasta and Scott watersheds, organize a quarterly forum for exchange of information between parties collecting data, conducting research, and implementing restoration projects on the ground. These meetings will be open to the public. **Short-term:** Organize meetings in the Shasta and Scott watersheds quarterly. **Long-term:** Continue to organize quarterly meetings.	SRWC, CRMP, RCDs	Interim/ Continual	**Short-term:** $800/yr. **Long-term:** $800/yr.
4	D	EO-21	Produce quarterly Congressional Briefings (State and Federal). **Short-term:** Each briefing should summarize recent fish run trends, projects funded/ completed, projects recently applied for, upcoming project applications, and pressing issues. **Long-term:** Continue to submit quarterly Congressional Briefings.	SRWC, CRMP, RCDs, Siskiyou County, USFWS, NOAA Fisheries, CDFG	Interim/ Continual	**Short-term:** $1,000/yr. **Long-term:** $1,000/yr.
4	D	EO-22	Conduct tours for media, legislators (State and Federal), schools, public, and others to show coho salmon and habitat recovery efforts. **Short-term:** Organize tours during summer, late fall (during coho salmon run), and spring. **Long-term:** Continue to organize tours, as necessary.	SRWC, CRMP, RCDs, CDFG, Tribes, Siskiyou County	Interim	**Short-term:** $1,000/yr. **Long-term:** $1,000/yr.

11 Economics of Recovery

An estimate of the cost of implementing the Recovery Strategy is required by California statute. In cooperation with the CRT and the SSRT, quantitative estimates were developed for both the fiscal cost of implementing the Recovery Strategy, and the socioeconomic impacts of implementing the Recovery Strategy. Summary information is provided below. For a more in-depth discussion, refer to the complete economic report in Appendix I.

The assumption in the economic analysis is that Governments will bear the cost of "positive" incentives needed to acquire water, conservation easements and other assets, and will also bear the cost of public works projects, dam removal, and timber management Alternative C, which was selected for inclusion by the Commission. Private landowners will bear the cost of coming into compliance with existing laws and the cost of additional regulations that pertain to listing of the species.

11.1 ECONOMIC BENEFITS

Coho salmon recovery will have significant costs, but will also provide economic benefits. Benefits associated with Yurok and Hoopa Valley tribes' Federally reserved fishing rights, increased commercial land and water use activities, multiple species benefits, and improved water quality, and watershed health will be realized, but they are not quantified. Coho salmon recovery will also result in benefits to recreational and commercial fishing and related industries, which are also not quantified in this document.

Benefits associated with non-use values include intrinsic, or existence, values which are derived from the knowledge that coho salmon populations exist, and bequest values which confer value to the resource for the benefit of future generations. Based on studies that examined streams in Colorado and salmon restoration in the Columbia River Basin, the San Joaquin River, and the Elwha River, the extrapolated value of California coho salmon recovery could be significantly larger than the fiscal or socioeconomic costs of recovery.

11.2 FISCAL COSTS AND SOCIOECONOMIC IMPACTS

The economics analysis (Appendix I) considers the costs of a variety of recovery recommendations implemented in diverse regions of California. The fiscal or budgetary cost of a recovery recommendation is the expenditure needed to physically perform the action. The socioeconomic impact of a recovery recommendation includes: 1) income foregone because the recovery recommendation is undertaken, and 2) transfers to the local region (in this case, the HSA) from outside the region because the recovery recommendation is undertaken.

Fiscal cost impacts of the various recovery recommendations are presented in the simplest possible terms: the current dollar cost of completing the project now. Absent information about the specific sequencing of recovery recommendations over the coming decades, and lacking information on how State obligations would be financed, it is impossible to calculate financing costs, or convert actions over some period of time into current dollar equivalents. Instead, the costs were simply calculated as if all recovery recommendations would be completed immediately.

In order to develop these cost and impact assessments, the primary unit of analysis is the HSA. There are three classes of recovery costs at the HSA level. The first class of costs is the cost of commonly recommended recovery recommendations that are proposed for many HSAs. The second category is those costs unique to the specific circumstances of an HSA or HU. The third category is costs that have been identified but which cannot be quantified at this time. Each of these classes of costs has associated socioeconomic impacts.

The total fiscal cost of the Recovery Strategy is about $4.5 billion. This cost estimate may understate the full cost of Recovery Strategy implementation, because some costs cannot be quantified at this time. There is limited information available about the quantity of each recovery action that will be undertaken and these cost estimates can be revised as additional information becomes available. On the other hand, this cost estimate may overestimate the cost of Recovery Strategy implementation because some costs may be incurred even if the Recovery Strategy were not implemented. In addition, some costs may be incurred as a result of actions taken to avoid take of coho salmon or to fully mitigate impacts of authorized take once the species is listed. The following cost estimates must be viewed with these considerations in mind.

Using the current level of information on the recommendations contained in this strategy, about $466 million, or 9% of the total, will be incurred to implement the SSPP. However, it should be noted that the actual fraction of costs incurred in Shasta Valley and Scott River HAs will be less than this because the cost of water acquisition has been included for the SSPP, but has not been measured for the rest of the coho salmon range. The SSPP recommendations also are intended to be more focused than those in other watersheds. Nonetheless, a notably large portion of costs will be incurred in these HAs. If water acquisition costs in other areas of the SONCC Coho ESU and in the CCC Coho ESU are proportional to those in the SSPP (where water acquisition accounts for about 20% of the total) it is likely that the costs of recovery under the strategy will approach $5 billion.

Restoration costs are higher in the SONCC Coho ESU than the CCC Coho ESU, likely because coho salmon are more widely distributed within the SONCC Coho ESU. Costs are especially high in the Klamath River HU, where Iron Gate Dam is located. High costs were also noted in the Mendocino Coast and Trinity River HUs. These three HUs, combined, account for over 85% of measured restoration costs.

Monitoring, evaluation, planning, and education and outreach costs are about $90 million dollars; about 2% of total estimate fiscal costs. There are no significant socioeconomic impacts associated with these recommendations.

Restoration activities will generate positive socioeconomic impacts. Socioeconomic impacts generated from restoration equal about one-half of the fiscal costs of restoration or $2.1 billion. The socioeconomic impacts of water acquisition in the SONCC range will be negative (for the SSPP these negative impacts equal about $6 million), as will the socioeconomic impacts of timber management changes. Negative socioeconomic impacts of the timber management changes are not expected to be significant. Implementing the timber management recommendations will result in few incremental costs.

11.2.1 UNIT COSTS

In the first step of measuring the economic cost and impact of implementing the Recovery Strategy, recovery recommendations common to many HSAs are identified. Unit costs for these activities were estimated, and ways in which costs vary systematically across HSAs were identified. Unit cost estimates were developed for the following commonly recommended recovery recommendations:

a. Removing or alleviating barriers to fish passage;
b. Implementing riparian revegetation and other stream-bank improvements;
c. Improving in-stream complexity, including the placement of LWD;
d. Road treatment and/or decommissioning;
e. Restoring wetlands and off-channel areas;
f. Water acquisitions;
g. Undertaking biological studies to understand and monitor coho salmon behavior;
h. Watershed planning and other non-biological studies;
i. Education and outreach efforts (including improvements in coordination among participants); and
j. Timber management.

Aggregate cost estimates for these common recovery recommendations were developed with a series of restoration cost models. These models are designed to combine unit cost estimates with information on the potential scale at which recommended activities could be undertaken and information about the ways that unit costs are likely to vary across HU/HSAs.[1] At this time, limited information is available about the quantity of each recovery recommendation that will be undertaken. Maximum flexibility was built into these spreadsheet models so that, as additional information about the scale at which recovery recommendations will be undertaken becomes available, more accurate estimates of the aggregate cost of recovery can be made easily and quickly.

In some cases the recommendations in the Recovery Strategy do not provide guidance on the scale at which recommended activities should be undertaken. For example, at the HU- and HSA-level the recommendations do not specify the amount of water acquisition that may be required to meet recovery goals. This omission precludes the comprehensive measurement of the cost of coho salmon recovery. Nonetheless, cost and socioeconomic impact estimates for many recovery recommendations can be developed, and unit costs can be characterized in even more cases.

11.2.1.1 Fish Passage

The cost of treating barriers to fish passage includes a discussion of the unit cost of dam removal, installing fish ladders, treating non-structural sites, replacing culverts, and screening water diversions. To estimate the fiscal cost of treating barriers to fish passage, surveys of the cost of fish passage improvement in general and indicative project costs in California and to a lesser extent Oregon and Washington, were used. The review of historical barrier treatment projects allows an estimate of the fraction of project costs that are attributable to permitting, planning, and mobilization. The socioeconomic impact was calculated in the form of regional transfers that will occur as a result of barrier treatment to be total fiscal costs less that fraction.

[1] A major source of variation is likely to come from regional differences in wage rates since labor costs form a large part of the total unit cost of most recovery recommendations. Data on average wages paid to constructions workers in California counties were used to identify how recovery costs are likely to vary across HSAs as a result of labor costs. For HSAs that fall in more than one county, wages are assumed to be a simple average of the wages in all counties covered

11.2.1.2 Riparian Restoration

The fiscal costs of riparian revegetation or planting and other stream-bank improvement activities, including fencing, depend on the complexity of the project to be undertaken (e.g., the materials to be used), the remoteness of the parcel of land to be treated, and the degree of site preparation that is needed. While the quantity of stream bank that may need treatment and/or riparian planting was estimated, no information is currently available about the nature of sites that will be treated. The unit costs of stream-side activities were estimated using average construction cost estimates developed by the United States Department of Agriculture (USDA) and surveys of historical project costs. The assumption was used that at any stream mile that needs riparian revegetation, the width of the buffer created will be 50 feet. A review of historical projects allows one to estimate the fraction of project costs that are attributable to permitting, planning, and mobilization. The socioeconomic impact was calculated in the form of regional transfers that will occur as a result of riparian revegetation and stream-bank restoration to be total fiscal costs less that fraction. There will be other welfare costs associated with removing land from its highest and best private use and dedicating this land to habitat for salmon. These costs cannot be quantified at this time.

11.2.1.3 In-channel Restoration

The costs of in-channel restoration work, including the placement of LWD, depend on the remoteness of the site to be treated and the width of the waterway to be treated. No information was available about these parameters for the in-stream sites that will be treated as a result of the Recovery Strategy. Illustrative unit costs for these activities were developed by surveying historical project costs and previous literature on this topic. The review of historical projects allows one to estimate the fraction of project costs that are attributable to permitting, planning, and mobilization. The socioeconomic impact was calculated in the form of regional transfers that will occur as a result of in-stream restoration to be total fiscal costs less that fraction.

11.2.1.4 Road Treatment and Decommissioning

The Recovery Strategy contains several broad categories of recommendations dealing with roads, which differ in their unit cost, socioeconomic impacts and, likely, in their cost-effectiveness. The broad categories of recommendations are:

a. Road decommissioning;
b. Road upgrading;
c. Relocation of roads in riparian areas;
d. Implementation of best-management practices (BMPs) in road construction; and
e. Limiting use of roads (e.g., in winter or if road is legally closed).

The average unit cost and socioeconomic impact of road decommissioning and upgrading was estimated based on surveys of historical project costs. However, no information is available about which roads will actually be treated, relocated, or have access limited. This precludes a full accounting of impacts of this class of recovery recommendation.

11.2.1.5 Wetlands Restoration

In a limited number of HUs/HSAs wetlands restoration is mentioned as a recovery recommendation. Many of the activities that fall under the category of wetlands restoration, as defined by the USDA, are also common to the other categories of restoration activities considered. For example, the USDA considers culvert replacement, fencing, and critical area planting to be activities that may be undertaken as part of wetlands restoration. Since the quantities of these activities that will be undertaken in any given HSA are not known, the aggregate cost of wetlands restoration is not calculated distinct from other, related, recovery recommendations. The socioeconomic impacts of wetland restoration will depend on the alternative use of the land devoted to coho salmon as a result of the restoration effort but these costs cannot be quantified at this time.

11.2.1.6 Water Acquisition

The aggregate fiscal cost of water acquisition and/or agricultural land acquisition within the range of coho salmon will depend on the quantity of water and/or land to be acquired and whether water rights will be permanently transferred or purchased for single periods. Because potential sellers of water rights may decide to forgo the agricultural profits they would have gained from irrigating (instead of making alternative arrangements for other sources of water), we can predict that in those circumstances the annual cost of an acre-foot of water in a particular HSA is predicted to be equal to the net agricultural returns (gross returns less operating costs) that water would have created. The unit cost of water acquisition increases sharply when acquisition of irrigation water for pasture is complete and water that is used to irrigate increasingly high value cropland (e.g., wine grapes, broccoli) is acquired.

Taking agricultural land out of production so that more water is available for coho salmon recovery has a socioeconomic cost because land that once provided private income no longer does so. Conceptually, when agricultural land is left fallow because irrigation water has been transferred to serving the needs of coho salmon, the farmer that sold the water right has neither lost nor gained income. However, the laborers that worked this land and the firms that sold the farmer inputs for this land have not been made whole. Their lost income, equal to the farmer's operating costs in the event that the parcel of land had been planted and harvested, is the socioeconomic cost of this recovery recommendation.

Aggregate water acquisition costs are estimated only for the SSPP. The SSPP contains several recovery recommendations intended to increased instream flows for coho salmon. These include, but are not limited to, verifying compliance with adjudicated water rights, donation of unused water rights, providing alternative stock water systems, substitution of groundwater for surface water for irrigation, and water acquisition. It cannot be known with certainty how much water will be produced for coho salmon through each of these strategies. To obtain an estimate of the full costs of securing instream flows for coho salmon, this analysis assumes that additional instream flows will be generated solely through the acquisition of water rights from willing sellers. This assumption is made only for the purposes of an illustrative calculation of the cost of recovery and should not be taken as an endorsement of this approach to increasing instream flows in the SSPP area or elsewhere.

11.2.1.7 Monitoring and Research

Technical studies that the Recovery Strategy recommends range from monitoring efforts to genetic analyses. A review of the Department's inventory of previously funded restoration activities allows us to estimate the cost of recovery recommendations that are technical monitoring or biological research activities when project-specific cost estimates are not readily available. A similar approach is used to estimate the cost of non-biological studies or planning exercises and education and outreach efforts. The assumption is that these costs do not vary systematically by HSA. The socioeconomic impacts of this class of recovery recommendations are not expected to be significant.

11.2.2 COST ESTIMATES

The aggregate cost estimates presented in Appendix I include not only the cost of performing recommendations that are common to many HU/HSAs, but also the cost of specific tasks that respond to the unique circumstances of each HU/HSA. Some of these items are a significant portion of the costs estimated here. For example, restoring coarse sediment transport near Iron Gate Dam may cost as much as $500 million. Implementing the Trinity Record of Decision is estimated to cost about $12 million per year.

Separate cost and socioeconomic impact estimates have been developed for the Shasta Valley and Scott River HSAs. The methodology used to estimate the cost of implementing the SSPP is similar to the methodology used to estimate the cost of the general Recovery Strategy. For habitat restoration in particular, the methodology described above is directly applied. However, by working closely with the SSRT cost estimates are provided for nearly every suggested recovery recommendation.[2] These cost estimates are included in Appendix I. This approach reflects the fact that the SSPP contains many recovery recommendations related to water management and acquisition that are not found in the larger Recovery Strategy.

Three alternative sets of recommendations were developed regarding timber management in areas with coho salmon. Alternative C (and elements of Alternative B that have few costs associated with them) were adopted by the Commission. There are few incremental costs and socioeconomic impacts associated with Alternative C and elements 19 and 20 of Alternative B.

The adopted timber management recommendations do not imply significant incremental costs above those estimated in other sections of the economic report. The recommendations call for implementation of road management plans, which may imply that costs will be incurred to decommission or treat roads, treatment of watercourse crossings, riparian revegetation, watershed planning, education, and monitoring of recovery measures. The costs of these actions have been estimated in other sections of the economic report.

To illustrate which costs previously estimated are also associated with the adopted timber management recommendations, the following were identified: 1) HSAs with at least 75 percent of land cover in forest; 2) HUs containing these HSAs; and 3) costs of road treatment, road decommissioning, riparian revegetation, and treatment of stream crossings in those HUs. These estimated costs are summarized in Table 11-1. The total amount of costs associated with timber management recommendations, excluding planning, education, and monitoring, is about $1.7 billion.

Some items included in the estimate of the aggregate cost of the Recovery Strategy are costs that may be incurred even if this Recovery Strategy were not implemented. For example, the cost of implementing the Trinity River Record of Decision is included as a cost associated with coho salmon recovery. To the extent that these costs would be incurred in the absence of this Recovery Strategy, the cost estimates presented here overstate the cost of implementation. In addition, some of these costs may be incurred not as a result of implementing the Recovery Strategy, but as a result of listing to the extent that costs are incurred as a result of actions taken to avoid take or to fully mitigate impacts of the authorized take of coho salmon. On the other hand, costs that would be incurred as a result of the Clean Water Act or other related statutes and regulations were excluded. While TMDL regulations, for example, are quite relevant to coho salmon recovery, costs attributable to this process are not counted as a cost of coho salmon recovery as the regulations would have been enacted anyway. However, many recommendations that target a reduction in sedimentation, which are included in Recovery Strategy costs, will also aid compliance with established TMDLs.

[2] No cost estimates have been developed for P-6, P-7, WUE-6a, WUE-6b, and WUE-6c. At this time, these recommendations are too general to cost.

Tables 11-1 through 11-3 summarize the measured fiscal cost of the Recovery Strategy. Habitat restoration costs are presented by HU; other costs are presented on a range-wide basis. Tables 11-4 and 11-5 summarize the measured socioeconomic impacts of the Recovery Strategy. Habitat restoration impacts are presented by HU, while other costs are presented on a range-wide basis. These estimates include the cost of implementing the SSPP, which is shown separately.

Some identified costs are not calculated at this stage. For example, the aggregate cost estimates in Tables 11-1 through 11-5 do not include specific line items for the range-wide recommendations because the majority of these recommendations cannot be assigned an estimated cost at this time. In addition, the cost of many of the range-wide recommendations will be captured by estimating the cost of the HU/HSA-specific recommendations. Given the magnitude of the measured recovery costs, failure to measure the costs of the range-wide recommendations explicitly does not qualitatively impact the recovery cost calculations. Another important unmeasured cost is the cost of water acquisition outside of the Shasta Valley and Scott River HSAs. These costs are likely to be significant, as are the associated socioeconomic impacts.

Another important unresolved issue with the cost of coho salmon recovery under the strategy is the role of increased enforcement of permits and take restrictions. There is some amount of unpermitted water diversion from streams containing coho salmon, for example, and some diverters take more than their allowable quantity. With regard to other issues like fencing, ESA and CESA take prohibitions may require that ranchers construct fencing and stock watering facilities more than is currently the case. This analysis has not attempted to parse out the total quantity of actions for recovery as opposed to actions required by the listing of the coho salmon. The costs of recovery were calculated based on the increment of various actions relative to the status quo.

The cost of achieving interim recovery goals is likely to include the cost of most of the biological and non-biological studies and watershed plan preparation called for in the Recovery Strategy. These costs will likely be incurred before many restoration costs. Other interim costs will include the cost of implementing restoration recommendations in the highest priority watersheds.

TABLE 11-1: Recovery strategy costs by Hydrologic Unit

HYDROLOGIC UNIT	COST ($)
Big Basin	253,907,283
Bodega	17,574,450
Cape Mendocino	146,915,528
Eel River	612,526,817
Eureka Plain	22,403,308
Klamath River	849,118,462
Mad River	26,176,223
Marin Coastal	57,802,142
Mendocino Coast	780,043,197
Redwood Creek	23,866,194
Rogue River	7,034,832
Russian River	265,193,565
San Francisco Bay	130,564,775
San Mateo	63,270,569
Smith River	21,864,544
Trinidad	21,864,544
Trinity River	564,392,468
Winchuck River	2,827,116
Total SONCC (w/o SSPP)	1,680,502,407
Total CCC	1,465,138,565
Total SONCC/CCC Restoration Costs	3,954,194,850
Total SSPP Restoration	371,583,569
Total Restoration Incl. SSPP	4,325,778,420

SOURCE: Authors' calculation. Habitat restoration includes removal of barriers to fish passage, riparian revegetation and stream-bank improvements, placement of LWD and improvements in instream complexity, and road treatment and decommissioning. SSPP is the Shasta-Scott Pilot Program.

TABLE 11-2: Range-wide costs

COST CATEGORY	COST ($)
MONITORING, EVALUATION AND PLANNING	
Total excl. SSPP	44,000,000
Total SSPP	10,604,000
Total incl. SSPP	54,604,000
EDUCATION AND OUTREACH	
Total excl. SSPP	31,000,000
Total SSPP	8,832,520
Total incl. SSPP	39,832,520
WATER MANAGEMENT	
Total excl. SSPP	--
Total SSPP	10,334,024
WATER USE EFFICIENCY	
Total excl. SSPP	--
Total SSPP	3,200,000
WATER ACQUISITION	
Total excl. SSPP	UNKNOWN
Total SSPP	60,217,676
PROTECTION	
Total excl. SSPP	0
Total SSPP	1,244,789
TIMBER MANAGEMENT	
Alternative C and elements 19 and 20 of Alternative B	FEW INCREMENTAL COSTS

SOURCE: Authors' calculation. SSPP is the Shasta-Scott Pilot Program. No cost estimates are available for water acquisition in the CCC or SONCC excluding the SSPP.

TABLE 11-3: Total estimated costs of coho salmon recovery

Total SONCC/CCC costs excluding water ($)	4,492,194,850
Total SSPP costs ($)	466,016,578

SOURCE: Authors' calculation. SSPP is the Shasta-Scott Pilot Program. No cost estimates are available for water acquisition in the CCC or SONCC excluding the SSPP. Excludes costs identified but not quantified.

TABLE 11-4: Socioeconomic impacts of restoration

HYDROLOGIC UNIT	IMPACTS ($)
Big Basin	157,582,359
Bodega	6,867,489
Cape Mendocino	87,121,241
Eel River	346,282,468
Eureka Plain	5,404,169
Klamath River	219,664,691
Mad River	15,304,285
Marin Coastal	36,888,250
Mendocino Coast	465,155,708
Redwood Creek	12,975,736
Rogue River	4,980,192
Russian River	169,652,499
San Francisco Bay HUs	82,073,590
San Mateo	42,081,530
Smith River	68,695,861
Trinidad	15,330,384
Trinity River	247,326,119
Winchuck River	1,917,551
Total SONCC (w/o SSPP)	1,082,338,237
Total CCC	902,965,885
TOTAL SONCC/CCC RESTORATION COSTS	1,985,304,122
TOTAL SSPP RESTORATION	159,296,346
TOTAL RESTORATION INCLUDING SSPP	2,144,600,468

SOURCE: Authors' calculation. Habitat restoration includes removal of barriers to fish passage, riparian revegetation and stream-bank improvements, placement of LWD and improvements in instream complexity, and road treatment and decommissioning. SSPP is the Shasta-Scott Pilot Program.

TABLE 11-5: Range-wide measured socioeconomic impacts

COST CATEGORY	IMPACT ($)
MONITORING, EVALUATION AND PLANNING	
Total excl. SSPP	0
Total SSPP	0
Total incl. SSPP	0
EDUCATION AND OUTREACH	
Total excl. SSPP	0
Total SSPP	0
Total incl. SSPP	0
WATER MANAGEMENT	
Total excl. SSPP	--
Total SSPP	0
WATER USE EFFICIENCY	
Total excl. SSPP	--
Total SSPP	2,020,000
WATER ACQUISITION	
Total excl. SSPP	UNKNOWN
Total SSPP	(6,143,359)
PROTECTION	
Total excl. SSPP	0
Total SSPP	0
TIMBER MANAGEMENT	
Alternative C and elements 19 and 20 of Alternative B	FEW INCREMENTAL IMPACTS

SOURCE: Authors' calculation. SSPP is the Shasta-Scott Pilot Program. No socioeconomic estimates are available for water acquisition in the CCC or SONCC excluding the SSPP.

12 Process for Managing and Revising the Recovery Strategy

Any recovery strategy includes provisions for management and coordination of implementation, periodic review, and revision of specific strategy elements. Given the extensive range of coho salmon, the number and complexity of the recovery tasks, and the comprehensive nature of this Recovery Strategy, communication and coordination among participating groups, private entities, landowners, and agencies, is a basic requirement for success.

The recovery of coho salmon is long-term in nature, and as such, the Recovery Strategy must be flexible and responsive to changing conditions and new information. The Recovery Strategy is based on the best available, current information. However, comprehensive and predictive information is currently not available regarding many ecological processes, cumulative effects of human activities, effects of stochastic natural events, the most effective conservation management practices for several land-use activities, and the most effective and appropriate means of addressing stakeholder issues or conflicts. As the Department receives more information regarding these and other topics, the strategy will be improved, and consequently, coho salmon will benefit.

The Department has established an adaptive management approach (*sensu* Blann 2000) as part of this Recovery Strategy. The purpose of the adaptive management approach is to combine the scientific method, the best available science, and the experience of stakeholders and land managers in an iterative process involving:

a. Implementing the recommended recovery tasks;

b. Monitoring coho salmon and its habitat, and the social, economic, and political consequences;

c. Reviewing monitoring and research information; and

d. Determining what, if any, changes are necessary to achieve the Recovery Strategy goals and criteria.

Further information on the adaptive management process is provided in Section 12.4, below.

12.1 MANAGEMENT AND COORDINATION OF IMPLEMENTATION

It is readily apparent that the two-tiered approach (i.e., landscape-level and watershed-specific) to recovery of coho salmon populations across their range in California is complex. Successful implementation of even the highest priority tasks will require individuals, organizations, and agencies to work in concert and with a clear understanding of what must be done to complete the recommended tasks, and the time frame under which the tasks should be completed.

To establish and maintain the coordination necessary for coho salmon recovery, the Department will designate a range-wide coordinator and at least one regional coordinator for each of the Department's two northern coastal regions. The coordinators will work with the appropriate Department personnel, representatives from other agencies, watershed groups, landowners, and private and non-profit entities to:

a. Support regional efforts to implement the strategy by providing a clear interpretation of the tasks, including a detailed schedule of required actions, who must complete the actions, when the actions need to be accomplished, and potential sources for funding;

b. Work with data groups, such as the Department's Wildlife and Habitat Data Analysis Branch (WHDAB), to set up an accessible database of information and a planning and progress tracking system;

c. Represent the Department in meetings with city, county, other State, and Federal agencies to coordinate activities recommended for coho salmon recovery;

d. Ensure interaction between the Department and local watershed groups so that information generated by these groups may be used to update the Recovery Strategy;

e. Assist in the establishment or broadening the scope of watershed planning groups in high priority watersheds that have been identified through the gap analysis (Appendix E) as areas where more information and project planning is needed;

f. Work with the California Watershed Council (partnership between California Environmental Protection Agency and The Resources Agency) to ensure that the coho salmon recovery strategy is duly applied through the programs and priorities set by this council;

g. Organize annual meetings of recovery teams and entities participating in recovery actions with updates on progress and consideration of new information;

h. Conduct an annual review and update, if necessary, of the prioritization of recommended tasks; and

i. Assemble annual progress reports.

In conjunction with developing a schedule of actions, the coho salmon recovery implementation coordinators will develop milestones for the strategy for the first five years, based on the interim priorities. As progress is made and new information analyzed, milestones will be developed for further five-year increments until coho recovery is achieved. Example milestones include:

a. Work with NOAA Fisheries to re-evaluate and potentially revise recovery criteria and recovery units (Year 1);

b. Coordinate with the Department's Fisheries Restoration Grant Program (FRGP) to integrate the strategy into the solicitation for 2004/05 grant cycle (Feb 2004 - Year 1);

c. Convene an annual meeting of coastal funding entities (e.g., Coastal Conservancy, Regional Water Quality Control Boards, etc.) that fund recovery and restoration efforts to promote understanding of funding programs and priorities, identify funding gaps, discuss projects, and evaluate progress;

d. Consider creation of regional watershed coordinators in order to better coordinate local and regional efforts in developing local watershed plans and priority actions, and coordinate the implementation of these plans by working closely with regional entities involved in recovery and restoration efforts;

e. Work with the Department's Conservation Education Branch to develop a public outreach program for priority watersheds and essential recommendations, and for recommendations identified for enforcement (Year 1);

f. Work with the Department's wardens to monitor and develop enforcement strategies in watersheds that support key coho salmon populations (Year 1-5);

g. Work with the Department's basin planners or other designees to build planning/implementation capacity with watershed groups in high priority watersheds (Year 1);

h. Meet with other agencies to coordinate implementation of recommended tasks under their authority and/or responsibility (Years 1-2);

i. Meet with the SWRCB and the NCRWQCB to develop an MOA/MOU for coordination of tasks addressing water rights, flows, and quality;

j. Coordinate with data management groups to update coho salmon monitoring and population data, and locations for collection of such data (Years 1 through 5);

k. Determine which highest priority (Task Level "E" in implementation table) recommended tasks can be addressed with the funding available (all years);

l. Determine which barrier removal projects in medium to high priority watersheds (ranks 3-5) that will re-establish access to formerly occupied habitat can be achieved with existing funding (Years 1-5); and

m. Make significant progress toward achieving highest priority recommended tasks for which funding is available in priority watersheds (Years 1- 5).

12.2 TIMETABLE AND PROCESS FOR REPORTING AND REVISION

Pursuant to FGC §2113, the Department will convene the CRT and the SSRT and report to the Commission on an annual basis regarding the status and progress of implementation of the Recovery Strategy. The Department, with the input of the recovery teams, will review and update prioritization of recommended tasks, and address any new information or changed conditions by developing recommendations to the Commission for modification of the strategy. Recommendations for recovery plan element modification would be formulated using information from monitoring/research and feedback from participants indicating a change is necessary to remain on track toward meeting the goals and criteria of the Recovery Strategy. In reporting annually to the Commission regarding the status and progress of implementation of the Recovery Strategy, the Department will include recommendations for modification of the strategy. Annual coho salmon recovery reports that are sent to the Commission will be posted on the Department's web site.

The initial years of implementation will involve securing funds and working with local, State, and Federal entities to initiate high priority programs and tasks called for in the range-wide and watershed implementation schedules of the Recovery Strategy. The assessment and monitoring elements will also be in their formative state. Annual meetings will be important during these early years to assess progress on strategy elements and decide on any necessary adjustments to the strategy for purposes of clarity and aiding implementation.

Over time, trends should be visible in habitat monitoring and project-level effectiveness monitoring. Information on coho salmon distribution and abundance may also give indications of response to management decisions based on the Recovery Strategy. Larger adjustments to the strategy for the purpose of improving efficacy or making progress toward goals and objectives may be warranted at this time.

Information from these annual progress reports will become part of the Department's coho salmon status review pursuant to FGC §2077, which requires the Department to review listed species every five years to determine if conditions that led to the original listing are still present. Information regarding the population trend, range, distribution, abundance, the factors affecting the ability of the population to survive and reproduce, the degree and immediacy of the threat, and the impact of existing management efforts will be reviewed.

Department reports to the Commission may include a review of the identification of the habitat that may be essential to the continued existence of the species and the department's recommendations for management activities and other recommendations for recovery of the species. If CESA recovery goals and delisting criteria are considered to have been met, the Department coho salmon status review report may contain a recommendation to remove the species from the list of endangered species or the list of threatened species for the Commission's consideration.

12.3 TIMETABLE CLARIFYING NON-SPECIFIC LONG-TERM GOALS

As information regarding the time and cost for successful implementation of recovery goals and objectives becomes available, the Department will be able to provide more details on specific, long-term recovery goals. These long-term goals will be re-visited during the annual reviews. Long-term goals may be refined with new information on changed environmental conditions (e.g., significant floods or wildfires, fluctuation in ocean condition), better knowledge of effects of human activities on coho salmon populations and habitat, better understanding of the biology of coho salmon, progress or increased effectiveness in recovery actions, and/or other information.

12.4 ADAPTIVE MANAGEMENT[1]

The Department believes adaptive management is essential for successful planning and implementation of coho salmon recovery.

> *Adaptive management is a systematic process for continually improving Department management policies and practices concerning coho salmon recovery by learning from the outcomes of recovery strategy programs and activities.*

This management approach will allow for application of recovery actions regarding the various issues and scales, both identified and future; coordination and cooperation with other agencies, landowners, private industry, fishing organizations, and environmental organizations; testing alternative recovery and conservation land-use practices; ecosystem-based management for whole watersheds or portions of a watershed; evaluation of coho salmon population health and habitat condition; and incorporation of new information and better decision making based on research and monitoring of coho salmon recovery.

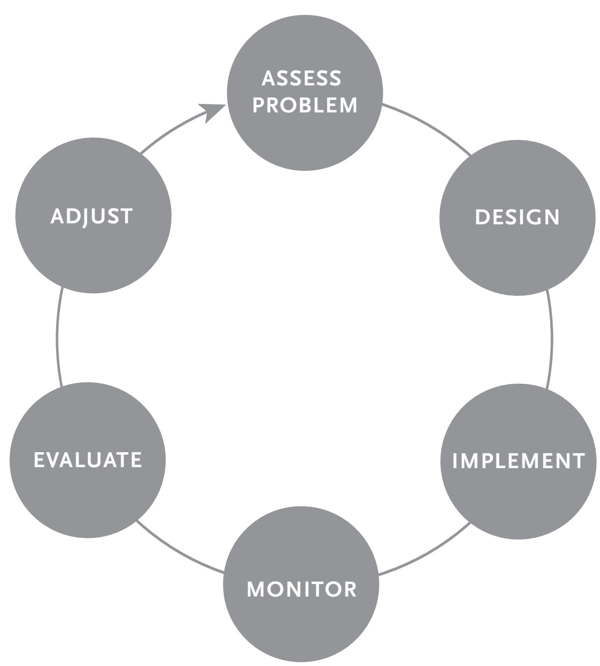
Essential to the progress of adaptive management will be input from local resource managers in government and industry, communities, and landowners who make decisions about land use and management, protecting and managing natural resources, and who will be responsible for implementing the majority of the recovery actions for coho salmon.

The Recovery Strategy adaptive management process is a six-step cycle (Figure 12-1), the success of which depends on the completion of all six steps:

[1] Adapted from Taylor et al. 1997.

1. *Assess Problem*. There are several processes to this step:
   a. Identify the problems and issues facing coho salmon and habitat and evaluate the scientific, management, and economic options and feasibility of potential solutions;
   b. Acknowledge where there are uncertainties in policy or practice and that what is "best" for a particular management issue may vary by region and over time; and
   c. Assess the current condition of factors affecting coho salmon recovery and where assessment is still necessary.
2. *Design*. Thoughtful selection of the policies, programs, and activities to be applied to recovery and additional assessment.
3. *Implement*. Implementation of identified programs and activities for recovery of coho salmon and continuing assessment designed to reveal the critical knowledge that is currently lacking,
4. *Monitor*. Examination of the key response indicators that inform the Department on the progress and effectiveness of recovery programs and activities and status and trend of coho salmon and habitat.
5. *Evaluate*. Analysis of the outcomes of recovery activities and programs and assessment and monitoring information during evaluation of the progress of coho salmon recovery, reassessment of the original objectives, and consideration of revising the Recovery Strategy.
6. *Adjust*. Incorporation of the results of implementation and monitoring into future decisions and revisions of the Recovery Strategy.

FIGURE 12-1: Adaptive management cycle



13 References Cited

Allendorf, F.W. and F.M. Utter. 1979. Population genetics. In *Fish physiology,* W.J. Hoar, D.J. Randall, and J.R. Brett, eds. Vol. 8. New York: Academic Press.

Ambrose, J. and D. Hines. 1997. Ten Mile River watershed 1996 instream monitoring results. Georgia-Pacific West, Inc.

Ambrose, J. and D. Hines. 1998. Ten Mile River watershed 1997 instream monitoring results. Georgia-Pacific West, Inc.

Ambrose, J., D. Hines, D. Lundby, and J. Drew. 1996. Ten Mile River watershed 1995 instream monitoring results. Georgia-Pacific West, Inc.

Anderson, D.G. 1988. Juvenile salmonid habitat of the Redwood Creek Basin Humboldt County, California. M.S. Thesis, Humboldt State University, Arcata, CA.

Anderson, K. R. 1995. A status review of the coho salmon *(Oncorhynchus kisutch)* in California south of San Francisco Bay. Report to the California Fish and Game Commission. CDFG.

Armour, C. L., D. A. Duff, and W. Elmore. 1991. The effects of livestock grazing on riparian and stream ecosystems. *Fisheries* 16: 7–11.

Baker, P., and F. Reynolds. 1986. Life history, habitat requirements, and status of coho salmon in California. Report to the California Fish and Game Commission. CDFG.

Banks, M., J. Robertson, K. Bucklin, P. Siri, and D. Hedgecock. 1999. Population genetics criteria for restoration of coho salmon *(Oncorhynchus kisutch)* in northern California. Sonoma County Water Agency.

Bartley, D.M., B. Bentley, P.G. Olin, and G.A.E. Gall. 1992. Population structure of coho salmon *(Oncorhynchus kisutch)* in California. California Fish and Game 78(3): 88–104.

Bartson, A. P. 1997. Restoration strategy for the fisheries of the Smith River (Draft). Institute for River Ecosystems, Humboldt State University, Arcata, California. 96 pp.

Beacham, T. D., and C. B. Murray. 1990. Temperature, egg size, and development of embryos and alevins of five species of Pacific salmon: a comparative analysis. *Transactions of the American Fisheries Society* 119: 927–945.

Beamish, R.J., B.L. Thomson, and G.A. McFarlane. 1992. Spiny dogfish predation on Chinook and coho salmon and the potential effects on hatchery-produced salmon. *Transactions of the American Fisheries Society* 121: 444–455.

Behnke, R. J., and M. Zarn. 1976. Biology and management of threatened and endangered western trouts. U.S. Department of Agriculture, Forest Service, General Technical Report RM-28.

Bell, E. 2001. Low growth rates and possible life-history consequences for juvenile coho salmon. Abstract of presentation given at the American Fisheries Society, California-Nevada and Humboldt Chapters 35th Annual Meeting. March 29–31, 2001. Santa Rosa, California.

Bell, M. C. 1986. Fisheries handbook of engineering requirements and biological criteria. U.S. Army Corps of Engineers, Office of the Chief of Engineers, Fish Passage Development and Evaluation Program, Portland, Oregon.

Belt, T. Captain, Central Coast Region, CDFG. A compilation of information from coastal and regional wardens within the petitioned area. E-mail, December 7, 2001.

Berggren, T.J., and M. Filardo. 1993. An analysis of variables influencing the migration of juvenile salmonids in the Columbia River Basin. *North American Journal of Fisheries Management* 13: 48–63.

Bilby, R. E. 1984. Characteristics and frequency of cool-water areas in a western Washington stream. *Journal of Freshwater Ecology* 2: 593–602.

Birch, P.B., H.E. Pressley, and P.D. Hartigan. 1992. Stormwater management manual for the Puget Sound basin. Washington Dept. of Ecology.

Bisson, P. A., R. A. Bilby, M. D. Bryant, C. A. Dolloff, G. B. Grette, R. A. House, M. L. Murphey, K. V. Koski, and J. R. Sedell. 1987. Large woody debris in forested streams in the Pacific northwest: past, present and future. In Streamside management: forestry and fishery interactions, Salo and Cundy, eds. 143–190. College of Forest Resources, Contribution 57. University of Washington.

Bjornn T. C., and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. In Influences of forest and rangeland management on salmonid fishes and their habitats, Meehan, W. R. 1991. *American Fisheries Society Special Publication* 19: 83–138.

Blann, K. 2000. Adaptive Management Practitioner's Network. A compilation of adaptive management definitions by scientists and managers in forum titled "Taking Stock: Implementing Adaptive Management in Large River Systems." (http://www.adaptivemanagement.net)

Booth, D. B. 1991. Urbanization and the natural drainage system—impacts, solutions, and prognoses. *Northwest Journal of Environmental Law and Policy* 7: 93–118.

Botkin, D., K. Cummins, T. Dunne, H. Reiger, M. Sobel, L. Talbot, and L. Simpson. 1995. Status and future of salmon in western Oregon and northern California: findings and options. The Center for the Study of the Environment. Report No. 8. May, 1995.

Botkin, D.B., D.L. Peterson, and J.M. Calhoun, technical editors. 2000. The scientific basis for validation monitoring of salmon for conservation and restoration plans. Olympic Natural Resources Technical Report. University of Washington. 82 pages.

Bovee, K. D. 1978. Probability-of-use criteria for the family Salmonidae. U.S. Department of the Interior, Fish and Wildlife Service FWS/OBS-78-07.

Brett, J. R. and D. MacKinnon. 1954. Some aspects of olfactory perception in migrating adult coho and spring salmon. *Journal of the Fisheries Research Board Canada* 11: 310-318.

Briggs, J.C. 1953. The behavior and reproduction of salmonid fishes in small coastal streams. CDFG Bulletin No. 94.

Brown, R. A. 1988. Physical rearing habitat for anadromous salmonids in the Redwood Creek Basin, Humboldt County, California. M.S. Thesis, Humboldt State University, Arcata, CA.

Brown, D.J.A., and K. Sadler. 1989. Fish survival in acid waters. In *Acid toxicity and aquatic animals,* R. Morris, E.W. Taylor, D.J.A. Brown, and J.A. Brown, eds. Cambridge, England: Cambridge University Press.

Brown, L.R., and P.B. Moyle. 1991. Status of coho salmon in California. Report to the National Marine Fisheries Service, Department of Wildlife and Fisheries Biology, University of California at Davis.

Brown, L.R., P.B. Moyle, and R. M. Yoshiyama. 1994. Historical decline and current status of coho salmon in California. *North American Journal of Fisheries Management* 14(2): 237–261.

Brown, R.F. and B.R. Mate. 1983. Abundance, movements and feeding habits of harbor seals *(Phoca vitulina)* at Netarts and Tillamook bays, Oregon. *NOAA Fishery Bulletin* 81(2): 291–301.

Bryan, E. H. 1972. Quality of stormwater drainage from urban land. *American Water Resources Association Water Resources Bulletin* 8(3): 578-588.

Busack, C.A., and K.P. Currens. 1995. Genetic risks and hazards in hatchery operations: fundamental concepts and issues. *American Fisheries Society Symposium* 15:71-80.

CACSST (California Advisory Committee on Salmon and Steelhead Trout). 1988. Restoring the balance. Annual Report No.124-J.

CALFED Bay Delta Program. 2000. Comprehensive Monitoring, Assessment, and Research Program. Final Programmatic EIS/EIR Technical Appendix. 164 pages.

Campton, D.E. 1995. Genetic effects of hatchery fish on wild populations of Pacific salmon and steelhead: What do we really know? *American Fisheries Society Symposium* 15: 337–353.

Cavalli-Sforza, L.L., and A.W.F. Edwards. 1967. Phylogenetic analysis: models and estimation procedures. *Evolution* 21:550-570.

California Coastal Conservancy. 2003. Assessment of barriers to fish passage in California coastal watersheds, draft edition. 269 pp.

CDFG (California Department of Fish and Game). 1959. Preliminary report on fish and wildlife in relation to plans for water development in Shasta Valley. California Department of Water Resources Bulletin 87, Shasta Valley Investigation. 1964.

CDFG 1965. California Fish and Wildlife Plan. State of California Resources Agency, Department of Fish and Game. Vols. I, II and III B.

CDFG. 1979. The status of salmon populations in California Coastal Rivers. CDFG, Anadromous Fisheries Branch.

CDFG. 1991. Lower Yuba River fisheries management plan. Stream Evaluation Report No. 91-1.

CDFG. 1994. Petition to the Board of Forestry to list coho salmon *(Oncorhynchus kisutch)* as a sensitive species.

CDFG. 1997. Biological needs assessment for anadromous fish in the Shasta River Siskiyou County, California. Northern California-North Coast Region. Redding, CA. 29 pp.

CDFG. 1998. Report to the Fish and Game Commission: a status review of the spring-run Chinook salmon *(Oncorhynchus tshawytscha)* in the Sacramento River drainage. CDFG Candidate Species Status Report 98-01.

CDFG. 2001. Draft Russian River Basin Plan, Central Coast Region, 145pp plus Appendices in prep.

CDFG. 2002. Status review of California coho salmon north of San Francisco. Report to the California Fish and Game Commission, April 2002.

CDFG/NOAA Fisheries. 2002. Draft Guidelines for Maintaining Instream Flows to Protect Fisheries Resources Downstream of water Diversions in Mid-California Coastal Streams.

CDWR (California Department of Water Resources). 1965. Bulletin No.136, North Coastal Area Investigation, Appendix C Fish and Wildlife. Prepared by California Department of Fish and Game Water Projects Branch, Sacramento CA.

Cederholm, C.J., L. M. Reid, and E. O. Salo. 1981. Cumulative effects of logging road sediment on salmonid populations in the Clearwater River, Jefferson County, Washington. State of Washington Water Research Center. Washington State University, Pullman.

Cederholm, C.J., and L.M. Reid. 1987. Impact of forest management on coho salmon *(Oncorhynchus kisutch)* populations of the Clearwater River, Washington: a project summary. In *Streamside management: forestry and fishery interactions,* E.O. Salo and T.W. Cundy, eds. Institute of Forest Resources, Contributions No. 57, University of Washington, Seattle. pp. 373–398.

CH2M HILL. 1985. Klamath River Basin Fisheries Resource Plan. Prepared for the Bureau of Indian Affairs. Department of Interior.

Chapman, D., A. Giorgi, T. Hillman, D. Deppert, M. Erho, S. Hays, C. Peven, B. Suzumoto, and R. Klinge. 1994. Status of summer/fall chinook salmon in the mid-Columbia region. Report for Chelan, Douglas, and Grant county public utility districts.

Cole, J. 2000. Coastal sea surface temperature and coho salmon production off the north-west United States. *Fisheries Oceanography* 9(1): 1-16.

Collins, B., and T. Dunne. 1990. Fluvial geomorphology and river-gravel mining: a guide for planners, case studies included. Department of Conservation, Division of Mines and Geology, Special Publication No. 98.

Cooper, A. C. 1959. Discussion of the effects of silt on survival of salmon eggs and larvae. Proceedings of the fifth symposium (Pacific Northwest) on siltation: its source and effects on aquatic environment. U.S. Department of Health, Education and Welfare, Portland, Oregon.

Cooper, A.B., and M. Mangel. 1999. The dangers of ignoring metapopulation structure for the conservation of salmonids. *U.S. Bureau of Fisheries Bulletin* No. 97: 213–226.

Cooper, R., and T. H. Johnson. 1992. Trends in steelhead *(Oncorhynchus mykiss)* abundance in Washington and along the Pacific coast of North America. Washington Department of Wildlife, Fisheries Management Division, Report No. 92-20.

Cox, William. Senior Fish Pathologist, Fish Health Laboratory, California Department of Fish and Game, pers. comm. (as taken from the Status Review of California Coho Salmon North of San Francisco), Sept. 10, 2001.

Cramer, S.P., S.W. Alley, J.E. Baldrige, K. Barnard, D.B. Demko, D.H. Dettman, B. Farrell, J. Hagar, T.P. Keegan, A. Laird, W.T. Mitchell, R.C. Nuzum, R. Orton, J.J. Smith, T.L. Taylor, P.A. Unger, and E.S. Van Dyke. 1995. The status of steelhead populations in California in regards to the Endangered Species Act. S.P. Cramer and Associates, Inc., Gresham, Oregon.

Currens, K.P., and C.A. Busack. 1995. A framework for assessing genetic vulnerability. *Fisheries* 20(1):24-31.

Davidson, F. A., and S. J. Hutchinson. 1938. The geographic and environmental limitations of the Pacific salmon (Genus *Oncorhynchus*). *U.S. Bureau of Fisheries Bulletin* No. 48: 667–692.

Davis, G. E., J. Foster, C. E. Warren, and P. Doudoroff. 1963. The influence of oxygen concentration on the swimming performance of juvenile Pacific salmon at various temperatures. *Transactions of the American Fisheries Society* 92: 111–124.

Dorn, M. W. 1989. A conditional logistic regression model for the onset of riverine salmon migrations. M.S. thesis, University of Washington, Seattle.

Downie, S. T., C. W. Davenport, E. Dudik, F. Yee, and J. Clements. 2002. Mattole River Watershed Assessment Report. North Coast Watershed Assessment Program. California Resources Agency, and California Environmental Protection Agency, Sacramento, California.

Ebel, W. J., and H. L. Raymond. 1976. Effect of atmospheric gas supersaturation on salmon and steelhead trout of the Snake and Columbia rivers. *Marine Fisheries Review* 38: 1–14.

Ellis, D.V. 1962. Preliminary studies on the visible migrations of adult salmon. *Journal of the Fisheries Research Board Canada* 19: 137–148.

Emmett, R. L., and M. H. Schiewe, eds. 1997. Estuarine and ocean survival of northeastern Pacific salmon: proceedings of the workshop. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-NEFSC-29.

Essig, D.A. 1998. The dilemma of applying uniform temperature criteria in a diverse environment: an issue analysis. Idaho Division of Environmental Quality, Water Quality Assessment and Standards Bureau.

Everest, F. H., N. B. Armantrout, S. M. Keller, W. D. Parante, J. R. Sedell, T. E. Nickelson, J. M. Johnston, and G. N. Haugen. 1985. Salmonids. In Management of wildlife and fish habitats in forests of western Oregon and Washington, E. R. Brown, ed. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, Portland, Oregon. Publication R6-F&WL-192-1985.

Federal Register. 1996. Final Rule. Endangered and threatened species: Threatened status for Central California Coast coho salmon evolutionarily significant unit (ESU), October 31, 1996. 61(212): 56138-56149.

Federal Register. 1997. Final Rule. Endangered and threatened species: Threatened status for Southern Oregon/Northern California Coast evolutionarily significant unit (ESU) of coho salmon, May 5, 1997. 62(87): 24588-24609.

FishNet 4C. 2004. Guidelines for protecting aquatic habitat and salmon fisheries for county road maintenance.

Flagg, T.A., B.A. Berejikian, J.E. Colt, W.W. Dickhoff, L.W. Harrell, D.J. Maynard, C.E. Nash, M.S. Strom, R.N. Iwamoto, and C.V. Mahnken. 2000. Ecological and behavioral impacts of artificial production strategies on the abundance of wild salmon populations. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-XX.

Fleming, I.A., and M.R. Gross. 1993. Breeding success of hatchery and wild coho salmon *(Oncorhynchus kisutch)* in competition. *Ecological Applications* 3: 230–245.

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins. 1998. California salmonid stream habitat restoration manual, 3rd edition. CDFG.

Ford, M.J., P.J. Thornton, and L.K. Park. 1999. Natural selection promotes divergence of transferrin among salmonid species. *Molecular Ecology* 8: 1055–1061.

Forest Ecosystem Management Assessment Team. 1993. Forest ecosystem management: an ecological, economic, and social assessment (report). U.S.: Bureau of Land Management, Environmental Protection Agency, National Marine Fisheries Service, National Park Service, Fish and Wildlife Service and Forest Service.

Frankham, R., K. Lees, M. E. Montgomery, P.R. England, E.H. Lowe, and D. A. Briscoe. 1999. Do population size bottlenecks reduce evolutionary potential? *Animal Conservation* 2:255-260.

Franklin, J.R. 1980. Evolutionary changes in small populations. Pp. 135-149, *In* M. Soule (ed.) *Conservation Biology: and evolutionary-ecological perspective*. Sinauer Associates, Sunderland, MA.

Fresh, K.L. 1997. The role of competition and predation in the decline of pacific salmon and steelhead. In *Pacific salmon and their ecosystems*, D. Stroder, P. Bisson, R. Naiman, editors. Chapman and Hall, New York. 685 p.

Fry, D. H. 1936. Life history of *Hesperoleucas venustus* Snyder. *California Fish and Game* 22(2):65-98. cited in: Leidy 1984.

Fry, D. 1973. Anadromous fishes of California. CDFG.

Gale, D.B. 2003. Inventory and assessment of anadromous fish passage barriers in the lower Klamath River sub-basin, California. Yurok Tribal Fisheries Program, Habitat Assessment and Biological Monitoring Division Technical Report No. 9, Klamath, California.

Gale, D.B. and D.B. Randolph. 2000. Lower Klamath River sub-basin watershed restoration plan (Draft). Yurok Tribal Fisheries Program, Klamath, California.

George, M., N. McDougald, K. Tate, and R. Larson. 2002. Sediment dynamics and sources in a grazed hardwood rangeland watershed. USDA Forest Service Tech. Rep. PSW-GTR-184.

Goley, D. and A. Gemmer. 2000. Pinniped/salmonid interactions on the Smith, Mad and Eel rivers in northern California between 31 August and 15 December 1999. Unpublished report, Humboldt State University Marine Mammal Education and Research Program, Arcata, California.

Grant, S. (editor). 1997. Genetic effects of straying of non-native hatchery fish into natural populations. U.S. Dept. of Commer., NOAA Tech. Memo, NMFS-NWFSC-30, Seattle, WA.

Graybill, M.R. 1981. Haul-out patterns and diet of harbor seals, *Phoca vitulina,* in Coos County, Oregon. M.S. thesis. University of Oregon.

Gribanov, V.I. 1948. The coho salmon *(Oncorhynchus kisutch):* a biological sketch. Izvestiya Tikhookeanskogo nauchno-issledovatel'skogo *Instituta rybnogo knoziastva okeanografii* 28: 43–101. Translated from the Russian. Fisheries Research Board of Canada Translation Service.

Griffith, J. S., and D. A. Andrews. 1981. Effects of a small suction dredge on fishes and aquatic invertebrates in Idaho streams. *North American Journal of Fisheries Management* 1: 21–28. 38: 1444–1448.

Groot, C. 1982. Modifications on a theme—a perspective on migratory behavior of Pacific salmon. *In* Proceedings, salmon and trout migratory behavior symposium, E. L. Brannon and E. O. Salo, eds., 1–21. College of Fisheries, University of Washington, Seattle.

Haible, W.W. 1976. Holocene profile changes along a California coastal stream. Master of science thesis. Geology and Geophysics, University of California, Berkeley, California.

Halligan, D. 2000. pers. comm.

Halligan, D. 1997. Final report on the results of the 1996 fisheries monitoring program on the Trinity and lower Mad, Eel, and Van Duzen Rivers. Natural Resources Management Corporation, Eureka, California.

Hallock, R .J. and D. H. Fry. 1967. Five species of salmon, *Oncorhynchus,* in the Sacramento River, *California. California Fish and Game* 53(1): 5–22.

Hanson, L.C. 1993. The foraging ecology of harbor seals, *Phoca vitulina,* and California sea lions, *Zalophus californianus,* at the mouth of the Russian River, California. Master's thesis, Sonoma State University, California.

Harvey, B.C. 1986. Effects of suction gold dredging on fish and invertebrates in two California streams. *North American Journal of Fisheries Management* 6: 401–409.

Hassler, T.J., C.M. Sullivan, and G.R. Stern. 1991. Distribution of coho salmon in California. Annual Report to CDFG.

Hedgecock, D. 2001. Unpublished progress report memo to California Department of Fish and Game.

Hedgecock, D, M. Banks, K. Bucklin, C. Dean, W. Eichert, C. Greig, P. Siri, P. Nyden, and J. Waters. 2002. Documenting biodiversity of coastal salmon *(Oncorhynchus spp.)* in Northern California. Final Report. Sonoma County Water Agency contract #TW-99/00-110. 61 p.

Henly,R., S. Cannata, J. Erler, J. Sunahara, and J. Clements. 2002. Redwood Creek Watershed Assessment Report. North Coast Watershed Assessment Program. California Resources Agency and California Environmental Protection Agency, Sacramento, California.

Hicks, B.J., J.D. Hall, P.A. Bisson, and J.R. Sedall. 1991. Response of salmonids to habitat changes. In: W.R. Meehan (ed.). Influences of Forest and Rangeland Management on Salmonid Fish and their Habitats. American Fisheries Society Special Publication 19:483-518.

Hillemeier, D. Fisheries Program Manager, Yurok Tribe. E-mail, November 9, 2001.

Hindar, K., N. Ryman, and F. Utter. 1991. Genetic effects of cultured fish on natural fish populations. *Canadian Journal of Fisheries and Aquatic Sciences* 48: 945–957.

Hines, D. and J. Ambrose. ND. Evaluation of stream temperatures based on observations of juvenile coho salmon in northern California streams. Unpublished cooperative report. Campbell Timberland Management, Inc. and National Marine Fisheries Service.

Holtby, L.B. 1988. Effects of logging on stream temperatures in Carnation Creek, British Columbia, and associated impacts on the coho salmon *(Oncorhynchus kisutch)*. *Canadian Journal of Fisheries and Aquatic Sciences* 45: 502–515.

Holtby, L. B., B. C. Andersen, and R. K. Kadowaki. 1990. Importance of smolt size and early ocean growth to interannual variability in marine survival of coho salmon *(Oncorhynchus kisutch)*. *Canadian Journal of Fisheries and Aquatic Sciences* 47: 2181–2194.

Hopkirk, J. D. 1973. Endemism in fishes of the Clear Lake region of central California. Berkeley and Los Angeles: University of California Press.

Humboldt County Public Works. 1992. Final program EIR on gravel removal from the lower Eel River. Natural Resources Division.

Jager, D. 1994. Program environmental impact report on gravel removal from the lower Eel and Van Duzen rivers. Prepared for the County of Humboldt, Eureka, California.

Jameson, R.J. and K.W. Kenyon. 1977. Prey of sea lions in the Rogue River, Oregon. *Journal of Mammalogy* 58(4): 672.

Johnson, S.L. 1988. The effects of the 1983 El Niño on Oregon's coho, *Oncorhynchus kisutch,* and Chinook, *O. tshawytscha,* salmon. *Fisheries Research* 6(2): 105–123.

Jones, R.C. and C.C. Clark. 1987. Impact of watershed urbanization on stream insect communities. *Water Resources Bulletin* 23:1,047-1,055.

Klamt, Robert R., C. LeDoux-Bloom, J. Clements, M. Fuller, D. Morse and M. Scruggs (multi-disciplinary team leads). 2002. Gualala River Watershed Assessment Report. North Coast Watershed Assessment Program, 367 pp plus Appendices. California Resources Agency, and California Environmental Protection Agency, Sacramento, California.

Klein, R.D. 1979. Urbanization and stream quality impairment. *American Water Resources Association Water Resources Bulletin* 15 (4): 948-963.

Knutson, K. L. and V. L. Naef. 1997. Management recommendations for Washington's priority habitats. Washington Department of Fish and Wildlife, Olympia.

Kondolf, G.M. 1993. The reclamation concept in regulation of gravel mining in California. *Journal of Environmental Planning and Management* 36: 395–406.

Koslow, J.A., A.J. Hobday, and G.W. Boehlert. 2002. Climate variability and marine survival of coho salmon *(Oncorhynchus kisutch)* in the Oregon production area. *Fisheries Oceanography* 11(2): 65-77.

KRBFTF (Klamath River Basin Fisheries Task Force). 1991. Long range plan for the Klamath River basin conservation area fishery restoration program. Available from the U.S. Fish and Wildlife Service, Yreka Fish and Wildlife Office, Yreka, CA. 96097.

Lande, R. 1995. Mutation and conservation. *Conservation Biology* 9:782-791.

Lande, R., and G.F. Barrowclough. 1987. Effective population size, genetic variation and their use in population management. Pp 87-124, In M. Soule (ed.) *Conservation Biology: An evolutionary-ecological perspective.* Sunderland, MA: Sinauer Associates.

Laufle, J. C., G. B. Pauley, and M. F. Shepard. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest): Coho salmon. U.S. Fish and Wildlife Service Biological Report No. 82(11.48). U.S. Army Corps of Engineers, TR EL-82-4.

Larsson, P. O. 1985. Predation on migrating smolt as a regulating factor of Baltic salmon, *Salmo salar L.,* populations. *Journal of Fish Biology* 26: 391–397.

Lawson, P. W. 1993. Cycles in ocean productivity, trends in habitat quality, and the restoration of salmon runs in Oregon. *Fisheries* 18(8): 6–10.

Leider, S.A., P.L. Hulett, J.J. Loch, and M.W. Chilcote. 1990. Electrophoretic comparison of the reproductive success of naturally spawning transplanted and wild steelhead trout through the returning adult stage. *Aquaculture* 88: 239–252.

Leidy, R. A. 1984. Distribution and ecology of stream fishes in the San Francisco Bay drainage. *Hilgardia* 52 (8): 1-177

Leidy, R. and G. Becker. 2001. Letter to Dennis McEwan, California Department of Fish and Game.

Leitritz, E. and R.C. Lewis. 1980. Trout and salmon culture. CDFG Bulletin No.164.

Levin, P.S. and M.H. Schiewe. 2001. Preserving salmon biodiversity. *American Scientist* 89(3): 220–227.

Levins, R. 1969. Some demographic and genetic consequences of environmental heterogeneity for biological control. *Bulletin of the Entomological Society of America* 15: 237–240.

Lewis, D.J., K.W. Tate, J.M. Harper, and J. Price 2001. Survey identifies sediment sources in North Coast rangelands. *California Agriculture,* Vol. 55, No. 4.

Li, H. W., M. Dutchuk, C. B. Schreck. 1979. Unpublished data, available from the senior author, Department of Fisheries and Wildlife, Oregon State University, Corvallis, Oregon.

Limburg, K.E, and R.E. Schmidt. 1990. Patterns of fish spawning in Hudson River tributaries: response to an urban gradient? *Ecology* 71: 1238-1245.

Lloyd, D. S., J. P. Koenings, and J. D. LaPerriere. 1987. Effects of turbidity in fresh waters of Alaska. *North American Journal of Fisheries Management* 7: 18–33.

Lucchetti, G. and R. Fuerstenberg. 1993. Management of coho salmon habitat in urbanizing landscapes of King County, Washington, USA. In *Proceedings of the coho salmon workshop*. Canadian Dept. of Fisheries and Oceans, pages 308-317.

Lucoff, W. 1980. The distribution of six selected species from the genera *Oncorhynchus, Salmo,* and *Salvelinus* in California. M.S. thesis, California State University, Hayward.

Lynch, M. 1990. Mutation load and the survival of small populations. *Evolution* 44:1725-1737.

Mantua, N.J., 2003. The Pacific decadal oscillation and climate forecasting for North America. (http://www.atmos.washington.edu/~mantua/REPORTS/PDO/PDO_cs.htm)

Mantua, N.J., S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. *American Meteorological Society Bulletin* 78:1069-1079.

McDonnell, M.J. and S.T.A. Pickett. 1990. Ecosystem structure and function along urban-rural gradients: an unexploited opportunity for ecology. Ecology 71: 1,232-1,237.

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-42.

McHenry, M. L., D. C. Morrill, and E. Currence. 1994. Spawning gravel quality, watershed characteristics and early life history survival of coho salmon and steelhead in five North Olympic Peninsula watersheds. A study funded by the Department of Ecology, Centennial Clean Water Fund & Section 205J Clean Water Act. Prepared by the Lower Elwha S'Kallan Tribe and the Makah Tribe, Port Angeles and Neah Bay, Washington.

Meehan, W.R., ed. 1991. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication No. 19.

Meffe, G.K. 1992. Techno-arrogance and halfway technologies—Salmon hatcheries on the Pacific coast of North America. *Conservation Biology* 6: 350–354.

Merenlender, A. M., C. N. Brooks, and G. A. Giusti. 2000. Policy analysis related to the conversion of native habitat to vineyard: Sonoma County's vineyard erosion and sediment control ordinance as a case study. University of California, Berkeley. Integrated Hardwood Range Management Program. (http://danr.ucop.edu/ihrmp/policy_paper.pdf)

Milner, G. B. 1993. Isozyme variation of coho salmon *(Oncorhynchus kisutch)* and its potential to estimate stock compositions of mixed stock fisheries. *In* Proceedings of the coho workshop, Nanaimo, B.C., May 26-28, Berg and P.W. Delany eds., 182–192. Available from Canadian Department of Fisheries and Oceans, Vancouver.

Monan, G. E., J. H. Johnson, and G. F. Esterberg. 1975. Electronic tags and related tracking techniques aid in study of migrating salmon and steelhead trout in the Columbia River basin. *Marine Fisheries Review* 37: 9–15.

Monschke, J. 1996. Overview of stream channel conditions, North Fork Garcia River. A report submitted for Coastal Forestlands, Ltd.

Moring, J.R., G.C. Garman, and D.M. Mullen. 1994. Effects of logging practices on fishes in streams and techniques for protection: a review of four studies in the United States. In *Rehabilitation of Freshwater Fishes*, I.G. Cowx, ed. Hull International Fisheries Institute, University of Hull, U.K.

Mortensen, D. G., B. P. Snyder, and E. O. Salo. 1976. An analysis of the literature on the effects of dredging on juvenile salmonids. Special report to the Department of Navy, College of Fisheries, Fisheries Research Institute, University of Washington, Seattle.

Moyle, P.B. 1976. Inland fishes of California. Berkeley: University of California Press.

Moyle, P. B., R. M. Yoshiyama, J. E. Williams, E. D. Wikramanayake. 1995. Fish species of special concern in California, second edition. CDFG.

Murphy, M.L. 1995. Forestry impacts on freshwater habitat of anadromous salmonids in the Pacific Northwest and Alaska: requirements for protection and restoration. NOAA Coastal Ocean Program, Decision Analysis Series No. 7.

Naiman, R.J., T.J. Beechie, L.E. Benda, D.R. Berg, P.A. Bisson, L.H. MacDonald, M.D. O'Connor, P.L. Olson, and E.A. Steel. 1992. Fundamental elements of ecologically healthy watersheds in the Pacific Northwest coastal ecoregion. In *Watershed management: balancing sustainability and environmental change,* R.J. Naiman, ed., pages 127–188. New York: Springer-Verlag.

National Council on Gene Resources. 1982. Anadromous salmonid genetic resources: and assessment plan for California. California Gene Resources Program, Berkeley.

Neave, F. 1943. Diurnal fluctuations in the upstream migration of coho and spring salmon. *Journal of the Fisheries Research Board Canada* 6: 158–163.

Nei, M. 1987. Genetic distance and molecular phylogeny. In *Population genetics and fishery management,* N. Ryman ed., p.193–215. Seattle: University of Washington Press.

Neillands, G.W. 1990. Natural hybridization between coastal cutthroat trout *(Oncorhynchus clarki)* and steelhead trout *(Oncorhynchus mykiss)* within Redwood Creek, California. Humboldt State University, Arcata, CA.

Nielsen, J.L., T.E. Lisle, and V. Ozaki. 1994. Thermally stratified pools and their use by steelhead in northern California streams. *Transactions of the American Fisheries Society* 123: 613–626.

NMFS (National Marine Fisheries Service). 1996. National gravel extraction policy. Santa Rosa, California. (http://swr.ucsd.edu/hcd/gravelsw.htm).

NMFS. 1998. Factors contributing to the decline of Chinook salmon: an addendum to the 1996 west coast steelhead factors for decline report. Protected Resources Division, NMFS, Portland, Oregon.

NMFS. 2001. Status review update for coho salmon *(Oncorhynchus kisutch)* from the central California coast and the California portion of the southern Oregon/northern California coasts Evolutionarily Significant Units. Southwest Fisheries Science Center, Santa Cruz Laboratory.

National Research Council. 1996. Upstream: salmon and society in the Pacific Northwest. Washington, D.C. National Academy Press.

Novitzki, R.P. 1973. Improvement of trout streams in Wisconsin by augmenting low flows with ground water. Geological Survey Water-Supply Paper 2017.

O'Brien, S. and J. Everman. 1989. Interactive influence of infectious disease and genetic diversity in natural populations. *Trends in Ecology and Evolution* 3:254-259.

Olin, P.G. 1984. Genetic variability in hatchery and wild populations of coho salmon, *Oncorhynchus kisutch,* in Oregon. M.S. thesis, University of California, Davis.

Omernik, J.M. 1977. Nonpoint source-stream nutrient level relationships: a nationwide study. EPA-600/3/77-105. U.S. EPA.

Oregon, State of. 1997. Coastal Salmon Restoration Initiative. The Oregon Plan: Restoring an Oregon Legacy through cooperative efforts.

PCFWWRA 1995. Prairie Creek salmon progress report. Pacific Coast Fish, Wildlife, and Wetlands Restoration Association, Arcata, California.

Pacific Coast Fish and Wildlife Wetlands Restoration Association. 2001. Stream surveys.

Parrish, R.R., and M.J. Tegner. 2001. California's variable ocean environment. In California's living marine resources: a status report, Leet, W.S., C.M. Dewees, R. Klingbeil, and E.J. Larsen, eds., p. 21–28. The Resources Agency, CDFG.

Pert, H. A. 1993. Winter food habits of coastal juvenile steelhead and coho salmon in Pudding Creek, northern California. M.S. thesis, University of California, Berkeley.

PFMC (Pacific Fishery Management Council). 1999. Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon. Amendment 14 to the Pacific Coast salmon plan.

Phillips, R.W., and H.J. Campbell. 1961. The embryonic survival of coho salmon and steelhead trout as influenced by some environmental conditions in gravel beds. In 14th annual report of the Pacific Marine Fisheries Commission, 60–73. Portland, Oregon.

Pulliam, H.R. 1988. Sources, sinks, and population regulation. *American Naturalist* 132: 652–661.

Quinn, T.P., and K. Fresh. 1984. Homing and straying in Chinook salmon *Oncorhynchus tshawytscha* from Cowlitz River Hatchery, Washington. *Canadian Journal of Fisheries and Aquatic Sciences* 41: 1078–1082.

Reid, L. M. 1998. Forest roads, chronic turbidity, and salmon. *American Geophysical Union EOS Transactions,* 79(45): F285.

Reisenbichler, R.R. and S.P. Rubin. 1999. Genetic changes from artificial propagation of Pacific salmon affect the productivity and viability of supplemented populations. *ICES Journal of Marine Science* 56: 459–466.

Reiser, D.W. and T.C. Bjornn. 1979. Habitat requirements of anadromous salmonids. *In* Influence of forest and rangeland management on anadromous fish habitat in western North America, W.R. Meehan, ed. Pacific Northwest Forest and Range Experiment Station, U.S. Forest Service. GTR-PNW-96.

Reynolds, F. L., T. J. Mills, R. Benthin, and A. Low. 1993. Restoring Central Valley streams: a plan for action.

Rich, A. A. 1995. Feasibility Study to Rehabilitate the Fishery Resources of the Arroyo Corte Madera Del Presidio Watershed, Mill Valley, California.

Rich, A.A. 1991. The impacts of timber harvest practices on the fishery resources of the Navarro River watershed, Mendocino County, California. Phase III: Fishery resources and baseline surveys. Annual Report. Prepared for Louisiana-Pacific, Samoa, California.

Richards, C., L.B. Johnson, and G.E. Host. 1996. Landscape-scale influences on stream habitats and biota. *Canadian Journal Fish and Aquatic Sciences* 53:295-311.

Ricker, W.E. 1972. Heredity and environmental factors affecting certain salmonid populations. In *The stock concept in Pacific salmon*, R.C. Simon and P.A. Larkin, eds. Vancouver: University of British Columbia.

Roffe, T.J. and B.R. Mate. 1984. Abundance and feeding habits of pinnipeds in the Rogue River, Oregon. *Journal of Wildlife Management* 48(4): 1262–1274.

Ryding, K.E. and J.R. Skalski. 1999. Multivariate regression relationships between ocean conditions and early marine survival of coho salmon *(Oncorhynchus kisutch)*. *Canadian Journal of Fisheries and Aquatic Science* 56(12): 2374-2384.

Saccheri, I., M. Kuussaari, M. Kankare, P. Vikman, W. Fortelius, and I. Hanski. 1998. Inbreeding and extinction in a butterfly metapopulation. *Nature* 392:491-494.

Salo, E.O. and T. W. Cundy, editors. 1987. Streamside management: forestry and fishery interactions. Contribution No. 57. Institute of Forest Resources, University of Washington, Seattle, Washington.

Sandercock, F.K. 1991. Life history of coho salmon, *Oncorhynchus kisutch*. In *Pacific salmon life histories,* C. Groot and L. Margolis eds. Vancouver: University of British Columbia Press.

Scheffer, T.H., and C.C. Sperry. 1931. Food habits of the Pacific harbor seal, *Phoca vitulina richardsi*. *Journal of Mammalogy* 12(3): 214–226.

Schlosser, I.J. and P.L. Angermeier. 1995. Spatial variation in demographic processes of lotic fishes: conceptual models, empirical evidence, and implications for conservation. In Evolution and the aquatic ecosystem: defining unique units in population conservation, J.L. Nielsen, ed. Symposium of American Fisheries Society, Bethesda, Maryland.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Bulletin No.184, Fisheries Research Board of Canada, Ottawa. Pp. 158–164.

SEC (Steiner Environmental Consulting). 1996. A history of the salmonid decline in the Russian River. Sonoma County Water Agency, California State Coastal Conservancy, Steiner Environmental Consulting.

Sedell, J.R. and K.J. Luchessa. 1982. Using the historical record as an aid to salmonid habitat enhancement. *In* Acquisition and utilization of aquatic habitat inventory information, N. B. Armantrout, ed. Symposium of American Fisheries Society, Bethesda, Maryland.

Sedell, J.R., F.H. Leone, and W. S. Duval. 1991. Water transportation and storage of logs. American Fisheries Society Special Publication No. 19: 325–368.

Shapovalov, L. and A.C. Taft. 1954. The life histories of the steelhead rainbow trout *(Salmo gairdneri)* and silver salmon *(Oncorhynchus kisutch)* with special reference to Waddell Creek, California, and recommendations regarding their management. CDFG Bulletin No. 98.

Shirazi, M.A. and W.K. Seim. 1981. Stream system evaluation with emphasis on spawning habitat for salmonids. *Water Resources Research* 17: 592–594.

Snider, W., K.A. F. Urquhart, and D. Marston. 1995. The Relationship between instream flow and coho salmon and steelhead habitat availability in Scott Creek, Santa Cruz County, California. CDFG Stream flow and habitat evaluation program.

Snyder, J.O. 1931. Salmon of the Klamath River, California. CDFG Bulletin No. 34.

Solazzi, M.G. 1986. Electrophoretic stock characterization of coho salmon populations in Oregon and Washington, and coastal Chinook salmon populations in Oregon. Oregon Department of Fish and Wildlife Information Report, 86-5, 16 p.

Sorenson, D.L., M.M. McCarthy, E.J. Middlebrooks, and D.B. Porcella. 1977. Suspended and dissolved solids effects on freshwater biota. U.S. Environmental Protection Agency, Corvallis, Oregon.

Sparkman, M. 2000. Summary report on salmon & steelhead out migration, Upper Redwood Creek, Humboldt County, California. Douglas Parkinson and Associates. Arcata, CA.

Sparkman, M. 2001. Fishery Biologist, California Department of Fish and Game, pers. comm.

Sparkman, M. 2002. Fishery Biologist, California Department of Fish and Game, pers. comm.

Sparkman, M. 2002. Annual Report Upper Redwood Creek juvenile salmonid downstream migration study, 2000-01. CDFG, North Coast Region.

Spence, B.C. 1995. Geographic variation in timing of fry emergence and smolt migration of coho salmon *(Oncorhynchus kisutch)*. Ph.D diss. Oregon State University, Corvallis.

Spence, B.C., G. A. Lomnicky, R. M. Hughes, and R. P. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-401-96-6057. ManTech Environmental Research Services Corporation, Corvallis, OR. 356 pp.

SRCO (Simpson Resource Company). 2002. Section 4. Description and assessment of the current status of aquatic habitat and covered species in the area where the plan will be implemented. *In* Public review draft aquatic habitat conservation plan and candidate conservation agreement with assurances.

Steward, E.R. and T.C. Bjornn. 1990. Supplementation of salmon and steelhead stocks with hatchery fish; a synthesis of published literature. Bonneville Power Administration Project, Part 2, 88-100. Portland, Oregon.

Tagart, J.V. 1984. Coho salmon survival from egg deposition to fry emergence. *In* Proceedings of the Olympic Wild Fish Conference, March 23-25, 1983, J.M. Walton and B. Houston , eds. Fisheries Technology Program, Peninsula College, Port Angeles, Washington.

Taylor, B., L. Kremsater, and R. Ellis. 1997. Adaptive Management of Forests in British Columbia. British Columbia Ministry of Forests.

Terrell, C.R., and P.B. Perfetti. 1989. Water quality indicators guide: surface waters. U.S. Soil Conservation Service. SCS-TP-161. Washington, D.C.

Thomas, V.G. 1985. Experimentally determined impacts of a small, suction gold dredge on a Montana stream. *North American Journal of Fisheries Management* 5: 480–488.

Thompson, K. 1972. Determining stream flows for fish life. *In* Proceedings, instream flow requirements workshop. Pacific Northwest River Basins Commission, Vancouver and Washington.

Tschaplinski, P. J. 1999. The effects of forest harvesting, fishing, climate variation, and ocean conditions on salmonid populations of Carnation Creek, Vancouver Island, British Columbia. In *Sustainable fisheries management Pacific salmon,* E.E. Knudsen, C. R Steward, D. D. MacDonald, J. E. Williams, D. W. Reiser, eds. CRC Press LLC, Lewis Publishers.

USFWS (U. S. Fish and Wildlife Service). 1979. Klamath River fisheries investigations: progress, problems and prospects. Annual Report, Arcata, California, November 21, 1979.

USFWS. 1996. Endangered and threatened wildlife and plants; determination of threatened status for the California red-legged frog. Federal Register, May 23, 1996 (Volume 61, Number 101).

Utter, F. 1998. Genetic problems of hatchery-reared progeny released into the wild, and how to deal with them. *Bulletin of Marine Science* 62:623-640.

Wang, L., J. Lyons, and P. Kanehl. 2003. Impacts of urban land cover on trout streams in Wisconsin and Minnesota. *Transactions of the American Fisheries Society* 132: 825-839.

Wang, L., J. Lyons, P. Kanehl, and R. Gatti. 1997. Influences of watershed land use on habitat quality and biotic integrity in Wisconsin streams. *Fisheries*. 22(6): 6-12.

Wanielista, M.P. 1978. Stormwater management: quantity and quality. Ann Arbor Science, Ann Arbor, Mich.

Waples, R.S. 1991a. Definition of “species” under the Endangered Species Act; application to Pacific salmon. NOAA Technical Memorandum NMFS F/NWC-194.

Waples, R.S. 1991b. Genetic interactions between hatchery and wild salmonids: lessons from the Pacific Northwest. *Canadian Journal of Fisheries and Aquatic Sciences* 48 (Suppl. 1): 124–133.

Waples, R.S., R.G. Gustafson, L.A. Weitkamp, J.M. Myers, O.W. Johnson, P.J. Busby, J.J. Hard, G.J. Bryant, F.W. Waknitz, K. Neely, D. Teel, W.S. Grant, G.A. Winans, S. Phelps, A. Marshall, and B.M. Baker. 2001. Characterizing diversity in salmon from the Pacific Northwest. *Journal of Fish Biology* 59 (Supplement A): 1–41.

Warren, J.W. 1991. Diseases of hatchery fish, 6th edition. U. S. Fish and Wildlife Service, Pacific Region,

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope, and R.S. Waples. 1995. Status review of coho salmon from Washington, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum.NMFS-NWFSC-24.

Welsh, Jr., H.W., G.R. Hodgson, B.C. Harvey, and M.F. Roche. 2001. Distribution of juvenile coho salmon in relation to water temperature in tributaries of the Mattole River, California. *North American Journal of Fisheries Management* 21: 464–470.

Williamson, K. and D. Hillemeier. 2001a. An assessment of pinniped predation upon fall-run Chinook salmon in the Klamath River estuary, California. Yurok Tribal Fisheries Program. 1998.

Williamson, K. and D. Hillemeier. 2001b. An assessment of pinniped predation upon fall-run Chinook salmon in the Klamath River estuary, California. Yurok Tribal Fisheries Program. 1999.

Appendix A
Abbreviations and Acronyms

ABAG	Association of Bay Area Governments
BLM	Bureau of Land Management
BMPs	Best Management Practices
BOF	California Board of Forestry and Fire Protection
CALFED	CALFED Bay-Delta Program
Caltrans	California Department of Transportation
CCC	Central California Coast
CCR	California Code of Regulations
CDF	California Department of Forestry and Fire Protection
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFIP	California Forest Improvement Program
cfs	cubic feet per second
CGS	California Geological Survey
CHERT	County of Humboldt Extraction Review Team
CIMIS	California Irrigation Management Information System
Commission	California Fish and Game Commission
CRMP	coordinated resources management planning
CRP	Conservation Reserve Program
CRT	California Range-wide Coho Salmon Recovery Team
CWA	Clean Water Act
Department	California Department of Fish and Game
DIRT	direct inventory of roads and their treatment
DLRP	Division of Land Resource Protection
DNA	deoxyribonucleic acid
DO	dissolved oxygen

DOC	Department of Conservation
DOD	Department of Defense
DOI	Department of the Interior
DPR	California Department of Parks and Recreation
DWR	California Department of Water Resources
ENSO	El Niño/Southern Oscillation
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FEMA	Federal Emergency Management Agency
FEMAT	Forest Ecosystem Management Assessment
FERC	Federal Energy Regulatory Commission
FGC	California Fish and Game Code
FLPMA	Federal Land Policy and Management Act
FPA	Forest Practice Act
FPR	Forest Practice Rules
FRGP	Fisheries Restoration Grant Program
FY	fiscal year
GIS	geographic information system
HA	hydrologic area
HCP	habitat conservation plan
HGMP	hatchery genetic management plan
HQI	habitat quality index
HSA	hydrologic subarea
HU	hydrologic unit
LWD	large woody debris
MMWD	Marin Municipal Water District
MOA	memorandum of agreement
MWAT	maximum weekly average temperature
MWMT	maximum weekly maximum temperature
NCRWQCB	North Coast Regional Water Quality Control Board

NCWAP	North Coast Watershed Assessment Program
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NTP	Non-industrial Timber Plan
NTU	Nephelometric Turbidity Unit
NRC	National Research Council
NRCS	Natural Resources Conservation Service
PAH	polycyclic aromatic hydrocarbon
PALCO	Pacific Lumber Company
PCB	polychlorinated biphenyl
PCSRF	Pacific Coastal Salmon Recovery Fund
PDO	Pacific interdecadal oscillation
PFMC	Pacific Fishery Management Council
PIT	passive integrated transponder
RCD	Resource Conservation District
RM	river mile
ROD	record of decision
RPF	registered professional foresters
RWQCB	California Regional Water Quality Control Board
SLC	State Lands Commission
SMARA	Surface Mine and Reclamation Act
SONCC	Southern Oregon/Northern California Coasts
SPAWN	Salmon Protection and Watershed Network
SRAC	Smith River Advisory Council
SRWC	Scott River Watershed Council
SSPP	Shasta-Scott Pilot Program
SSRT	Shasta-Scott Recovery Team
SWRCB	State Water Resources Control Board
SYP	sustained yield plans
T & I	threatened and impaired water body
THP	timber harvest plan

TMDL	total maximum daily load
TRT	Technical Review Team
UPGMA	unweighted pair group method with arithmetic averages
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
WRP	Wetlands Reserve Program
WSH	Warm Springs Hatchery

Appendix B Glossary

Adaptive management: A systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Active adaptive management employs management programs that are designed to experimentally compare selected policies or practices, by evaluating alternative hypotheses about the system being managed.

Adjudication: A process whereby the quantity and priority date of all water rights in a given area are determined either by civil action in a court of law, or by statutory adjudication before the State Water Resources Control Board.

Aggradation: In reference to streams, the raising of stream beds or flood plains by deposition of sediment eroded and transported from upstream.

Aggregate extraction: The mining of sand, gravel, and (sometimes) bedrock from a river or stream.

Alevin: Stage in the life cycle of salmon following emergence from the egg stage, characterized by the presence of a yolk sac attached to the body.

Allele: Any of the different forms of a gene.

Allele frequency: The proportion of a particular allele in a population.

Allozyme: Variant form of an enzyme encoded by a particular allele at a given locus. Allozymes can often be distinguished by protein electrophoresis.

Alluvial: Composed of material deposited by running water.

Anadromous: Pertaining to fish that spend part of their life cycle in the ocean and return to freshwater streams to spawn, for example salmon, trout, and shad.

Appropriated water: A quantity of water authorized for a specific use.

Appropriative water rights: Right to use a given quantity of water for reasonable and beneficial use in a prescribed place in order of priority based on the time water is first put to use. Since December 19, 1914, the exclusive method for establishing an appropriative water right is through the permit system administered by the State Water Resources Control Board. Percolating groundwater is governed by a separate body of law not addressed here.

Artificial propagation: Human assistance in the reproduction of an organism. In Pacific salmon, artificial propagation may include spawning and rearing in hatcheries, stock transfers, creation of spawning habitat, egg bank programs, captive broodstock programs, and cryopreservation of gametes.

Benthic: Belonging or pertaining to the bottom sediment zone of a body of water.

Biological refugia: For Pacific salmon, parts of the freshwater habitat unperturbed by human activities or other factors that would diminish the natural production of a population.

Brood year: Population of coho salmon that perpetuates itself by spawning in three-year intervals. Due to the rigid three-year life cycle of coho salmon, any given stream may provide habitat for three temporally separated populations, or brood years, that are largely reproductively independent from each other (with the exception of precocious males and females, called jacks and jills, respectively, that engage in spawning after two years and thus provide gene flow between brood years). When the spawning season spans portions of more than one year, as it does for coho salmon, the brood year is identified by the year in which spawning began. For example, offspring of coho salmon that spawned in 1996-1997 are identified as "brood year 1996." Because most coho salmon of a brood year return to spawn after one summer of freshwater life and two summers of ocean life, a brood year tends to form a distinct genetic lineage.

By-catch: Non-target fish or other organisms caught in a particular fishery. Among Pacific salmon, coho salmon may constitute part of the by-catch of the commercial Chinook salmon fishery.

Carrying capacity: The maximum equilibrium number of individuals of a particular species that can be supported indefinitely in a given environment. *Abbr.: K.*

Cohort: A group of fish that hatched during a given spawning season. When the spawning season spans portions of more than one year, as it does for coho salmon, the brood year is identified by the year in which spawning began. For example, offspring of coho salmon that spawned in 1996-1997 are identified as "brood year 1996." (Synonym: brood year).

Cohort failure: Extinction of a cohort (year-class) of fish due to either a lack of spawning in that year or the failure of any offspring of a spawning event to survive. Also called brood-year extinction.

Conservation hatchery: Fish hatchery that follows practices designed to stabilize and increase the size of a natural population while maintaining its phenotypic characteristics and genotypic integrity.

Conspecific: Belonging to the same species.

Cryopreservation: Preservation of living gametes at very low temperature; typically, freezing and storage of sperm in liquid nitrogen for later use in spawning.

Dendrogram: A branching diagram showing hierarchical structure in a data set resulting from cluster analysis (a type of statistical analysis for grouping individuals or units based on quantifiable similarities). Dendrograms are often used to show the genetic relationships among populations or higher taxa.

Distribution: The number of, and geographic relationship among streams inhabited by coho salmon within the ESU and species (see range).

Domestication selection: Used in management of genetic resources to express information about expected rates of random genetic change due to inbreeding and/or genetic drift. The size of a hypothetical ideal population with the same amount of random genetic change as the actual population experiences. Typically the effective population size is lower than the census population size. *Abbr.: NE.*

Downlisting: The moving of a species from the "Endangered" list to the "Threatened" list under CESA as a result of recovery of population sizes to the point where danger of extinction is less extreme than before, although continued protection is still warranted.

Effective population size: The effective number of breeding individuals in a population. The size of a hypothetical idealized population that would exhibit the same amount of genetic drift and loss of genetic variation as the actual population. Typically the effective population size is lower than the actual or census population size. *Abbr.: Ne.*

El Niño/Southern Oscillation (ENSO): A term describing fluctuations of the ocean-atmosphere system in the tropical Pacific that can have secondary effects in the north Pacific range of coho salmon. During El Niño conditions the normal westerly trade winds across the tropical Pacific relax, creating (among many other effects) a rise in sea-surface temperatures in the eastern Pacific along South America. During strong El Niño events, sea surface temperatures along California may also increase and can contribute to poor ocean survival of coho salmon. The reversal of this condition (the Southern Oscillation or La Niña) produces a decrease in sea surface temperatures and is often associated with good ocean survival of coho salmon. Typical ENSO events are of relatively short duration, lasting between 6 to 18 months (see Pacific (Inter)Decadal Oscillation).

Embeddedness: The degree to which rocks and gravel are surrounded or covered by fine sediment on a stream or lake bottom.

Emigration: Seaward migration of salmon from their natal streams to the ocean. Also called "outmigration."

Entrainment: The incidental trapping of fish and other organisms in the water diverted from a stream or other source for purposes of agricultural irrigation, cooling of power plants, or other industrial activity.

Epibenthic: Belonging or pertaining to the top surface of the bottom sediment zone of a body of water.

Escapement: In reference to Pacific salmon, the number of fish of a population that return to a stream to spawn (spawning escapement).

Estuary: The seaward end or the widened tidal mouth of a river where fresh water comes into contact with seawater and where tidal effects are evident.

Evolutionarily Significant Unit (ESU): A population or group of populations that is considered distinct, and hence a species, for purposes of the Endangered Species Act. An ESU must be reproductively isolated from other populations of the same species and must represent an important component in the evolutionary legacy of the species.

Eutrophic: Pertaining to a lake or other body of water characterized by high concentrations of nutrients such as nitrogen and phosphorus resulting in high productivity. Eutrophic waters are often shallow and sometimes experience algal blooms and periods of low oxygen concentrations.

Exotic: An organism that is not native to the area where it is found. A non-native or non-indigenous species, often introduced as a result of human activities.

Extinction: In evolutionary biology, the failure of a group of organisms of variable size and inclusiveness (e.g., ranging from local geographic or temporally defined groups to species) to have surviving descendents.

Extinction risk: In this document, the probability that a given population will become extinct within 100 years. Low probability of extinction is arbitrarily defined for this purpose as 5% over 100 years.

Fecundity: In salmon, the number of eggs produced by a female.

Fish screen: A porous barrier placed across the inlet or outlet of a lake or stream or across the opening of a water diversion structure in a stream to prevent the passage of fish.

Fitness: The probability of an organism to reach reproductive age and produce viable offspring. For a population, fitness is the frequency distribution of reproductive success of sexually mature adults.

Fragmentation: In reference to salmon, the loss of connection of freshwater habitat due to migration barriers such as impassable dams or inadequate water quantity or quality, resulting in the inability of the fish to reach and fully utilize the habitat necessary to complete their life cycle and maintain natural levels of productivity.

Freshet (or Storm Flow): Rapid temporary rise in stream discharge caused by heavy rain or rapid melting of snow or ice.

Fry: Stage in the life cycle of salmon following the "alevin" stage, characterized by the loss of the yolk sac and beginning of feeding on external prey.

Gene flow: The introduction of genes into the gene pool of a population due to migration of individuals between populations.

Genetic drift: Random changes in allele frequencies due to the sampling error associated with a moderate to small number of matings. Genetic drift typically results in the loss of genetic variation (e.g., loss of rare alleles or decrease of heterozygosity) and increases as the effective population size (Ne) decreases.

Head Gate: The gate that controls water flow into irrigation canals and ditches; the controls or gate at the entrance to a canal or conduit system. Also, the diversion structure that controls the flow rate from a conveyance system (canals and laterals) into the farm conveyance system.

Heterozygosity: The fraction of individuals in a population that are heterozygous (having two different alleles) at a particular locus. Also, the fraction of heterozygous loci in the genome of an individual.

Hydrograph: A graphic representation or plot of changes in the flow of water or in the elevation of water level plotted against time. A hydrograph may contain information on stage, flow, velocity, and other hydraulic properties of water.

Hydrologic connectivity: A direct connection between run-off to a stream and development sites, typically roads, that contributes sediment or other pollutants to the stream.

Hyporheic: Pertaining to the zone of substrate in a stream bottom that extends 1 to 2 meters (approx. 3 to 6 ft.) below the surface of the stream bed.

Immigration: Migration of salmon from the ocean to their freshwater spawning grounds.

Incidental mortality: The unintentional death of an organism caused during the course of an otherwise lawful activity. In the context of recreational fishing, this refers to coho salmon that die after being caught and released by anglers fishing for other species.

Incidental take: Under CESA, it is the taking of a State-listed or candidate species where the taking is incidental to and not the purpose of carrying out otherwise lawful activities.

Interim actions: Actions contributing to recovery that will be: 1) immediate in their implementation, i.e., within the first five years of implementation of the Recovery Strategy; and 2) do not require legal or regulatory changes. These actions may be of temporary duration to meet an urgent need or they may lay the groundwork for more long-term actions.

Interstices: The physical spaces between gravel or other substrate particles.

Intragravel: Within the gravel substrate of a stream.

Invasive non-native species: Animal or plant species present in an ecosystem where it did not naturally occur and is increasing in number and range with significant negative effects on native animal or plant species.

Key populations: Populations of coho salmon that qualify as likely refugia, source populations, or metapopulations. Generally, key populations are those populations that occur in coho salmon habitat of relatively high quality, with a full complement of year-classes, or with abundances that are high relative to other populations within the same recovery unit, or place them at an insignificant risk of extinction.

Lagoon: Within the range of coho salmon, a lagoon is an estuary that is separated from tidal action during the summer by the formation of a sand bar at its mouth. This is the case in many California coastal streams and rivers.

Large woody debris (LWD): Large, relatively stable woody material usually having a diameter greater than 30 cm (12 inches) and a length greater than 2 m (6 feet) that intrudes into the stream channel.

Locus (Pl.: Loci): The physical location of a gene or other DNA sequence on a chromosome.

Macroinvertebrates: Aquatic invertebrates that conventionally are at least 0.5 mm in length and live primarily on the bottom substrate of streams and rivers. They feed on plant matter, detritus, or smaller animals and, in turn, provide food for larger consumers such as fish.

Maintain: To prevent further decline in the number and size of populations and the amount and quality of their habitat.

Mass wasting: The down-slope movement of rock and soil near the Earth's surface mainly due to the force of gravity. Mass-wasting is an important part of the erosion process, occurring continuously on all slopes. Some mass-wasting processes act very slowly, others occur very suddenly, often with disastrous results. The eroded materials often end up in rivers or streams where they may be transported further downstream.

Metapopulation: A set of largely isolated subpopulations connected by some degree of migration among them.

Microsatellite DNA: DNA sequences consisting of tandem repeats of short oligonucleotide sequences, such as poly-(AT) or poly-(TAGC). The repeats are usually two to five nucleotides long and are inherited in a Mendelian fashion. Analysis of microsatellite inheritance can be used to gain information about microevolutionary processes such as migration and gene flow.

Mine tailings: Mine waste and mine tailings are often used interchangeably to describe the waste material remaining after a mineral commodity is extracted from the host rock(s). Mine tailings more specifically refers to the waste material that results from processing the mineral commodity. True mine tailings usually are high in metals, low in pH, and composed of materials the size of sand to silt. Dredger tailings such as those associated with gold separation activities are usually comprised of unsorted cobbles, gravel, and fine sediments.

Mitigation hatcheries: Fish hatcheries, usually built below flood control or power-generating dams, that are intended to compensate for the loss of upstream spawning habitat and natural fish production resulting from dam construction.

Natural-origin fish: Also called "natural fish." Fish that are offspring of parents that spawned in the wild. Natural-origin fish spend their entire lives in the natural environment. (See "Hatchery-origin fish").

Nutrification: An increase in the concentrations of nutrients such as nitrogen and phosphorus in a body of water.

Pacific (Inter)Decadal Oscillation (PDO): The "Pacific Decadal Oscillation" (PDO) describes a long-lived pattern of Pacific climate variability that can affect ocean survival of coho salmon. Unlike El Niño/Southern Oscillation events, which originate in the tropics and last from 6 to 18 months, PDO events originate in the northeastern Pacific and cycle over periods of about 50 years. Within a PDO cycle there may be short lived reversals of conditions. "Warm" or "positive" PDO phases are associated with enhanced ocean productivity in Alaska and inhibited productivity off the west coast of the contiguous United States. "Cold" or "negative" PDO eras have the opposite pattern, and are generally favorable for ocean survival of coho salmon from California. Causes for the PDO are not currently known.

Parr: Stage in the life cycle of salmon following the "fry" stage, characterized by the presence of dark vertical bands on the side of its body.

Population: A group of individuals of the same species that live in the same place at the same time and exhibit some level of reproductive isolation from other such groups. In some contexts, a randomly mating group of individuals that is reproductively isolated from other groups. A population may consist of a single isolated run or more than one connected run. Synonymous with "stock" in this document.

Population risk: Defined here as risks to coho salmon from human activities (range-wide coho salmon population abundance and genetic data are not available). It combines anthropogenic risk factors (e.g., human population density, water diversions, road density) and population parameters (e.g., consistent presence of coho salmon, isolation index for coho salmon populations, and run length of coho salmon populations).

Population viability analysis: Analysis of a species and its population genetic structure to determine the level of independence of the populations. A viable salmonid population has been defined by NOAA Fisheries as "an independent population of any Pacific salmonid (genus *Oncorhynchus*) that has a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year time frame."

Probability of extinction: See Extinction Risk.

Properly Functioning Condition (PFC): With regard to conifer LWD recruitment. A concept used by NOAA Fisheries to describe the sustained presence of natural processes leading to habitat conditions that are necessary for the long-term survival and recovery of a fish species through the full range of environmental variation. In terms of conifer LWD recruitment, PFC refers to achieving a natural rate of large conifers falling directly in or sliding downslope to become active in channel processes such as pool formation, sediment retention, or otherwise providing the habitat complexity sufficient to ensure long-term survival of salmonid populations. This rate of LWD recruitment is to be determined by the best available science. (NMFS 1999).

Protect: To ensure the status and integrity of coho salmon populations, habitat, and essential ecological processes.

Pulse flows: Temporarily increased water flow in a river or stream at specific opportune times intended to increase habitat for migrating fish .

Ramped flows: The sequential and gradual, rather than simultaneous, initiation and completion of water diversions from a river or stream to buffer significant changes in water levels and instream flows.

Range: The geographic area and extent within California that is defined by the watersheds where coho salmon were historically (including currently) present.

Recovery: The re-establishment or rehabilitation of a threatened or endangered species to a self-sustaining level in its natural ecosystem.

Recovery supplementation: Short-term artificial propagation designed to reduce the risk of extinction of a small or chaotically fluctuating recovering population in its natural habitat by temporarily increasing population size using conservation hatchery fish, while maintaining genetic diversity and minimizing genetic change in the natural and hatchery populations.

Recovery unit: A geographic and hydrologically distinct area within each ESU that includes a number of related coho salmon populations and which will be the scale at which successful achievement of delisting goals and criteria will be measured and evaluated.

Recruitment: The natural process of replenishing a resource, such as gravel recruitment or recruitment of large woody debris in a stream. With reference to fish and fisheries, recruitment refers to the development and growth of the fish to a point where they enter the fishable stock.

Redd: Nest of a salmon, usually a depression within the gravel substrate of a stream, into which the female deposits her eggs.

Reproductive isolation: Absence of gene flow between a population and other populations of the same species.

Restore: In the context of coho salmon recovery, to return coho salmon to self-sustaining levels within their natural habitat throughout their historic range, or to return habitat attributes (e.g., flow, sediment characteristics, water temperature, water quality and habitat complexity) to a condition that will support the recovery of coho salmon to self-sustaining levels.

Riffle: A shallow rapids where the water flows swiftly over completely or partially submerged obstructions to produce surface agitation. Substrate is usually composed of gravel, pebble, and cobble-sized particles.

Riparian zone: The terrestrial zone adjacent to a water course.

Riprap: A man-made facing layer (protective cover) of stones, rocks, or other hard, durable material for stream-bank protection and stabilization and to reduce erosion.

Run: The spawning adults of a given species that return to a stream during a given season.

Short-term actions: See Interim Actions.

Siltation: The deposition and build-up of silt (detrital rock particle having a diameter in the range of 1/256 to 1/16 mm) that is suspended in a body of water. The term is often used to include larger and smaller sedimentary particles ranging in size from clay to sand.

Sink population or subpopulation: Populations that, within a given metapopulation structure of a species, are characterized by vastly lower productivities than other (source) populations and consistently receive individuals from the source populations through one-way movement of migrants.

Smolt: Stage in the life cycle of salmon following the "parr" stage, characterized by hormonal and other physiological changes that prepare the fish for its seaward migration and life in salt water, the loss of parr marks, and appearance of a silvery color.

Smoltification: Hormonal and other physiological changes associated with the seaward migration of salmon and adaptation to a saltwater environment.

Source population or subpopulation: Populations that, within a given metapopulation structure of a species, are characterized by vastly higher productivities than other (sink) populations and consistently contribute individuals to the sink populations through one-way movement of migrants.

Source-sink relationship: Metapopulation structure in which subpopulations in the source areas have vastly higher productivities than those in the sink areas, and characterized by one-way movement of migrants from the source area to the sink area.

Stock: See Population.

Stock transfer: Human transfer of fish from one location to another, often between separate basins or ESUs.

Stream buffer zone: Riparian zone of specified width that is given some measure of protection from developmental activities such as logging or road construction.

Stream order: Designation of stream segments within a drainage basin; a system of numbering streams according to sequence of tributary size. The smallest perennial tributary is designated as order 1, the junction of two first-order streams produces a stream segment of order 2, etc. The main stream is always of the highest order.

Substrate: Particulate material comprising the bottom of a body of water, such as mud, silt, gravel, or rock.

Suspended sediment: Material (usually clay, silt, and sand) carried for a considerable period of time in suspension without deposition on the bed of the body of water .

Supersaturation: Presence of a solute (e.g., salt or oxygen) in a solvent at levels that exceed saturation for a given set of conditions, especially temperature and pressure.

Tailwater reclamation: The process of collecting irrigation water runoff for reuse in the system. Also called "tailwater recovery."

Take: "Take" under California law is defined by FGC §86 as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill."

Transferrin: A protein synthesized in the liver that transports iron in the blood to the erythrocytes for use in heme synthesis. Transferrin has been used in the past in immunological procedures such as microcomplement fixation assays to examine the genetic relationship between populations and other related taxa.

Turbidity: Reduced clarity of a liquid due to the presence of suspended matter.

Watershed: The topographic region drained by or contributing water to a stream, river system, or lake.

Watershed recovery unit: See Recovery Unit.

Appendix C Other Species at Risk

Table of Contents

CONSTRAINTS ON RECOVERY ACTIONS C.1

OTHER AT-RISK SPECIES IN THE RANGE OF COHO SALMON C.2

Trinity Bristle Snail *(Monadenia setosa)* C.2

California Freshwater Shrimp *(Syncaris pacifica)* C.2

Lost River Sucker *(Delistes luxatus)* C.2

Shortnose Sucker *(Chasmistes brevirostris)* C.3

Tidewater Goby *(Eucyclogobius newberryi)* C.3

Green Sturgeon *(Acipenser medirostris)* C.3

Steelhead *(Oncorhynchus mykiss)* C.3

Chinook Salmon *(O. tshawytscha)* – California Coastal ESU C.4

Siskiyou Mountains Salamander *(Plethodon stormi)* C.4

California Tiger Salamander *(Ambystoma californiense)* C.4

California Red-legged Frog *(Rana aurora draytonii)* C.4

San Francisco Garter Snake *(Thamnophis sirtalis tetrataenia)* C.4

Greater Sandhill Crane *(Grus canadensis tabida)* C.5

California Brown Pelican *(Pelecanus occidentalis californicus)* C.5

Western Yellow-billed Cuckoo *(Coccyzus americanus occidentalis)* C.5

Willow Flycatcher *(Empidonax traillii)* C.5

Northern Spotted Owl *(Strix occidentalis caurina)* C.6

Marbeled Murrelet *(Brachyramphus marmoratus marmoratus)* C.6

Western Snowy Plover *(Charadrius alexandrinus nivosus)* C.6

Bank Swallow *(Riparia riparia)* C.6

Bald Eagle *(Haliaeetus leucocephalus)* C.6

California Clapper Rail *(Rallus longirostris obsoletus)* C.7

California Black Rail *(Laterallus jamaicensis coturniculus)* C.7

Point Arena Mountain Beaver *(Aplodontia rufa nigra)* C.7

Salt-marsh Harvest Mouse *(Reithrodontomys raviventris)* C.7

Recovery actions for coho salmon have the potential to affect other species listed under the Federal Endangered Species Act of 1973, as amended (ESA) [16 USC section 1 *et seq*.] and under the California Endangered Species Act (CESA) [FGC §2050 *et seq*.]. Potential effects could range from beneficial to detrimental to the conservation of these species.

CONSTRAINTS ON RECOVERY ACTIONS

The presence of listed species may limit coho salmon recovery actions at a site. For example, vortex rock weirs are commonly used to improve pool development for juvenile coho salmon (Flosi et al. 1998), but these structures are not permitted in streams where California freshwater shrimp are present. The presence of other listed species may also increase the time and/or cost required to implement a coho salmon recovery action. For example, to avoid noise disturbance to nesting marbled murrelets, heavy equipment work is typically prohibited within known murrelet habitat until after September 15. This restricts the work window to conduct some projects requiring heavy equipment, and can cause significant delays. In turn, delays can increase costs such as equipment mobilization and may create problems for projects involving public funds, which are typically allocated for a set time period.

Coho salmon recovery actions are not expected to have long-term adverse impacts on other listed species. However, recovery actions may require consultation with appropriate agencies, and/or the issuance of incidental take authorizations and/or other permits.

The presence of listed species (including coho salmon) could also increase the time and cost of California Environmental Quality Act (CEQA) review required for State or local permits associated with coho salmon recovery. The CEQA mandatory findings of significance (CEQA Guidelines section 15065(a)) require an Environmental Impact Report (EIR) if an action has the potential to "...reduce the number or restrict the range of a rare or endangered plant or animal..." Under existing case law, the threshold for triggering this mandatory finding of significance is very low (San Bernardino Audubon Society v. Metropolitan Water District, 1999, 7 1Cal.App.4th 382). The additional time required for an EIR (as compared to a Negative Declaration (or a CEQA exemption) could significantly add to the time and cost required to implement a recovery action having the potential for take. The Department and other implementing public agencies undertaking recovery actions will have to assess on a case-by-case basis the potential of the proposed action to meaningfully reduce the number or restrict the range of other listed species when approving recovery projects.

Another potential complication could occur if State-designated "fully protected" species are present, as the Department is prohibited from authorizing any take of fully protected species, (See FGC §55 15, 5050, 35 1 1 and 4700). The Commission can, however, authorize take of fully protected species for necessary scientific research and many recovery projects may be susceptible to design so as to avoid the take of fully protected species.

OTHER AT-RISK SPECIES IN THE RANGE OF COHO SALMON

Below are brief descriptions of other at-risk species that should be considered when implementing the coho salmon Recovery Strategy. Individual listed plant species are not discussed in this Recovery Strategy, although they also must be considered when implementing coho salmon recovery actions. It has been the Department's practice for salmonid restoration grant projects to require rare plant surveys prior to implementing ground-disturbing actions and, if necessary, to modify projects to avoid any disturbance of rare plant colonies; in practice, conflicts between rare plants and salmonid habitat restoration actions have been infrequent and avoidance of such conflicts is relatively simple.

Trinity Bristle Snail *(Monadenia setosa)*

The Trinity bristle snail is listed as threatened under CESA and only occurs in the Trinity River HU This species typically occupies conifer and mixed conifer/hardwood stands with tree diameter greater than 11 inches at breast height and canopy cover greater than 60%. The snail prefers moist microhabitats where large woody debris is greater than 10 inches and is moderately decayed. Lichens and mosses on rocks and logs are typically present on occupied sites. Maple and alder tree species are often present, indicating a reliable moisture content on which the snails depend.

Increased large woody debris recruitment in riparian zones would benefit Trinity bristle snails. Areas of potential habitat within the range of the Trinity bristle snail should be surveyed according to published protocol prior to commencement of any coho salmon recovery activities. Occupied habitat will need to be identified and avoided. If a project would result in incidental take of Trinity bristle snail, the project would require incidental take authorization from the Department.

California Freshwater Shrimp *(Syncaris pacifica)*

The California freshwater shrimp is listed as endangered under both ESA and CESA. It is endemic to Marin, Sonoma, and Napa counties, where it occurs in low-gradient streams (< 1%) with moderate to heavy riparian vegetation. Freshwater shrimp are usually associated with pools 1 to 3 feet deep, especially those with stable undercut banks with exposed root systems and the top of the undercut below the water surface.

Protection and improvement of riparian habitat would increase vegetative cover required for protection from predators. Sediment control and placement of large woody debris would improve habitat quality for shrimp by increasing pool development and structural cover. Replacement of culverts with bridges or arch culverts would promote connectivity of shrimp habitat. Fish habitat structures that completely span a stream (including vortex rock weirs) must be avoided in shrimp habitat to avoid creating barriers to instream movement of shrimp. Any planning for in-water work in shrimp habitat should include surveys to determine if they are present. If they are present, the project will require take authorization from U.S. Fish and Wildlife Service (FWS) and the Department.

Lost River Sucker *(Delistes luxatus)*

The Lost River sucker is listed as endangered under both ESA and CESA, and is fully protected. Lost River suckers are found in the Lost River system and the Upper Klamath River watershed with a few uncertain sized populations in Copco and Iron Gate reservoirs. These populations are thought to be maintained by entrained fish in the Klamath hydropower project. The reduction of pesticides, fertilizers and other pollutants from entering the lake would increase viable habitat by decreasing the contaminants that start and/or cause the process of excessive eutrophication and anoxic water conditions. The improvement of water quality conditions would benefit both Lost River suckers and coho salmon. Maintaining lake levels to benefit suckers may impact the flows needed for coho salmon downstream.

Shortnose Sucker *(Chasmistes brevirostris)*

The shortnose sucker is listed as endangered under both ESA and CESA and it is a State fully protected species. Shortnose suckers are know to occur in the Upper Klamath River watershed with undetermined populations in Copco and Iron Gate reservoirs and the most abundant populations in the Lost River system. The reduction of pesticides, fertilizers and other pollutants from entering Upper Klamath Lake would increase viable habitat by decreasing the contaminants that start or cause the process of excessive eutrophication and anoxic water conditions. The improvement of water quality conditions would benefit both shortnose suckers and coho salmon. Maintaining lake levels to benefit suckers may impact the flows needed for coho salmon downstream.

Tidewater Goby *(Eucyclogobius newberryi)*

The tidewater goby is listed as endangered under ESA. The tidewater goby's habitat consists of brackish shallow lagoons and lower freshwater stream reaches where the water is fairly still but not stagnant. They tend to be associated with muddy substrates (Jim Watkins pers. comm. 1/23/03).

In general, actions to restore coho salmon are not likely to impact tidewater goby, although efforts to protect and restore coho salmon nursery habitat in estuaries is likely to have a positive influence on the preservation of goby habitat; this includes such actions as re-establishment of functional estuaries and lagoons by the removal, or setback, of levees that confine the water course, and allowing for the reconnection of wetlands, sloughs, and the tidal influenced areas. Any planning for in-water work in goby habitat (such as placing LWD in estuaries) should include surveys to determine goby presence. If gobies are present, the project will require take authorization from FWS.

Green Sturgeon *(Acipenser medirostris)*

In January 2003, NOAA Fisheries determined that listing green sturgeon under the ESA was not warranted. However, because of uncertain population structure and status of the species, NOAA Fisheries is adding two distinct populations segments of green sturgeon (one north of the Eel River, the other south of the Eel River) to the agency's list of candidate species. Green sturgeon is presumed extant in the mainstem Klamath and Trinity rivers and possibly in the Eel River.

Development of cold-water flows would decrease the incidence of disease outbreak benefiting sturgeon and coho salmon in the Klamath, Trinity, and Eel River systems. Implementing a Hardy Phase II like flow regime in the Klamath River would give these fish greater access to the upper portion of the watershed for spawning. Other benefits include the control of upslope sedimentation through increased buffer areas and the reduction of human caused disturbances in unstable soil types, and decreased sediment input from existing roads through sediment control measures.

Steelhead *(Oncorhynchus mykiss)*

Steelhead in both Northern California and Central California Coastal ESUs often share the same habitat or reaches of streams with coho salmon, therefore both species would likely benefit from habitat improvements projects for either species. Projects that decrease the sediment input into the stream, provide cooler (more optimal) water temperatures, and sufficient flows for all life stages would benefit both of these species.

Chinook Salmon *(O. tshawytscha)* – California Coastal ESU

Chinook salmon generally spawn in larger streams than coho salmon. Many of these streams are either migration corridors or are in themselves used by coho salmon for spawning. Projects that decrease sediment input into streams, provide cooler (more optimal) water temperatures, and sufficient flows for all life stages would benefit both of these species.

Siskiyou Mountains Salamander *(Plethodon stormi)*

The Siskiyou Mountains salamander is a lungless, completely terrestrial salamander listed as threatened under CESA. This species occurs in the Applegate HU and Seiad Valley HSA, in Siskiyou County. Suitable habitat includes rock outcrops, talus (rock on rock substrates), and forested rocky soils. Areas of potential habitat within the range of the Siskiyou Mountains salamander should be surveyed according to published protocol prior to commencement of any coho salmon recovery activities. Occupied habitat will need to be identified and avoided. If the project would result in incidental take of Siskiyou Mountain salamander, the project would require incidental take authorization from the Department.

California Tiger Salamander *(Ambystoma californiense)*

Recommendations and actions associated with recovery of coho salmon in California are not expected to have adverse effects on California tiger salamander populations, because potential actions are not expected to overlap with their habitat.

California Red-legged Frog *(Rana aurora draytonii)*

The California red-legged frog is listed as threatened under ESA. California red-legged frogs occur, within the range of the coho salmon, from Point Reyes south and inland to the Sacramento Valley. They are found primarily in the wetlands and streams in the coastal drainages of central California and there is a significant likelihood of co-occurring with coho salmon in the southern part of their range. The frogs are associated with dense riparian vegetation closely associated with deep (>2 feet) still or slow moving water, and may aestivate within 300 feet of a riparian area.

Although protection and improvement of habitat for coho salmon will sometimes improve habitat for California red-legged frogs, some activities to protect and restore coho salmon habitat (for example projects requiring heavy equipment) have the potential to take frogs. Any planning for restoration actions in California red-legged frog habitat should include surveys for the species. If the project would result in take of California red-legged frogs, the project would require incidental take authorization from FWS.

San Francisco Garter Snake *(Thamnophis sirtalis tetrataenia)*

The San Francisco garter snake (SFGS) is listed as endangered under both ESA and CESA, and has State fully protected status. SFGS presently range from San Mateo County to northern Santa Cruz County, however known populations are limited in extent. SFGS may co-occur with coho salmon in San Gregorio and La Honda creeks, Pescadero Marsh and Creek, Butano, Gazos, Old Woman, Whitehouse, and Waddell creeks.

Although protection and improvement of habitat for coho salmon will sometimes improve habitat for SFGS and their preferred prey (California red-legged frogs), some activities to protect and restore coho salmon habitat have the potential to take SFGS. For example, grading of hill slopes to reduce stream sedimentation attributable to gullying is an important activity for coho salmon recovery in coastal San Mateo County but can crush SFGS aestivating in rodent burrows.

Because of the potential for take of SFGS, planning for coho salmon habitat restoration activities within suitable habitat for the snake in San Mateo and Santa Cruz counties should include surveys for SFGS by a permitted biologist. If SFGS are identified at a project site, measures to avoid impacts would include (at least) that an experienced biologist, approved by the Department and named on a valid 10(a)(1)(A) Federal Scientific Collection Permit issued by USFWS for handling SFGS, be present during all project activities within areas of SFGS habitat. If necessary, habitat work could be scheduled to occur in September and October to avoid impacts to hibernating snakes and snakes concentrated along stream corridors feeding and giving birth to live young. Planning for coho salmon recovery actions within the range of the SFGS will need to consider the time and budget required for permitting and coordination. Federal permitting for coho salmon recovery actions in SFGS habitat could be facilitated by development of a programmatic FWS Section 7 consultation.

Greater Sandhill Crane *(Grus canadensis tabida)*

The greater sandhill crane is listed as threatened under CESA and has State fully protected status. This species breeds in northeastern California, the western most extent being Scott Valley (Siskiyou County). This species relies on permanently flooded wetlands for nesting with nearby flood irrigated pasture to provide food for newly hatched colts. Impacts to nesting or brooding birds from project activities such as building riparian fencing adjacent to crane breeding habitat would have to be evaluated on a case-by-case basis. However, impacts can usually be mitigated and take avoided by avoiding disturbance during the critical nesting period (March 1 to August 1) or maintaining a distance of 0.5 mile from the potential breeding habitat. The Department is developing a recovery plan for this species.

California Brown Pelican *(Pelecanus occidentalis californicus)*

The California brown pelican is listed as endangered under both ESA and CESA and has State fully protected status. In Northern California, the Brown Pelican inhabits the coastline and estuaries mainly in the late summer and fall (June to November) and is considered uncommon to rare from December to May. Actions to restore coho salmon are not likely to impact this species, although efforts to protect and restore estuarine habitat may have a positive influence on this species. Most breeding occurs in Southern California (Channel Islands), outside of the range of coho salmon.

Western Yellow-billed Cuckoo *(Coccyzus americanus occidentalis)*

The western yellow-billed cuckoo is listed as endangered under CESA. The most recent information indicates nesting pairs have been found on the lower Eel River (near Fortuna). Historically, there are scattered records around Humboldt Bay and south along the coast, but breeding status was undetermined. Cuckoo breeding habitat consists of riparian areas with a cottonwood and/or willow component. Alders have been found to be component of the habitat utilized by the birds found on the Eel River. They breed later than most migrant species, beginning in June and continuing through September. Projects that would increase both the quantity and quality of riparian vegetation would benefit this species. Projects that would take place during the critical breeding period (June through September) would require surveys to determine presence. If the project would result in take of western yellow-billed cuckoo, incidental take authorization from the Department would be required.

Willow Flycatcher *(Empidonax traillii)*

The willow flycatcher is listed as endangered under CESA and is found within the range of coho salmon. Protection and improvement of riparian habitat associated with coho salmon recovery actions will promote potential willow flycatcher habitat. However, care must be taken to avoid disturbing breeding sites of the flycatcher. Impacts to breeding sites can be mitigated by avoiding heavy equipment work and harvest of willow branches for riparian revegetation within 0.25 miles of any site with known or potential habitat for willow flycatcher during the breeding season. By limiting the harvest of willow for revegetation to no more than one-third of any willow plant annually and taking care not trample or over harvest the willow sources, the long-term integrity of willow flycatcher habitat can be protected. If the project would result in take of willow flycatchers, incidental take authorization from the Department would be required.

Northern Spotted Owl *(Strix occidentalis caurina)*

The northern spotted owl is listed as threatened under ESA. Activities to protect and restore coho salmon habitat should not alter habitat for the owls, however the potential exists for project-related noise (e.g., heavy equipment required for projects such as culvert removal or placement of large woody debris) to disturb nesting birds. Adverse impacts can be avoided by limiting heavy equipment work within 0.25 miles of spotted owl habitat to the period of August 1 to October 31. If the project would result in take of northern spotted owls, incidental take authorization from FWS and would be required.

Marbled Murrelet *(Brachyramphus marmoratus marmoratus)*

The marbled murrelet is listed as endangered under CESA and threatened under ESA. Activities to protect and restore coho salmon habitat should not alter habitat for marbled murrelets, however the potential exists for project-related noise (e.g., heavy equipment required for projects such as culvert removal or placement of large woody debris) to disturb nesting birds. Adverse impacts can be avoided by limiting heavy equipment work within 0.25 miles of marbled murrelet habitat to the period of September 15 to October 31. If the project would result in take of marbled murrelets, incidental take authorization from FWS and the Department would be required.

Western Snowy Plover *(Charadrius alexandrinus nivosus)*

The western snowy plover is listed as threatened under ESA. Snowy plovers have mainly been described as nesting adjacent to tidal waters, however some individuals may breed on gravel bars in coastal rivers; in particular, nesting snowy plovers have been identified in the Eel River watershed up to 50 miles inland. Activities to protect and restore coho salmon habitat should not alter habitat for snowy plover, however heavy equipment work in areas with extensive gravel bars relatively near the coast has the potential to disturb or injure nesting snowy plovers. Adverse impacts can be avoided by limiting heavy equipment work within 0.25 miles of snowy plover nesting habitat to the period October 1 to October 31. If the project would result in take of snowy plovers, incidental take authorization from FWS would be required.

Bank Swallow *(Riparia riparia)*

The bank swallow is listed as threatened under CESA. Presently the only known breeding population of bank swallows in the coho salmon range is along the Scott River. To avoid adverse impacts to bank swallows, any potential breeding habitat should be surveyed during the breeding season (March 1 to July 31) to determine swallow presence. Any modification of bank swallow nesting habitat should be avoided. If the project would result in take of bank swallows, incidental take authorization from the Department would be required.

Bald Eagle *(Haliaeetus leucocephalus)*

The bald eagle is listed as endangered under CESA and threatened under ESA. The bald eagle is also protected under Fish and Game Code section 3503.5, which prohibits take. Recovery of coho salmon will increase winter foraging opportunities for bald eagles. However, the potential exists for the noise from heavy equipment required for projects such as culvert removal or placement of large woody debris to disturb nesting birds. Such impacts can be avoided by limiting heavy equipment work within 0.25 miles of any bald eagle nests to the period of September 1 to October 31. To prevent possible impacts of turbidity on bald eagle foraging, necessary precautions must be used to avoid significant increases in turbidity during any construction, and erosion control measures must be in place before the first significant fall rains.

California Clapper Rail *(Rallus longirostris obsoletus)*

The California clapper rail is listed as endangered under ESA and CESA, and has State fully protected status. California clapper rails are found in tidal marshes around San Francisco Bay. In general, actions to restore coho salmon are not likely to impact this species, although efforts to protect and restore coho salmon nursery habitat in estuaries may have a positive influence on the preservation of marsh habitat for this species.

California Black Rail *(Laterallus jamaicensis coturniculus)*

The California black rail is listed as threatened under CESA and has State fully protected status. The California black rail is more widely distributed than the California clapper rail, from San Francisco Bay south and in both brackish and freshwater marsh habitat. In general, actions to restore coho salmon are not likely to impact this species, although efforts to protect and restore coho salmon nursery habitat in estuaries is likely to have a positive influence on the preservation of marsh habitat for this species.

Point Arena Mountain Beaver *(Aplodontia rufa nigra)*

The Point Arena mountain beaver is listed as endangered under ESA. Point Arena mountain beavers have been identified in the Alder Creek, Brush Creek, and Garcia River HSAs, in an area extending roughly five miles south and eight miles north of Point Arena, and up to approximately five miles inland from the coast.

Aspects of mountain beaver habitat are consistent with coho salmon habitat (such as cool climate, lush vegetation, stable stream banks), however some common habitat restoration methods (such as tree planting) may not be compatible with the herbaceous and small woody vegetation associated with mountain beaver habitat. In addition, special care is needed when working (or walking) in mountain beaver habitat to avoid collapsing burrows. Disturbance during the breeding season (December 15 to April 15) or juvenile dispersal season (December 15 to June 15) should be avoided in the course of adhering to criteria for protection of salmonids (i.e., no instream work until after July 1). Because of the potential for impacts to Point Arena mountain beaver, planning for coho salmon habitat restoration activities within the riparian zone in the Alder Creek, Brush Creek, and Garcia River HSAs should include mountain beaver surveys. If Point Arena mountain beaver are present the project will require take authorization from FWS.

Salt-marsh Harvest Mouse *(Reithrodontomys raviventris)*

The salt marsh harvest mouse is listed as endangered under ESA and CESA, and has State fully protected status; they are found in tidal marshes around San Francisco Bay. In general, actions to restore coho salmon are not likely to impact this species, although efforts to protect and restore coho salmon nursery habitat in estuaries may have a positive influence on the preservation of marsh habitat.

Appendix D
Key Streams and Rivers

This appendix lists streams and rivers preliminarily identified, based on current information, by the Department for the recovery goal of maintaining or improving key populations or establishing additional populations of coho salmon. Watercourse names in parentheses are commonly used synonyms.

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
Rogue/Winchuck rivers	South Fork Winchuck River	
	Broken Kettle Creek	
	South Fork Broken Kettle Creek	
	East Fork Illinois River	
	Elk Creek	
	Brushy Creek	
	Dunn Creek	
	North Fork Dunn Creek	
Smith River	Dominie Creek	Yonkers Creek
	Rowdy Creek	Jordan Creek
	South Fork Rowdy Creek	Buck Creek
	Savoy Creek	North Fork Smith River
	Copper Creek	Still Creek
	Morrison Creek	Diamond Creek
	Jaqua Creek (Little Mill Creek)	Shelly Creek
	Sultan Creek (Sutton Creek)	Monkey Creek
	Peacock Creek	Siskiyou Fork
	Clarks Creek	
	Mill Creek	
	East Fork Mill Creek	
	Bummer Lake Creek	
	West Branch Mill Creek	
	Elk Creek	
	South Fork Smith River	
	Craigs Creek	
	Hurdy Gurdy Creek	
	Jones Creek	
	Quartz Creek	
	Eightmile Creek	

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
Smith River (continued)	Middle Fork Smith River	
	Myrtle Creek	
	Patrick Creek	
	Griffin Creek	
	Knopti Creek	
	Wilson Creek	
Shasta Valley	Shasta River	Little Shasta River
	Big Springs Creek	Willow Creek
	Parks Creek	
	Yreka Creek	
Scott River	Mill Creek (near Scott Bar)	Tompkins Creek
	Wooliver Creek	Kidder Creek
	Kelsey Creek	Boulder Creek
	Canyon Creek	
	Shackleford Creek	
	Mill Creek	
	Patterson Creek	
	Etna Creek	
	French Creek	
	Miners Creek	
	Sugar Creek	
	South Fork Scott River	
	East Fork Scott River	
	Big Mill Creek	
Salmon River	Nordheimer Creek	Wooley Creek
	North Fork Salmon River	East Fork Knownothing Creek
	South Fork Salmon River (to Big Flat)	Negro Creek
	Knownothing Creek	East Fork-South Fork Salmon River
	Methodist Creek	
Middle Klamath River	Bluff Creek	Aikens Creek
	Slate Creek	Cougar Creek
	Red Cap Creek	Little Grider Creek
	Boise Creek	Doolittle Creek
	Camp Creek	Horse Creek *(Happy Camp HSA)*
	Irving Creek	China Creek
	Stanshaw Creek	West Fork Beaver Creek
	Sandy Bar Creek	Cow Creek
	Dillon Creek	Empire Creek
	Swillup Creek	Little Humbug Creek
	King Creek	Williams Creek

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
Middle Klamath River (continued)	Independence Creek	Cottonwood Creek
	Titus Creek	
	Clear Creek	
	South Fork Clear Creek	
	Elk Creek	
	East Fork Elk Creek	
	Indian Creek	
	South Fork Indian Creek	
	East Fork Indian Creek	
	Mill Creek	
	Thompson Creek	
	Fort Goff Creek	
	Portuguese Creek	
	Seiad Creek	
	East Fork Seiad Creek	
	Grider Creek	
	Walker Creek	
	Horse Creek *(Seiad Valley HSA)*	
	Buckhorn Creek	
	Salt Gulch	
	Middle Creek	
	Beaver Creek	
	Humbug Creek	
	Little Bogus Creek	
	Dry Creek	
	Bogus Creek	
Lower Klamath River	Salt Creek	
	Hunter Creek (East Fork Hunter Creek)	
	Mynot Creek	
	High Prairie Creek	
	Richardson Creek	
	Hoppaw Creek	
	Saugep Creek	
	Waukell Creek	
	Turwar Creek	
	McGarvey Creek	
	Tarup Creek	
	Omagaar Creek	
	Blue Creek	
	Pularvasar Creek	

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
Lower Klamath River (continued)	West Fork Blue Creek	
	Crescent City Fork Blue Creek	
	Ah Pah Creek	
	North Fork Ah Pah Creek	
	South Fork Ah Pah Creek	
	Bear Creek	
	Surpur Creek	
	Tectah Creek	
	Johnson Creek	
	Pecwan Creek	
	East Fork Pecwan Creek	
	Mettah Creek	
	Roach Creek	
	Tully Creek	
	Pine Creek	
	Cow Creek	
Trinity River	Soctish Creek	East Fork New River
	Mill Creek	Big French Creek
	Hostler Creek	Price Creek
	Supply Creek	Reading Creek
	Campbell Creek	
	Tish Tang Creek	
	Horse Linto Creek	
	Cedar Creek	
	Willow Creek	
	Sharber Creek	
	New River	
	Madden Creek (Old Campbell Creek)	
	Manzanita Creek	
	North Fork Trinity River	
	East Fork North Fork Trinity River	
	Canyon Creek	
	Dutch Creek	
	Little Browns Creek	
	Weaver Creek	
	East Weaver Creek	
	Five Cent Gulch	
	West Weaver Creek	
	Sidney Gulch	
	Browns Creek	

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
Trinity River (continued)	Indian Creek	
	Grass Valley Creek	
	Rush Creek	
	Deadwood Creek	
South Fork Trinity River	Eltapom Creek	Pelletreau Creek
	Hayfork Creek	
	Olsen Creek	
	Butter Creek	
Mad River	Warren Creek	Strawberry Creek
	Lindsay Creek	Mill Creek
	Grassy Creek	Kelly Creek
	Squaw Creek	Palmer Creek
	Mather Creek	Powers Creek (Dave Powers Creek)
	Hall Creek	Quarry Creek
	Noisy Creek	Black Creek
	Leggit Creek	
	Hatchery Creek (Camp Bauer Creek)	
	North Fork Mad River	
	Sullivan Gulch	
	Dry Creek	
	Canon Creek	
	Maple Creek	
	Boulder Creek	
Redwood Creek	Skunk Cabbage Creek	McArthur Creek
	Prairie Creek	Coyote Creek
	Little Lost Man Creek	Panther Creek
	Lost Man Creek	Lacks Creek
	Streelow Creek (Wolf Creek)	Minor Creek
	May Creek	Emerald Creek (Harry Weir Creek)
	Godwood Creek	
	Boyes Creek	
	Brown Creek	
	Elam Creek	
	Tom McDonald Creek	
	Bridge Creek	
Trinidad Plain	Maple Creek	
	Pitcher Creek	
	North Fork Maple Creek	
	Little River	
	South Fork Little River (Carson Creek)	

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
Trinidad Plain (continued)	Railroad Creek	
	Lower South Fork Little River	
	Upper South Fork Little River	
Eureka Plain	Jacoby Creek	Janes Creek
	Cochran Creek	Jolly Giant Creek
	Freshwater Creek	Washington Gulch
	Ryan Creek	Rocky Gulch
	McCready Gulch	
	Little Freshwater Creek	
	Cloney Gulch	
	Falls Gulch	
	Graham Gulch	
	South Fork Freshwater Creek	
	Elk River	
	Martin Slough	
	North Fork Elk River	
	Browns Gulch	
	Lake Creek	
	Bridge Creek	
	McWhinney Creek	
	South Branch North Fork Elk River	
	North Branch North Fork Elk River	
	Doe Creek	
	South Fork Elk River	
	Tom Gulch	
	Little South Fork Elk River	
	Salmon Creek	
Lower Eel-Van Duzen rivers	Howe Creek	Salt River
	Atwell Creek	Strongs Creek
	Larabee Creek	Price Creek
	Carson Creek	Oil Creek
	Jordan Creek	Monument Creek
	Shively Creek	Dinner Creek
	Bear Creek	Wolverton Gulch
	Chadd Creek	Wilson Creek
	Yager Creek	Cuddeback Creek
	Cooper Mill Creek	Fiedler Creek
	Lawrence Creek	Cummings Creek
	Shaw Creek	Root Creek
	Hely Creek	Stevens Creek
	Grizzly Creek	Newman Creek

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
South Fork Eel River	South Fork Eel River	Mill Creek (*Weott HSA;* tributary to Bull Creek)
	Bull Creek	Fish Creek *(Weott HSA)*
	Squaw Creek *(Weott HSA)*	Dean Creek
	Decker Creek	Bear Canyon Creek
	Canoe Creek	Warden Creek
	Elk Creek	Cox Creek
	Salmon Creek	East Branch South Fork Eel River
	Mill Creek *(Weott HSA; tributary to Salmon Creek)*	Squaw Creek *(Benbow HSA)*
	Butte Creek	Fish Creek *(Benbow HSA)*
	Leggett Creek	Connick Creek
	Redwood Creek (Pollock Creek; *Benbow*	*HSA)* Bridges Creek
	Seely Creek	Mill Creek *(Benbow HSA)*
	Miller Creek	Bear Creek*(Benbow HSA)*
	China Creek	Little Low Gap Creek
	Dinner Creek	Rattlesnake Creek
	Sproul Creek (Sprowl Creek)	Foster Creek
	Little Sproul Creek	Cummings Creek
	West Fork Sproul Creek	Streeter Creek
	Durphy Creek	Mill Creek *(Laytonville HSA)*
	Milk Ranch Creek	Barnwell Creek
	Indian Creek	Deer Creek
	Jones Creek	Mud Creek
	Moody Creek	
	Sebbas Creek	
	Coulborn Creek	
	Anderson Creek	
	Piercy Creek	
	Standley Creek	
	McCoy Creek	
	Bear Pen Creek	
	Red Mountain Creek	
	Wildcat Creek	
	Hollow Tree Creek	
	Walters Creek	
	Redwood Creek *(Benbow HSA)*	
	South Fork Redwood Creek	
	Bond Creek	
	Michaels Creek	
	Doctors Creek	
	Waldron Creek	
	Huckleberry Creek	

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
South Fork Eel River (continued)	Bear Wallow Creek	
	Little Bear Wallow Creek	
	Butler Creek	
	Mule Creek	
	Cedar Creek	
	Low Gap Creek	
	Ten Mile Creek	
	Grub Creek	
	Big Rock Creek	
	Mud Springs Creek	
	Cahto Creek	
	Elder Creek	
	Jack of Hearts Creek	
	Dark Canyon Creek	
	Little Charlie Creek	
	Dutch Charlie Creek	
	Redwood Creek *(Laytonville HSA)*	
	Rock Creek	
	Kenny creek	
	Haun Creek	
	Taylor Creek	
	Bear Creek *(Laytonville HSA)*	
Middle/Upper and North Fork Eel River	Outlet Creek	Long Valley Creek
(Tributaries to the mainstem Eel River)	Bloody Run Creek	Reeves Canyon Creek
	Ryan Creek	Haehl Creek
	Mill Creek	
	Willits Creek	
	Broaddus Creek	
	Baechtel Creek	
Cape Mendocino	Squaw Creek	Mill Creek (Lighthouse Road)
(Tributaries to the Mattole River)	Woods Creek	North Fork Mattole River
	Honeydew Creek	Mill Creek (Petrolia)
	Four Mile Creek	Clear Creek
	Sholes Creek	Indian Creek
	Grindstone Creek	Upper North Fork Mattole River
	Blue Slide Creek	Oil Creek
	Bear Creek	Devils Creek
	South Fork Bear Creek	Bear Trap Creek
	Eubank Creek	Middle Creek
	Bridge Creek	Westlund Creek
	Mckee Creek	Gilham Creek

COHO SALMON RECOVERY UNIT	KEY POPULATIONS TO MAINTAIN OR IMPROVE	SITES TO ESTABLISH POPULATIONS
SONCC COHO ESU		
Cape Mendocino (continued)	Van Auken Creek (Van Arken Creek)	Harrow Creek
	Anderson Creek	Mattole Canyon
	Mill Creek (headwaters)	Big Finley
	Baker Creek	Stanley Creek
	Thompson Creek	
CCC COHO ESU		
Mendocino Coast	Cottaneva Creek	To be determined
	Pudding Creek	
	Caspar Creek	
	North Fork Big Creek	
	Albion River	
	North Fork Navarro River	
	Elk Creek (Elk HSA)	
	South Fork Garcia River	
	North Fork Gualala River	
Russian River	Green Valley Creek	To be determined
Bodega-Marin Coastal	Lagunitas Creek	To be determined
	Redwood Creek	
San Francisco Bay	none	To be determined
San Mateo	none	To be determined
Big Basin	Scott Creek	To be determined

Appendix E Watershed Groups and Gap Analysis

Watershed programs and groups are recognized as valuable assets and partners in the recovery of coho salmon. The Department has identified watershed programs, groups, and other resources currently involved in making watershed improvements that may benefit salmonids. The purpose of this analysis was to determine whether or not medium to high priority watersheds (priority ranking 3 to 5) had affiliated watershed groups. In watersheds, or hydrologic subareas (HSAs), where groups were not identified (Table E-1), the Department will endeavor to work with landowners, the local people, agencies and associations to help develop a working group for that HSA. In those HSAs with an existing watershed program or group (Table E-2), the Department will collaborate with them to ensure that actions needed to benefit coho salmon are mutually acceptable.

TABLE E-1: High priority watersheds that do not have identified watershed groups

HYDROLOGIC UNIT	HYDROLOGIC SUBAREA
Trinidad	Big Lagoon
	Little River
Mendocino Coast	Wages Creek
	Ten Mile River
	Elk Creek
	North Fork Garcia
Marin Coastal	Bolinas

TABLE E-2: Existing Watershed programs and groups

HU	HSA	ORGANIZATION	CONTACT	EMAIL
SONCC COHO ESU				
WINCHUCK RIVER	Winchuck River	South Coast Watershed Council	Harry Hoogesteger	
ROGUE RIVER	Illinois River	Illinois Valley Watershed Council	Coordinator	jvswcdwc@cavenet.com
		Illinois Valley Soil and Watershed Conservation District	District Manager	jvswcdwc@cavenet.com
	Applegate River	Applegate River Watershed Council	Daniel Newberry	
SMITH RIVER	Smith River Plain	Smith River Advisory Council	Jim Waldvogel	cedelnorte@ucdavis.edu
	Rowdy Creek	Smith River Advisory Council	Jim Waldvogel	cedelnorte@ucdavis.edu
	Mill Creek	Smith River Advisory Council	Jim Waldvogel	cedelnorte@ucdavis.edu
	South Fork Smith River	Smith River Advisory Council	Jim Waldvogel	cedelnorte@ucdavis.edu
	Middle Fork Smith River	Smith River Advisory Council	Jim Waldvogel	cedelnorte@ucdavis.edu
	North Fork Smith River	Smith River Advisory Council	Jim Waldvogel	cedelnorte@ucdavis.edu
	Wilson Creek	Rural Human Services	Dan Burgess	
KLAMATH RIVER	Klamath Glen	Yurok Tribal Fisheries Program	Dale Gale	dgale@northcoast.com
		Klamath Resource Information System	Bill Kier Associates	
	Orleans	Karuk Tribal Fisheries		
		Klamath Resource Information System	Bill Kier Associates	
		Hoopa Tribal Fisheries	George Kautsky	
	Lower Salmon	Salmon River Restoration Council	Jim Villetonteaux	info@srrc.org
		Klamath Resource Information System	Bill Kier Associates	
	Wooley Creek	Salmon River Restoration Council	Jim Villetonteaux	info@srrc.org
	Sawyers Bar	Salmon River Restoration Council	Jim Villetonteaux	info@srrc.org
		Klamath Resource Information System	Bill Kier Associates	
	Cecilville	Salmon River Restoration Council	Jim Villetonteaux	info@srrc.org
		Klamath Resource Information System	Bill Kier Associates	
	Ukonom	Klamath Resource Information System	Bill Kier Associates	
	Happy Camp	Klamath Resource Information System	Bill Kier Associates	
	Seiad Valley	Klamath Resource Information System	Bill Kier Associates	

HU	HSA	ORGANIZATION	CONTACT	EMAIL
SONCC COHO ESU				
KLAMATH RIVER (continued)	Beaver Creek	Klamath Resource Information System	Bill Kier Associates	
	Hornbrook	Klamath Resource Information System	Bill Kier Associates	
	Iron Gate	Klamath Resource Information System	Bill Kier Associates	
	Copco Lake	Klamath Resource Information System	Bill Kier Associates	
	Scott Bar	Klamath Resource Information System	Bill Kier Associates	
		Scott River Watershed Council	Rhonda Muse	rmuse@sisqtel.net
	Scott Valley	Scott River Watershed Council	Rhonda Muse	rmuse@sisqtel.net
		Siskiyou Resource Conservation District		sisqrcd@sisqtel.net
		French Creek Watershed Advisory Group	Jay Powers	
		Klamath Resource Information System	Bill Kier Associates	
	Shasta Valley	Shasta River CRMP		
		Shasta Valley Resource Conservation District	Richard Christie	richard-christie@ca.nacdnet.org
		Klamath Resource Information System	Bill Kier Associates	
TRINITY RIVER	Hoopa	Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
		Hoopa Tribal Fisheries	George Kautsky	
		Friends of the Trinity River	Byron Leydecker	bw13@attbi.com
		Klamath Resource Information System	Bill Kier Associates	
	Willow Creek	Hoopa Tribal Fisheries	George Kautsky	
		Friends of the Trinity River	Byron Leydecker	bw13@attbi.com
		Klamath Resource Information System	Bill Kier Associates	
	Burnt Ranch	Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Friends of the Trinity River	Byron Leydecker	bw13@attbi.com
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	New River	Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.go
	Helena	Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net

HU	HSA	ORGANIZATION	CONTACT	EMAIL
SONCC COHO ESU				
TRINITY RIVER (continued)	Helena (continued)	Friends of the Trinity River	Byron Leydecker	bw13@attbi.com
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	Grouse Creek	South Fork Trinity River CRMP	Bill Huber	whuber@jeffnet.org
		Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	Hyampom	South Fork Trinity River CRMP	Bill Huber	whuber@jeffnet.org
		Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	Forest Glen	South Fork Trinity River CRMP	Bill Huber	whuber@jeffnet.org
		Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	Corral Creek	South Fork Trinity River CRMP	Bill Huber	whuber@jeffnet.org
		Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	Hayfork Valley	South Fork Trinity River CRMP	Bill Huber	whuber@jeffnet.org
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	Douglas City	Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Friends of the Trinity River	Byron Leydecker	bw13@attbi.com
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	Weaver Creek	Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Friends of the Trinity River	Byron Leydecker	bw13@attbi.com

HU	HSA	ORGANIZATION	CONTACT	EMAIL
SONCC COHO ESU				
TRINITY RIVER (continued)	Weaver Creek (continued)	Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
	Upper Trinity River	Trinity County Resource Conservation District	Pat Frost	tcrcd@snowcrest.net
		Klamath Resource Information System	Bill Kier Associates	
		Trinity River Restoration Program	Doug Schleusner	dschleusner@mp.usbr.gov
REDWOOD CREEK	Orick	Redwood Creek Landowners Association	Bernie Bush – Simpson Timber	
	Beaver	Redwood Creek Landowners Association	Bernie Bush – Simpson Timber	
	Lake Prairie	Redwood Creek Landowners Association	Bernie Bush – Simpson Timber	
TRINIDAD	Big Lagoon			
	Little River			
MAD RIVER	Blue Lake	Mad River Watershed Group	Dave Spheril	
	North Fork Mad River	Mad River Watershed Group	Dave Spheril	
	Butler Valley	Mad River Watershed Group	Dave Spheril	
	Ruth			
EUREKA PLAIN	Eureka Plain	Humboldt Bay Watershed Advisory Committee	Ruth Blyther	
		Harbor District	Dave Hull	
EEL RIVER	Ferndale	Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Scotia	Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Larabee Creek	Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Hydesville	Friends of the Eel River		foer@eelriver.org
		Friends of the Van Duzen		
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Bridgeville	Friends of the Eel River		foer@eelriver.org
		Friends of the Van Duzen		
		Eel River Watershed Improvement Group	Ruth Goodfield	

HU	HSA	ORGANIZATION	CONTACT	EMAIL
SONCC COHO ESU				
EEL RIVER (continued)	Yager Creek	Cummings Ck Watershed Advisory Council	Bill Matson	bmatson@saber.net
		Yager Environmental Stewards	Dina Moore	lonestar@humboldt1.com
		Friends of the Van Duzen		
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Weott	Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Benbow	China Creek Restoration Group	Jerry Sevier	
		Eel River Restoration Project	Harry Vaughn	hvaughn@northcoast.com
		Seely Creek Watershed Assoc.	Mike Vollmer	mike@isf-sw.org
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Laytonville	Woodman Creek Road Assoc.	Kent Westwood	
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Sequoia	Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Spy Rock	Upper Eel Watershed Forum	Dr. John Calaprice	uewatershed1@saber.net
		Mainstem Eel Restoration Group	Ann Forest	merg1997@yahoo.com
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	North Fork Eel River	Upper Eel Watershed Forum	Dr. John Calaprice	uewatershed1@saber.net
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Outlet Creek	Willits Landowner Group	Erlyne Schmidbauer	schmidtba@pacific.net
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Tomki Creek	Willits Landowner Group	Erlyne Schmidbauer	schmidtba@pacific.net

HU	HSA	ORGANIZATION	CONTACT	EMAIL
SONCC COHO ESU				
EEL RIVER (continued)	Tomiki Creek (continued)	Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Lake Pillsbury	Upper Eel Landowners Association	Stuart Smith	
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Eden Valley	Upper Eel Watershed Forum	Dr. John Calaprice	uewatershed1@saber.net
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Round Valley	Upper Eel Watershed Forum	Dr. John Calaprice	uewatershed1@saber.net
		Round Valley Indian Tribes	Warren Mitchell	rvinatres@saber.net
		Round Valley Resource Center	Brian Dick	rvcenter@pacific.net
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Black Butte River	Upper Eel Watershed Forum	Dr. John Calaprice	uewatershed1@saber.net
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
	Wilderness	Upper Eel Watershed Forum	Dr. John Calaprice	uewatershed1@saber.net
		Friends of the Eel River		foer@eelriver.org
		Eel River Watershed Improvement Group	Ruth Goodfield	
CAPE MENDOCINO	Oil Creek			
	Capetown	Bear River Regional Resource Conservancy		
	Mattole River	Mattole Restoration Council	Chris Larson	mrc@inreach.com
		Mattole Salmon Group	Gary Peterson	msg@mattolesalmon.org

HU	HSA	ORGANIZATION	CONTACT	EMAIL
CCC COHO ESU				
MENDOCINO COAST	Usal Creek	InterTribal Sinkyone Wilderness Council	Hawk Rosales	
	Wages Creek			
	Ten Mile River			
	Noyo River	Noyo Watershed Alliance	Michelle White	wildlifeworkshop@hotmail.com
	Big River			
	Albion River	Albion River Watershed Protection Association	Linda Perkins	
	Navarro River	Navarro River Watershed Working Group		
		Friends of the Navarro River	Diane Paget	
	Greenwood Creek			
	Elk Creek			
	Alder Creek			
	Brush Creek			
	Garcia River	Friends of the Garcia River		pdobbins@mcn.org
		Friends of Schooner Gulch	Peter Ryemiller	
	North Fork			
	Rockpile Creek			
	Buckeye Creek			
	Wheatfield Fork			
	Gualala	Friends of the Gualala River		
		Gualala River Watershed Council	Kathleen Morgan	kmorgan@mcn.org
	Russian Gulch			
RUSSIAN RIVER	Guerneville	West County Watershed Network		wcwnetwork@yahoogroups.com
		Stewards of Slavianka	Michele Luna	sos@mcn.org
		Dutch Bill Creek Watershed Group	Broc Dolman	broc@oaec.org
		Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
	Austin Creek	Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com

HU	HSA	ORGANIZATION	CONTACT	EMAIL
CCC COHO ESU				
RUSSIAN RIVER (continued)	Austin Creek (continued)	For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
	Laguna	Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
		Blucher Creek Watershed Council	Diane Niessen	diane.nissen@sonoma.edu
		West County Watershed Network		wcwnetwork@yahoogroups.com
	Santa Rosa	Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
	Mark West	Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
	Warm Springs	Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
	Geyserville	Fish Net 4C	Kallie Kull	Kallie@igc.org
		Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Russian River Unlimited	Rebecca Kress	russianriverunlimited@hotmail.com
	Sulphur Creek	Fish Net 4C	Kallie Kull	Kallie@igc.org
		Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
	Ukiah	Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
		Russian River Unlimited	Rebecca Kress	russianriverunlimited@hotmail.com
		Robinson Creek Watershed Group	Sheryl Greene	sgreen@pacific.net

HU	HSA	ORGANIZATION	CONTACT	EMAIL
CCC COHO ESU				
RUSSIAN RIVER (continued)	Ukiah Creek (continued)	For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
	Coyote Valley	Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
	Forsythe Creek	Forsythe Watershed Advisory Group	Mendocino County RCD	
		Friends of Forsythe Creek		
		Russian River Watershed Council	Linda Curry	watershedrrwc@hotmail.com
		Russian River Unlimited	Rebecca Kress	russianriverunlimited@hotmail.com
		For Sake of the Salmon	Jenifer Michaud	watershed_coordinator@pcz.org
		Fish Net 4C	Kallie Kull	Kallie@igc.org
BODEGA	Salmon Creek	Salmon Creek Watershed Council	Kathleen Kraft	KKKraft@yahoo.com
	Bodega Head			
	Bodega Bay	West County Watershed Group	Brock Dolman	
	Estero Americano	West County Watershed Group	Brock Dolman	
	Estero San Antonio			
MARIN COASTAL	Tomales Bay	Tomales Bay Watershed Council	Neysa King	neysaking@earthlink.net
	Walker Creek	Tomales Bay Watershed Council	Neysa King	neysaking@earthlink.net
	Lagunitas Creek	Tomales Bay Watershed Council	Neysa King	neysaking@earthlink.net
		MMWD Lagunitas TAC	Greg Andrew	gandrew@marinwater.org
		SPAWN	Reuven Walder	reuven@spawnusa.org
		Trout Unlimited	Stan Griffen	
	Inverness	Tomales Bay Watershed Council	Neysa King	neysaking@earthlink.net
	Point Reyes	Tomales Bay Watershed Council	Neysa King	neysaking@earthlink.net
		Pt. Reyes NS Salmon Program	Brannon Ketcham	Brannon_ketcham@nps.gov
	Drakes Estero			
	Bolinas	Pt. Reyes NS Salmon Program	Brannon Ketcham	Brannon_ketcham@nps.gov
SAN MATEO	San Francisco Coastal	N/A	N/A	N/A
	Pacifica	San Pedro Creek Watershed Coalition	Christine Chan	sgerc@attbi.com

HU	HSA	ORGANIZATION	CONTACT	EMAIL
CCC COHO ESU				
SAN MATEO (continued)	Half Moon Bay	Pilarcitos Creek Advisory Committee	Tim Frahm	Timfrahm@hotmail.com
	Tunitas Creek	N/A	N/A	N/A
	San Gregorio Creeek	San Gregorio Environmental Resource Center	Catherine Swatland	sgerc@attbi.co
	Año Nuevo	Coastal Watershed Council	Tamara Dolan	cwc_office@yahoo.com
	Pescadero Creek	Pescadero Conservation Alliance	John Wade	jwsavsland@aol.com
BAY BRIDGES	Bay Waters			
	San Rafael	Friends of Corte Madera Creek Watershed	Carole d'Alessio	dalessio@microweb.com
		Mill Valley Streamkeepers	Betsy Bikle	betsybikle@wellesley.alum.edu
	Berkeley			
	San Francisco Bayside			
SOUTH BAY	Bay Channel			
	East Bay Cities			
	Alameda Creek			
	San Mateo Bayside			
SANTA CLARA	Dumbarton South			
	Fremont Bayside			
	Coyote Creek			
	Guadalupe River			
	Palo Alto			
SAN PABLO	San Pablo Bay			
	Novato	Friends of Novato Creek	Sue Lattanzio	suelattanzio@earthlink.net
	Petaluma River	Petaluma River Foundation	Andy Rodgers	arodgers@econ-inc.net
	Sonoma Creek	Sonoma Ecology Center	Will Pier	sec-pier@vom.com
	Napa River	Various (see below)		
		Carneros Stewardship Group	Leigh Sharpe	Leigh@naparcd.org
		Dry Creek Watershed Group	Leigh Sharpe	Leigh@naparcd.org
		Sulphur Creek Watershed Group	Leigh Sharpe	Leigh@naparcd.org
		Friends of Napa River	Bernhard Krevet	krevet@attglobal.net

HU	HSA	ORGANIZATION	CONTACT	EMAIL
CCC COHO ESU				
SAN PABLO (continued)	Napa River (continued)	Rutherford Dust Society	Davie Pina	davie@pinavineyards.com
	Pinole			
SUISUN	Suisun Bay			
	Benicia			
	Suisun Creek	Suisun Creek Restoration Team	Laurel Marcus	laurelm@ix.netcom.com
	Suisun Slough			
	Grizzly Island			
	Grizzly Island – in Delta			
	Suisun Slough – in Delta			
	Pittsburg			
	Walnut Creek			
	Martinez			
	Pittsburg – in Delta			
	Suisun Bay – in Delta			
BIG BASIN	Davenport	San Andreas Land Conservancy	David Kossack	dkossack@igc.org
	San Lorenzo	San Lorenzo Watershed Caretakers	Karen Christensen	sccrcd@cruzio.com
	Aptos-Soquel	Friends of Soquel Creek	Kay Spencer	oya@friendsofsoquelcreek.org
	Año Nuevo	Scotts Creek Watershed Council	Mathers Rowley	ScottsCreekCRMP@aol.com

Appendix F
Watershed Prioritization

This document describes the data, processes, and methods used by the CRT in developing the Watershed Prioritization (Section 6.3). It also discusses the limitations of the data and methods, and thus, the limitations of the results.

Watershed delineations are based on the CALWATER Hydrologic Subareas (HSAs), as described in Chapter 6 (Recovery Units and Watersheds). Four maps were generated to implement the prioritization. This section describes each of these maps and the data used in their development.

MAP 1: CONSISTENT PRESENCE

What: Shows the percentage of streams surveyed, in each HSA, that have Consistent Presence of coho salmon over two or three years.

Data: Coho salmon presence/absence tables found in the watershed summaries provided to the CRT by the Department regions.

Analysis: Since presence/absence data for only two years (2001 and 2002) were available for many of the watersheds, the analysis was based on the two years that were found consistently across HSAs. A handful of HSAs were surveyed in 2000 and those survey results were included.

Consistent Presence was defined as outlined below. Then, by counting the number of streams surveyed per HSA, a percentage of consistent presence (Consistent Presence in two of eight streams surveyed in that watershed = 25% Consistent Presence) was calculated.

Results were grouped into six rankings:

0 = No surveys in this watershed
1 = Streams surveyed, but no coho salmon found
2 = Coho salmon found, but no Consistent Presence
3 = 0-9% Consistent Presence
4 = 10-49% Consistent Presence
5 = 50-100% Consistent Presence

Shown below are the criteria used to determine if a stream had Consistent Presence:

FOR STREAMS WITH TWO YEARS OF SURVEY RESULTS

CONSISTENT PRESENCE	YEAR	YEAR
N	no data	no data
N	A	no data
N	A	A
N, but coho salmon found	P	A
Y	P	no data
Y	P	P

FOR STREAMS WITH THREE YEARS OF SURVEY RESULTS

CONSISTENT PRESENCE	YEAR	YEAR	YEAR
N	no data	no data	no data
N	A	(A)	(A)
N, but coho salmon found	P	A	no data
N, but coho salmon found	P	A	A
Y	P	P	A
Y	P	no data	no data
Y	P	P	no data
Y	P	P	P

Limitations: This map was produced using presence/absence data, not abundance data. Therefore, it doesn't represent the total numbers of fish in any given HSA, only that they were there. Also, since a consistent field data capture technique was used only in recent years, there are only two or three years of data to evaluate, which limits the scope of the results. Finally, this map only shows where streams have been surveyed and whether coho salmon were found. Many streams were not surveyed. This creates a bias based on how many streams were surveyed in a given HSA. Some HSAs had only one or two streams surveyed and could receive a 50% or 100% Consistent Presence with only one or two streams having coho salmon presence, while other HSAs had 20+ streams surveyed and could have many more streams with coho salmon presence and still not reach the 50% Consistent Presence mark. The streams that were surveyed, however, were based on historic data that showed where the coho salmon were most likely to be found, and it was assumed that there are very few additional streams that could have been surveyed where coho salmon would have been found.

Consistent Presence for the SONCC Coho ESU is shown on Figure 6-23 and for the CCC Coho ESU, on Figure 6-24.

MAP 2: COHO SALMON POPULATION AND RISK

What: Shows the combination of coho salmon population factors and risk factors by HSA.

Data: This map represents the compilation of several data sources. See below for details on the six combined analyses used.

Analysis: The rankings for the three coho salmon population factors were first added together, and then the three risk factor rankings were added together and divided by three. This added the risk factors in as equivalent to each individual population factor. Finally, both totals were added and then grouped into quintiles separately for each ESU.

Limitations: This map was produced by combining the rankings of six separate analyses (three for coho salmon population factors, and three for risk factors). See below for specific limitations on each of these.

Compiled Analysis: The following six items represent individual analyses that all were considered in the coho salmon population and risk map. All of these analyses involved assigning a score to each HSA and then grouping the scores into ranks (usually 1 to 5). Since there are many factors that differ between the two ESUs, these range breaks were often created separately for each ESU (3, 4, and 5).

1. CONSISTENT PRESENCE – SEE PREVIOUS MAP

2. ISOLATION INDEX

Data: CALWATER 2.2 HSAs and consistent presence data created from presence/absence data from watershed summaries.

Analysis: This analysis assessed the geographic isolation of every HSA that had any level of Consistent Presence (ranks 3, 4, and 5). To accomplish this, the following was done for each HSA that fell into this category:

1. Selected all HSAs within the same HU that were at least partially within a 5-mile radius of the boundary of the selected HSA.
2. Summed the area of all of the selected border HSAs.
3. Summed the area of all of the selected border HSAs that also had some level of Consistent Presence.
4. Calculated the percentage of Consistent Presence area out of the total area. The lower the percentage of nearby Consistent Presence HSAs, the more isolated the ranking.

The rankings were as follows:

1 = 100-70% (not very isolated)
3 = 70-45% (somewhat isolated)
5 = 45-0% (very isolated)

Limitations: This analysis is based on the proximity of HSAs to other HSAs within the larger HU. It does not look at direct hydrologic connectivity, but at clusters of HSAs that eventually drain to the same point.

3. RUN LENGTH

Data: 100K Department streams layer from Eric Haney (Region 1)

Analysis: For this analysis the downstream stream length from the output point of each HSA to the mouth (ocean or SF Bay) was used. Then a 'pseudo radius' value for each HSA based on its area was added. This addition created a run length that pushed partially into the HSA and it also provided run lengths for coastal HSAs that otherwise would have received a zero value. The results were then grouped into rankings based on five categories (different ranges for the two ESUs).

High rankings were given to both very short and very long runs, with the assumption that these represented potential unique populations of coho salmon.

RANKING	SONCC	CCC
5	0-13 miles	0-4 miles
3	14-40	5-6
1	41-82	7-8
3	83-126	9-11
5	127-200	12-31

Limitations: Because good point location data for the coho salmon are not available, exact run-lengths to spawning areas could not be calculated; instead, an average value (that goes mid-way into the HSA where there are coho salmon) was calculated.

4. CENSUS POPULATION DENSITY

Data: Year 2000 census data from Department library (by Census Tract)

Analysis: For this analysis the existing Density Class field (1-10) was used and aggregated up from Census Tract to HSA. For each Census Tract (or part of a Census Tract as clipped by the HSA boundary), the Density Class was multiplied by the percentage area of the Tract to the HSA, and then all the pieces were added. The results were then grouped into five rankings for each ESU.

Limitations: A risk to the coho salmon population is inferred based on the density of people. While the census data are fairly accurate, the relationship of human density to coho salmon risk is not necessarily a direct linear one.

5. POINTS OF WATER DIVERSION

Data: State Water Resources Control Board's Water Rights Information System (data from 12/2002).

Analysis: Within the historical range of coho salmon, the points of diversion were summarized by HSA. The totals were then grouped into ranks based on percentiles:

PERCENTILE	RANGE	RANK
50%	0-19	1
60%	20-41	2
70%	42-64	3
80%	65-186	4
95%	187-1045	5

Limitations: The data used for this analysis were the best available and capture most of the legal water diversions from streams. However, what they do not capture (at this time) is the amount of water pulled out at each diversion. Some diversions may be for a single residence, while another may be for a very large water district transfer or large irrigation project. Ideally, the amount of water diverted rather than the number of diversions would be used.

6. ROAD DENSITY

Data: 100K roads data from the Department library (USGS DLG data by county)

Analysis: Miles of roads per HSA were counted and then divided by total square miles per HSA to get a miles/sq mile figure. The results were then grouped into five rankings for each ESU.

Limitations: The 100K roads data used for this analysis are the best available for the whole coho salmon range at this time. However, at the 100K-scale of data capture, large numbers of smaller rural roads are left out, thus somewhat diminishing the road density in the rural areas. Ideally, 24K roads data would be used.

Risk of extinction for the SONCC Coho ESU is shown on Figure 6-25 and for the CCC Coho ESU on Figure 6-26.

MAP 3: PRIORITIZED WATERSHEDS FOR MANAGEMENT ACTIONS

What: Shows the combination of coho salmon population factors, risk factors and watershed status by HSA.

Data: This map represents the compilation of several data sources. It starts with Map 2: Coho salmon population and risk (see above) and adds a combined watershed status analysis that was compiled based on the professional opinion of Department field staff on three categories for each HSA: potential habitat, disconnected habitat, and watershed condition.

Analysis: Department field staff were asked to rank each HSA (1-5) in their region based on the following three categories: 1) potential habitat, stream gradient and pools; 2) disconnected habitat, barriers; and 3) watershed condition, overall condition, impairments, disturbances. These ranks were then added together and added to the totals from Map 2: Coho salmon population and risk. The totals were then grouped into ranks (1-5) separately for each ESU.

Limitations: The limitations for this map include the limitations from Map 2: Coho salmon population and risk. In addition, the three ranks collected from Department field staff are subjective.

MAP 4: DISCONNECTED HABITAT

What: Shows the amount and type of stream barriers to coho salmon migration.

Data: These data are based on the professional opinion of Department field staff.

Analysis: Department field staff were asked to rank each HSA (1-5) in their region based on disconnected habitat. The possible categories are as follows:

N/A = not current or known historic coho salmon habitat

0 = natural, permanent, or year-round barrier to coho salmon migration

1 = an extremely large barrier (e.g., major dam like Iron Gate) or an extremely large number of confirmed barriers

2 = large numbers of confirmed barriers

3 = a moderate number of barriers need to be removed or modified to allow all life stages passage to restorable coho salmon habitat

4 = a few barriers need to be removed or modified to allow all life stages passage to existing coho salmon habitat

5 = none to very few barriers need to be removed or modified to allow all life stages passage to existing coho salmon habitat

Limitations: The data for this map are based on professional opinions from Department field staff and are subjective.

Restoration and management potential for the SONCC Coho ESU is shown on Figure 6-27 and for the CCC Coho ESU on Figure 6-28. Disconnected habitat for the SONCC Coho ESU is shown on Figure 6-29 and for the CCC Coho ESU on Figure 6-30.

Appendix G
Role of Existing Hatcheries

Table of Contents

BACKGROUND G.1

NOAA FISHERIES PRELIMINARY EVALUATION OF THE POTENTIAL ROLE OF COHO SALMON HATCHERIES IN COHO RECOVERY G.2

1. Stock Name: Iron Gate Hatchery coho salmon G.3
   - Broodstock Origin and History G.3
   - Subsequent Events G.3
2. Stock Name: Trinity River Hatchery coho salmon G.4
   - Broodstock Origin and History G.4
   - Subsequent Events G.4
3. Stock Name: Mad River Hatchery coho salmon G.5
   - Broodstock Origin and History G.5
   - Subsequent Events G.5
4. Stock Name: Noyo River Fish Station coho salmon. G.6
   - Broodstock Origin and History G.6
   - Subsequent Events G.6
5. Stock Name: Don Clausen Hatchery coho salmon G.7
   - Broodstock Origin and History G.7
   - Subsequent Events G.7
6. Stock name: Kingfisher Flat (Big Creek) Hatchery coho salmon. G.7
   - Broodstock Origin and History G.8
   - Subsequent Events G.8

PRINCIPLES OF HATCHERY OPERATION IN SUPPORT OF COHO SALMON RECOVERY G.9

MONITORING AND EVALUATION RECOMMENDATIONS G.10

SPECIFIC RECOMMENDATIONS G.11

REFERENCES CITED G.12

List of Tables

TABLE G-1: Recent coho salmon production facilities in California G.1

This appendix describes how existing hatcheries may play a role in the recovery of California's coho salmon. Appendix H provides guidelines for the operation of hatcheries.

BACKGROUND

The Hatchery Working Group of the CRT met on June 12, 2003, to discuss the role of existing coho salmon artificial production facilities in coho salmon recovery. The following report contains elements agreed upon at that meeting and subsequent additions by Working Group members. Not all Working Group members supported the addition of the following subsections entitled "Principles of hatchery operation in support of coho salmon recovery," "Monitoring and Evaluation Recommendations," and "Specific Recommendations" in this section of the Recovery Strategy. However, these subsections are included in this draft to reflect the contributions of all Working Group members and decisions made at the meeting.

Table G-1 lists the coho salmon artificial production facilities that are currently active in California.

TABLE G-1: Recent coho salmon production facilities in California

FACILITY NAME	OPERATOR	TYPE OF FACILITY	STREAM	LOCATION (COUNTY)	ESU[1]	OPS. BEGAN
Big Creek Hatchery	Private/NOAA Fisheries	Cooperative Enhancement Recovery	Big Creek (Tributary to Scott Creek)	Santa Cruz	CCC	1986
Don Clausen/Warm Springs Hatchery	CDFG	Mitigation/Enhancement/Recovery	Dry Creek (Tributary to Russian River)	Sonoma	CCC	1980
Noyo Egg Taking Station	CDFG	Enhancement	South Fork Noyo River	Mendocino	CCC	1962
Mad River Hatchery	CDFG	Enhancement	Mad River	Humboldt	SONCC	1970
Trinity River Hatchery	CDFG	Mitigation	Trinity River	Trinity	SONCC	1958
Iron Gate Hatchery	CDFG	Mitigation	Klamath River	Siskiyou	SONCC	1965
Rowdy Creek Hatchery	Private	Cooperative Enhancement	Rowdy Creek (Tributary to Smith River)	Del Norte	SONCC	1972

NOTES:

1. ESU abbreviations are CCC: Central California Coast Coho ESU, SONCC: Southern Oregon/Northern California Coasts Coho ESU.

SOURCE: CDFG 2002 with modification

NOAA FISHERIES PRELIMINARY EVALUATION OF THE POTENTIAL ROLE OF COHO SALMON HATCHERIES IN COHO SALMON RECOVERY

NOAA Fisheries (2003) assigned each current California coho salmon hatchery program to a category from 1 to 4, based on variation in 1) the degree of genetic divergence between the hatchery stock and the natural populations that occupy the watershed into which the hatchery stock is released, 2) the origin of the hatchery stock, and 3) the status of the natural populations in the watershed. This categorization is intended to provide useful information for determining the ESU status of individual hatchery stocks, and may also be useful as a rough guide for determining the potential usefulness of a stock for conservation purposes. However, the decision to use or avoid using a particular stock for purposes of conservation requires a detailed evaluation of each particular case, including evaluation on the relative benefits and risks of artificial propagation and other conservation strategies (NOAA Fisheries 2003).

This information emphasizes a conservative approach towards the use of hatcheries in the role of recovery, and takes into consideration the fact that it is not known if or how current hatchery programs will fit into the coho salmon recovery process. NOAA Fisheries is currently undergoing review of its hatchery policy based on the most accurate scientific information pertinent to the consideration of artificial propagation in ESA listing decisions. The new Federal hatchery listing policy is intended to more clearly articulate how NOAA Fisheries will consider hatchery salmonids in evaluating the risk of extinction for Pacific salmon and steelhead Evolutionarily Significant Units (ESUs), and in making subsequent listing determinations under the ESA. Completion of this process and finalization of the NOAA Fisheries Hatchery Policy is not expected before the end of 2003. Concurrently, NOAA Fisheries initiated status reviews of 25 West Coast salmonid ESUs. Updated ESA listing determinations will be proposed after preliminary analysis and review of the best available scientific information, and after consideration of protective measures being carried out to protect the species. Finalization of updated Federal ESU listing determinations is expected in 2004.

In consideration of possible dichotomies between the final NOAA Fisheries policies and those of the CRT, the Department, in consultation with NOAA Fisheries, will evaluate how to incorporate these documents into the Coho Salmon Recovery Strategy when they become available.

The following is excerpted from NOAA Fisheries (2003). Hatchery categories are highlighted in bold and italics in the text. The profile of the each coho salmon hatchery in the following accounts is meant to provide background that led to its subsequent category rating. All citations and personal communications in this section are as cited in NOAA Fisheries (2003); the original citations were not necessarily reviewed by members of the Working Group. *Blank spaces in the following excerpt from NOAA Fisheries (2003) were left blank as in the original draft document.*

The categories in each account are defined as follows:

- Category 1 stocks are characterized by no more than minimal divergence between the hatchery stock and the local natural populations and regular, substantial incorporation of natural origin fish into the hatchery broodstock. Within category 1, category 1a stocks are characterized by the existence of a native natural population of the same species in the watershed, while category 1b stocks are characterized by the lack of such a population (e.g., the local naturally spawning population was introduced from elsewhere). Note that a category 1a designation can describe a range of biological scenarios, and does not necessarily imply that the hatchery stock and the associated natural population are close to a 'pristine' state.

- Category 2 stocks are no more than moderately diverged from the local, natural population(s) in the watershed. Category 2a stocks were founded from a local, native population in the watershed in which they are released. Category 2b stocks were founded non-locally but from within the ESU, and are released in a watershed that does not contain a native natural population. Category 2c stocks were founded non-locally but from within the ESU, and are released in a watershed that contains a native natural population.
- Category 3 stocks are substantially diverged from the natural populations in the watershed in which they are released. The >a=, >b=, and >c= designations are the same as described for category 2.
- Category 4 stocks are characterized either by being founded predominantly from sources that are not considered part of the ESU in question, or by extreme divergence from the natural populations in the watershed in which they are released, regardless of founding source.

1. STOCK NAME: IRON GATE HATCHERY COHO SALMON (KLAMATH COHO SALMON [CDFG])

Hatchery/Collection Site: Iron Gate Hatchery is on the Klamath River 306 km upriver near Hornbrook (CDFG/NMFS 2001). This hatchery was built by Pacific Power and Light Company to mitigate the Iron Gate Project and is operated by the Department. Fish are collected at an auxiliary ladder at the hatchery outlet and at the main ladder at the base of Iron Gate Dam.

Broodstock Origin and History

Year Founded: The hatchery was founded in 1965, with the first releases occurring in 1966.

Source: The Iron Gate Hatchery coho salmon stock was founded with Trinity River fish released in 1966 and Cascade (Columbia River) fish released in 1966, 1968, 1969, and 1970. Other stocks released from Iron Gate include Trinity (1969 and 1977) and unknown (1970). Only Klamath stocks have been released at the hatchery since 1977. The Klamath Basin has also been planted with other hatchery stocks including Darrah Springs and Mad River hatcheries (NMFS 1997).

Broodstock Size/Natural Population Size: An average of 1,120 adult coho salmon were trapped and 161 females were spawned during the brood years 1991 to 2000 (Hiser 1993-95, Rushton 1996-2002a). Coho salmon runs in the Klamath River Basin have been greatly diminished and are now largely composed of hatchery fish (CDFG 1994).

Subsequent Events

Recent Events: All coho salmon have been marked with a left maxillary clip since 1995. Hatchery and naturally spawned fish are used in the broodstock in proportion to that which return to the hatchery (CDFG/NMFS 2001).

Relationship to Current Natural Population: Data not available.

Current Program Goals: The hatchery coho salmon production goals are 75,000 yearlings raised to 1020/lb and released from March 15 to May 1 (CDFG/NMFS 2001).

Population Genetics: Allozyme data indicate that there is little genetic structure in California and Oregon coho salmon, but a Northern and a Southern group are apparent (Weitkamp et al. 1995). Iron Gate Hatchery samples fall within the Northern group, but are not uniquely grouped. New microsatellite DNA data for California coho salmon show Iron Gate and Trinity hatcheries grouped closely together as the only Northern samples and distant from other more Southern coho salmon samples (D. Hedgecock pers. comm.).

Morphology/Behavior/Fitness: No data available.

Previous Determination: NMFS (1997) was uncertain about the Iron Gate stock ESU status.

Category and Rationale: Category 2c. Since the late 1970s, the entire broodstock has originated from the Klamath River Basin, and has included some natural origin fish. The current relationship between the hatchery and natural populations in the basin is uncertain, however. The hatchery population may be somewhat diverged from the local natural populations. The pre-1977 introductions of non-local stocks may have also influenced the hatchery stock.

2. STOCK NAME: TRINITY RIVER HATCHERY COHO SALMON (TRINITY RIVER COHO SALMON [CDFG]).

Hatchery/Collection Site: Trinity River Hatchery is located below Lewiston Dam 248 km upriver (CDFG/NMFS 2001). The trap is located at the hatchery.

Broodstock Origin and History

Year Founded: The hatchery was completed in 1963 and the first release of coho salmon was in 1966. Trapping began in 1958.

Source: The Trinity River Hatchery coho salmon broodstock was started using progeny of fish collected at the weir, but Eel River (1965), Cascade (1966-1967, 1969), Alsea (1970), and Noyo (1970) stocks were released as well. Trinity River fish were also released in those years. Only Trinity River stocks have been released from the hatchery since 1970. Trinity River coho salmon has been a very productive program and is often used as a source of coho salmon in other hatcheries throughout California. The same non-local stocks used at the hatchery were also released elsewhere in the Trinity Basin.

Broodstock Size/Natural Population Size: About 3,814 adult coho salmon were trapped during 1991 to 2001, and about 562 females were spawned during brood years 1991 to 2001 (Ramsden 1993-2002). It is commonly assumed that there is little to no natural coho salmon production in the Trinity Basin except for Trinity River Hatchery strays (CDFG/NMFS 2001).

Subsequent Events

Recent Events: All coho salmon are marked starting with the 1995 brood year with a right maxillary clip. Hatchery and naturally spawned fish are used in the broodstock in proportion to that which return to the hatchery (CDFG/NMFS 2001).

Relationship to Current Natural Population: It is commonly assumed that there is little to no natural coho salmon production in the Trinity Basin except for Trinity River Hatchery strays (CDFG/NMFS 2001).[1]

Current Program Goals: The hatchery coho salmon production goals are 500,000 yearlings raised to 10-20/lb and released from March 15 to May 1 (CDFG/NMFS 2001).

Population Genetics: Allozyme data, as mentioned above, indicate little genetic structure for coho salmon in California (Weitkamp et al. 1995). All the Trinity samples are in the Northern group with the two Trinity River Hatchery samples grouped together within the Northern

[1] The hatchery category for this hatchery was influenced by the assumption that there is no natural production in the Trinity River. However, more recent information suggests that perhaps about 10% of the total production in the Trinity River is natural production (S. Witalis pers. comm.; W. Sinnen pers. comm. as cited in CDFG 2002). Reevaluation in light of this new information might result in modification of the NOAA Fisheries hatchery category for Trinity River Hatchery.

group. However, Trinity samples are separate from Deadwood Creek, Trinity River, and Iron Gate Hatchery. The microsatellite data show Iron Gate and Trinity Hatcheries grouped closely together and away from more Southern coho salmon (D. Hedgecock pers. comm.).

Morphology/Behavior/Fitness: No data available.

Previous Determination: NMFS (1997) determined that the Trinity River Hatchery stock was in the ESU, but not essential for recovery. However, it was determined that this hatchery may play an important role in recovery efforts because there appears to be no natural production in the basin.

Category and Rationale: Category 2b. Although this stock has had introductions from non-local sources, since 1970, all of the broodstock has come from the hatchery weir. Genetic evidence does not group Trinity fish with the recorded source populations, suggesting that these introductions may have had little influence on the current stock. The relationship between the hatchery stock and any remaining natural populations in the basin is uncertain, but because of extensive hatchery straying, there is little reason to believe that there is substantial divergence between the natural and hatchery populations.

3. STOCK NAME: MAD RIVER HATCHERY COHO SALMON (MAD RIVER COHO SALMON [CDFG]).

Hatchery/Collection Site: Mad River Hatchery is located 20 km upriver near the town of Blue Lake, California (CDFG/NMFS 2001). The trap is located at the hatchery. Since 1995, the trap has been inoperable and all fish entering the hatchery through the ladder have been volunteers.

Broodstock Origin and History

Year Founded: The hatchery opened in 1970 and the first coho salmon were released in 1971.

Source: Mad River Hatchery has used the greatest number of coho salmon broodstocks, both out-of-basin and out-of-ESU, of any Department hatchery. The stock was begun with Noyo broodstock, released in 1970. Fish from the Noyo stock were released from the hatchery for an additional 11 years (1971, 1972, 1975, 1976, 1981, 1985, 1988, 1991, 1993-1994, and 1996). Other stocks released from the hatchery include Alsea (1973), Klamath (1981, 1983, 1986-1989), Klaskanine (1973), Prairie Creek (1988, 1990), Sandy (1980), Green River (1979), Trask (1972), Trinity (1971), and unknown (1977). Darrah Springs used exotic stocks to also release numerous coho salmon into the Mad River during 1960s and 1970s (NMFS 1997).

Broodstock Size/Natural Population Size: About 38 adult coho salmon were trapped from 1991 to 2000, with 16 females spawned during the brood years 1991 to 1999 (Gallagher 1994 a, b, c, 1995; Cartwright 1996-2001).

Subsequent Events

Recent Events: Since the 1998 brood year, trapping operations have averaged 23 fish. The program is undergoing re-evaluation. The 1999 coho salmon brood year was the last raised and was released in March of 2001.

Relationship to Current Natural Population: There are no coho salmon abundance estimates for the Mad River, but juveniles are widely distributed throughout the basin (NMFS 2001).

Current Program Goals: The hatchery is California's only supplementation hatchery. Its coho salmon production goal before ending the program was 250,000 yearlings raised to 8-10/lb and released from March to May (CDFG/NMFS 2001).

Population Genetics: Hjort and Schreck (1982) evaluated a number of coho salmon hatchery stocks based on one locus. The Mad River Hatchery clusters separately from Iron Gate and Trinity hatcheries.

Morphology/Behavior/Fitness: No data available.

Previous Determination: NMFS (1997) determined that the Mad River Hatchery stock was not in the ESU.

Category and Rationale: Category 4. The program has a large, and recent, use of out-of-basin and out-of-ESU broodstock. The program has been ended and this decision only considers coho salmon that returned during 2002.

4. STOCK NAME: NOYO RIVER FISH STATION COHO SALMON (NOYO COHO SALMON [CDFG])

Hatchery/Collection Site: The Noyo River Egg Station is located on the South Fork Noyo River within the Jackson State Demonstration Forest 17 km inland of Fort Bragg (Jones 2001). Fish are spawned at the station, but incubated and raised at a number of Department facilities, most commonly Mad River Hatchery, Don Clausen Fish Hatchery, and Silverado Fish Transfer Station. Coho salmon are imprinted at the Noyo Station for a minimum of two weeks before release.

Broodstock Origin and History

Year Founded: The site was originally constructed as a research facility in 1961, but egg-taking activities were initiated immediately.

Source: There are no records of broodstock from other locations being used at Noyo. The Noyo program has been very successful. Introductions into other watersheds using Noyo fish have been extensive. Marking has been sporadic, but when available, hatchery fish are excluded from the broodstock. Out-of-ESU coho salmon have been planted in the Noyo River, including Alsea (Oregon Coast ESU) and Klaskanine (Lower Columbia River ESU) fish.

Broodstock Size/Natural Population Size: There was an average of 524 fish trapped from 1991 to 2001 and 100 females spawned in brood years 1991 to 2001 (Grass 1992-2002). However, in 1998 and 1999, only 16 and 85 fish were trapped. There are no coho salmon abundance estimates for the Noyo River, but juveniles are widely distributed and abundant throughout the basin (NMFS 2001).

Subsequent Events

Recent Events:

Relationship to Current Natural Population:

Current Program Goals: The program's goal is to develop a minimum sustained escapement to the South Fork Noyo River of 1,500 adult coho salmon annually. To reach this goal, the program target is 75,000 smolts released from March to April each year (Hunter 1987).

Population Genetics: Microsatellite data show Noyo samples clustering tightly with other coho salmon stocks south of the Eel River (D. Hedgecock pers. comm.).

Morphology/Behavior/Fitness:

Previous Determination: NMFS (1997) determined that the Noyo River Hatchery stock was in the ESU, but a final decision was deferred.

Category and Rationale: Category 2a. The stock founded several decades ago from local collections, and there have been no out-of-basin stocks introduced into the broodstock over its history. An unknown but probably no more than moderate proportion of naturally spawned fish have been included into broodstock ever year.

5. STOCK NAME: DON CLAUSEN HATCHERY COHO SALMON (WARM SPRINGS COHO SALMON [CDFG]).

Hatchery/Collection Site: The Don Clausen Fish Hatchery is located on Dry Creek at the base of Warm Springs Dam, 71 km upstream from the mouth of the Russian River. The trap is at the hatchery.

Broodstock Origin and History

Year Founded: The hatchery went into service in 1980. The first releases were in 1981.

Source: Noyo River coho salmon were heavily planted into the Russian River. The program was considered unsuccessful and ended in 1996. Starting in 2001, a captive broodstock program was initiated. Fish for the captive broodstock program are obtained by electrofishing 300 to 600 juveniles from the Green Valley and Mark West Springs Creeks (Russian River Basin), or the Olema and Redwood Creeks (Marin County) if necessary (NMFS 2002a).

Broodstock Size/Natural Population Size: From 300 to 600 juveniles will be taken from the Russian River, or failing that, the Lagunitas-Olema system. No population estimates are available for the Russian River Basin, but fish are rare and only occur consistently in Green Valley Creek (NMFS 2002a).

Subsequent Events

Recent events: In 2001, 337 juvenile coho salmon were taken from Green Valley and Mark West Springs Creeks (Russian River Basin), and Olema Creek to initiate the captive broodstock program (NMFS 2002a).

Relationship to Current Natural Population:

Current Program Goals: The captive broodstock program proposes to release 50,000 fingerlings and 50,000 yearlings into five Russian River streams.

Population Genetics: Allozyme data show Willow Creek, Russian River, grouping with the Southern cluster, closest to the South Fork of the Eel River (Weitkamp *et al.* 1995). Newer microsatellite data show the previous hatchery closely related to the Noyo River and Lagunitas Creek samples (D. Hedgecock pers. comm.)

Morphology/Behavior/Fitness.

Previous Determination: There has been no previous NMFS consideration of the new Don Clausen captive broodstock hatchery program.

Category and Rationale: Category 1a. This stock is recently founded from a native natural population.

6. STOCK NAME: KINGFISHER FLAT (BIG CREEK) HATCHERY COHO SALMON (SCOTT CREEK COHO SALMON [MBSTP]).

Hatchery/Collection Site: Kingfisher Flat Hatchery is located on Big Creek, a tributary of Scott Creek, 6 RM from the mouth. This hatchery takes on increased importance because it is the

Southern extent of coho salmon's range. Broodstock are taken by divers netting adults usually in Big Creek below the hatchery. However, this can also occur throughout the Scott Creek system (NMFS, draft biological opinion).

Broodstock Origin and History

Year Founded: The Monterey Bay Salmon & Trout Program (MBSTP) started the Kingfisher Flat hatchery in 1975, but it was not in operation until 1982. California State hatchery activity near this site has a long history back to 1904 (Strieg 1991). Due to flood damage, the State hatchery program ended in 1942. There was also a nearby ocean-ranching operation, SilverKing Oceanic Farms, at Waddell Creek and the San Lorenzo River from the 1960s until the early 1980s.

Source: Since 1976, when the MBSTP took over operations, there have been no out-of-basin fish introduced into Scott Creek. Since then, broodstock have been taken by nets in Scott Creek. All coho salmon are marked. No hatchery fish are used in spawning unless minimum goals are not met. Mating occurs in a factorial protocol. Prior to 1942, when there was a State hatchery, there were widespread introductions of broodstock from within California, including Mt. Shasta (1913, 1915, 1917, 1928, and 1937), Ft. Seward (1930, and 1932), and Prairie Creek (1933, 1934, 1936, 1938, and 1941) hatcheries. This stock was considered an extremely healthy one and was widely planted throughout the State's coastal streams. During the Silver-King operation, broodstock was obtained from Oregon, Washington, British Columbia, and Alaska.

Broodstock Size/Natural Population Size: Up to 30 females and 45 males can be taken with the restriction that the first 10 spawning pairs to be observed must be undisturbed. Then, only one out of four females may be taken to insure natural spawning. However, in recent years, few to no fish have been taken for spawning due to low abundance. However, in 2001, 123 coho salmon were observed and 26 wild females were taken for spawning. Of the remaining 97 coho salmon, 43 were marked. There are no abundance surveys, but coho salmon are well distributed within the Scott Creek basin (NMFS, Draft BO).

Subsequent Events

Recent Events: Starting in 2002, a captive broodstock program for Scott Creek was initiated at the NMFS Santa Cruz Laboratory. The 2001 returning coho salmon numbers to Scott Creek were estimated to be well over 300. The hatchery staff handled 109 females (26 wild) and 123 males (36 wild).

Relationship to Current Natural Population:

Current Program Goals: The goal is to spawn 30 unmarked females and 45 unmarked males to obtain approximately 60,000 eggs (NMFS 2002b).

Population Genetics: Microsatellite data show Scott Creek samples, including Big Creek Hatchery samples, clustering tightly together as a branch of the Central California group (D. Hedgecock pers. comm.).

Morphology/Behavior/Fitness:

Previous Determination: NMFS (1996) determined that the Kingfisher Flat Hatchery stock was in the ESU, but a final decision was deferred.

Category and Rationale: Category 1a. There have been no introductions into the watershed in the last 30 years and, in most years, the broodstock has consisted substantially or entirely of wild fish.

PRINCIPLES OF HATCHERY OPERATION IN SUPPORT OF COHO SALMON RECOVERY

To minimize the loss of both overall and adaptive genetic diversity in existing coho salmon populations with hatchery influence, incorporation of conservation strategies in hatchery operations should include comprehensive genetic analyses to detect inbreeding, outbreeding, and domestication selection, and rearing and release techniques that maximize fitness and reduce straying. All aspects of hatchery operations that affect the health and survival of both hatchery and natural fish should be rigorously monitored and evaluated to maximize the probability of long-term success.

Coho salmon production facilities should operate according to the following principles in support of recovery of coho salmon:

1. Justification for coho salmon hatchery production should be based on the best scientific information and be consistent with recovery goals.
2. Hatcheries should not impede recovery of coho salmon.
3. Hatcheries should:
    a. conserve the full range of existing genetic diversity of the run;
    b. not affect morphological, physiological, ecological, reproductive, or behavioral features of coho salmon that reduce fitness; and
    c. not negatively affect any endemic natural populations in the streams where hatchery fish are released.
4. Hatchery operations and monitoring should be managed in support of recovery using the best scientific information.
5. Hatcheries should as much as possible be managed to meet mitigation requirements, while avoiding further degradation of natural coho salmon production and impediments to recovery.
6. Department and Commission policies should focus on natural stocks as the basis of California's salmon production.
7. All artificially produced coho salmon should continue to receive an external mark along with any other marks or tags deemed necessary to effectively monitor and evaluate the effect of the hatchery program on recovery. Marking facilitates broodstock management and identification of all hatchery-origin coho salmon for monitoring.
8. Hatchery monitoring and evaluation plans should be designed to measure the effect of hatchery production on coho salmon recovery.
9. Hatchery management and operations should address Tribal Trust, Department/NOAA Fisheries Hatchery Recommendations, and Hatchery and Genetic Management Plans while maximizing attainment of recovery goals for coho salmon.
10. Coho salmon hatcheries should be managed to maintain Tribal fisheries to the maximum extent possible, while still attaining recovery goals.
11. Prior to the establishment of conservation programs, all hatcheries will be required to develop Hatchery and Genetic Management Plans.
12. Research is an appropriate secondary objective for a coho salmon hatchery, especially for research that addresses coho salmon recovery relative to hatchery operations.

13. Coho salmon hatcheries should operate in a way that maximizes the effective population size of the hatchery and hatchery + natural populations while at the same time preserving existing adaptive variation, within-population diversity, and between-population diversity.
14. Small rearing programs have traditionally produced coho salmon throughout their range in California. These programs should be consistent with the recovery guidelines presented here.

MONITORING AND EVALUATION RECOMMENDATIONS

Concurrent hatchery and recovery programs can only be successful with appropriate monitoring to estimate the contribution of artificially propagated fish to the natural population during the supplementation process, and to monitor genetic characteristics of the natural and hatchery populations. At the same time, habitat assessments and baseline monitoring and evaluation of the physical and biological components of the ecosystem are necessary to monitor quality and quantity in the receiving environment. These important tools provide a means to evaluate ways of improving hatchery activities and increase the chances of successful recovery efforts.

In order to effectively monitor the effects of current and future coho salmon artificial propagation on recovery of coho salmon, the Hatchery Working Group recommends that the Department work toward establishing or maintaining the following management, monitoring, and evaluation elements:

1. Obtain accurate adult censuses of natural- and hatchery-origin coho salmon whenever possible, including hatchery contribution to natural spawning, elucidate interactions among hatchery- and natural-origin fish, estimate natural- and hatchery-origin stray rates.
2. Continue and expand efforts to gather up-to-date baseline population genetics data on all natural- and hatchery-origin coho salmon stocks, especially those that have the potential to be affected (positively or negatively) by hatchery production.
3. Use historic and contemporary outmigrant and hatchery marking data to analyze production and outmigration timing of hatchery- and natural-origin stocks. Expand or modify monitoring as necessary to ensure that monitoring meets data needs for effective evaluation of hatchery/natural fish interactions.
4. Develop an overarching plan within the Department, NOAA Fisheries, and Tribal governments for achieving and modifying hatchery goals in the context of recovery of natural coho salmon runs while maintaining Tribal trust obligations to mitigate for lost habitat.
5. Develop a mechanism for proposing modifications to hatchery operations to aid recovery of coho salmon that is inclusive of all affected groups, that recognizes:
   a. the unique responsibilities of the Department's hatchery and biology staff and managers to manage these facilities according to the Department and FGC policies in the public trust;
   b. Federal Tribal trust obligations;
   c. NOAA Fisheries responsibilities under the ESA;
   d. existing agreements, regulations, mitigation obligations, and planning processes; and
   e. CESA requirements and other requirements under law.

6. Modify hatchery operations to actively aid recovery whenever possible and to, at minimum, avoid impeding coho salmon recovery.
7. Actively pursue opportunities to collect data on morphology, physiology, behavior, and ecology of hatchery- and natural-origin coho salmon with the goal of identifying and minimizing any negative fish culture or fish release effects on native, naturally occurring populations of CESA- and ESA-listed salmonids, and their habitat.
8. Continue evaluations of Department hatchery management with the goal of managing hatcheries to maximize natural production and minimize negative effects.
9. Increase broodstock monitoring and management intensity (e.g., genetic management of broodstock, broodstock collection and spawning strategies, rearing and release strategies, evaluation of effective population size) as necessary to a level commensurate with protection of listed stocks.
10. Avoid ecological/behavioral impacts of coho salmon hatchery releases on other endemic species (e.g., Chinook salmon and steelhead).
11. Avoid ecological/behavioral impacts of Chinook salmon and steelhead hatchery releases on coho salmon.
12. Initiate assessment and monitoring of stream and ocean carrying capacity and the relation of hatchery production to density dependent effects, especially density dependent mortality.

SPECIFIC RECOMMENDATIONS

The following specific recommendations were forwarded from the Hatchery Working Group and rely heavily on the Department/NOAA National Marine Fisheries Service Southwest Region Joint Hatchery Review Committee Final Report on Anadromous Salmonid Hatcheries in California (CDFG/NMFS 2001).

Since the hatchery review (CDFG/NMFS 2001) was prepared, more genetic information has become available with which to evaluate natural and hatchery coho salmon stocks in both the CCC Coho ESU and the SONCC Coho ESU (Hedgecock et al. 2003; J.C. Garza pers. comm.). This information and any new information on population genetics will be incorporated into recovery planning as it becomes available.

1. Evaluate the potential of the Noyo Fish Taking Station to develop a role as a research facility due to the putative purity of the stock there and the presence of a barrier at which to collect data and control entry to and exit from the system.
2. Incorporation of recovery strategies for coho salmon in hatchery operations should be consistent with other ongoing planning processes including NOAA Fisheries' ESA recovery planning process, annual reviews of Trinity River Hatchery operations in the context of the Federal Tribal Trust obligation of Trinity River Hatchery, and the re-licensing of the Klamath River Project, including the Iron Gate Dam and Hatchery.
3. The Department, Tribes and NOAA Fisheries should follow through with HGMP plans to consider how or whether the coho salmon program at Trinity River Hatchery should be utilized in the recovery of Trinity Basin coho salmon (CDFG/NMFS 2001). These plans should be based on the most recent popula-

tion genetics and demographic information on the composition of the existing coho salmon run to the basin and the influence of the abundant hatchery stock on the remnant natural stock.

REFERENCES CITED

Cartwright, W. F. 1996. Annual report Mad River salmon and steelhead hatchery, 1995-1996. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Cartwright, W. F. 1997. Annual report Mad River salmon and steelhead hatchery, 1996-1997. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Cartwright, W. F. 1998. Annual report Mad River salmon and steelhead hatchery, 1997-1998. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Cartwright, W. F. 1999. Annual report Mad River salmon and steelhead hatchery, 1998-1999. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Cartwright, W. F. 2000. Annual report Mad River salmon and steelhead hatchery, 1999-2000. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Cartwright, W. F. 2001. Annual report Mad River salmon and steelhead hatchery, 2000-2001. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

CDFG (California Department of Fish and Game). 1994. Petition to the Board of Forestry to list coho salmon (*Oncorhynchus kisutch*) as a sensitive species. CDFG, Sacramento, CA. 110 p.

CDFG. 2002. Status Review of California Coho Salmon North of San Francisco. Report to the California Fish and Game Commission. April, 2002. 336 p.

CDFG/NMFS (California Department of Fish and Game/National Marine Fisheries Service) Joint Hatchery Review Committee. 2001. Final Report on Anadromous Salmonid Fish Hatcheries in California. Available from Southwest Region, NMFS, Long Beach, CA. 87 pp.

Gallagher, K. I. 1994a. Annual report Mad River salmon and steelhead hatchery, 1991-1992. California Department of Fish and Game, Inland Fisheries Administrative Report No. 94-3. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Gallagher, K. I. 1994b. Annual report Mad River salmon and steelhead hatchery, 1992-1993. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Gallagher, K. I. 1994c. Annual report Mad River salmon and steelhead hatchery, 1993-1994. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Gallagher, K. I. 1995. Annual report Mad River salmon and steelhead hatchery, 1994-1995. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Garza, J.C., pers. comm. to Russian River Coho Captive Broodstock Hatchery and Genetics Subcommittee, May 5, 2003, Long Marine Laboratory, Santa Cruz, California.

Grass, A. F. 1992. Annual report Noyo River egg collecting station, 1991-1992. California Department of Fish and Game, Inland Fisheries Administrative Report No. 92-14. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Grass, A. F. 1993. Annual report Noyo River egg collecting station, 1992-1993. California Department of Fish and Game, Inland Fisheries Administrative Report No. 93. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Grass, A. F. 1995a. Annual report Noyo River egg collecting station, 1993-1994. California Department of Fish and Game, Inland Fisheries Administrative Report No. 95-4. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Grass, A. F. 1995b. Annual report Noyo River egg collecting station, 1994-1995. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Grass, A. F. 1996. Annual report Noyo River egg collecting station, 1995-1996. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Grass, A. F. 1997. Annual report Noyo River egg collecting station, 1996-1997. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Grass, A. F. 1998. Annual report Noyo River egg collecting station, 1997-1998. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Grass, A. F. 1999. Annual report Noyo River egg collecting station, 1998-1999. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Grass, A. F. 2000. Annual report Noyo River egg collecting station, 1999-2000. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Grass, A. F. 2001. Annual report Noyo River egg collecting station, 2000-2001. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Grass, A. F. 2002. Annual report Noyo River egg collecting station, 2001-2002. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Hedgecock, D., pers. comm. cited in NOAA Fisheries (2003).

Hedgecock, D, M. Banks, K. Bucklin, C. Dean, W. Eichert, C. Greig, P. Siri, P. Nyden, and J. Waters. 2002. Documenting biodiversity of coastal salmon (Oncorhynchus spp.) in Northern California. Final Report. Sonoma County Water Agency contract #TW-99/00-110. 61 p.

Hiser, C. A. 1993. Annual report Iron Gate salmon and steelhead hatchery, 1991-1992. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Hiser, C. A. 1994a. Annual report Iron Gate salmon and steelhead hatchery, 1992-1993. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Hiser, C. A. 1994b. Annual report Iron Gate salmon and steelhead hatchery, 1993-1994. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Hiser, C. A. 1995. Annual report Iron Gate salmon and steelhead hatchery, 1994-1995. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Hjort, R.C., and C.B. Schreck. 1982. Phenotypic differences among stocks of hatchery and wild coho salmon, *Oncorhynchus kisutch*, in Oregon Washington, and California. Fish. Bull., U.S. 80:105-119.

Hunter, B. 1987. Memorandum: Management Goals and Constraints for Noyo River Egg Taking Station. Available from CDFG. 14 p.

Jones, W. 2001. South Fork Noyo River coho salmon egg collecting station. A summary report of 2000-01 operations. Available from the Santa Cruz Laboratory, NMFS, Santa Cruz, CA. 28 p.

NMFS (National Marine Fisheries Service). Draft Biological Opinion cited in NOAA Fisheries (2003).

NMFS. 1997. West Coast Coho Salmon Biological Review Team (BRT). 1997. Status Review Update for Coho Salmon from the Oregon and Northern California Coasts. National Marine Fisheries Service, Seattle, WA.

NMFS. 2001. Status review update for coho salmon (*Oncorhynchus kisutch*) from the Central California Coast and the California portion of the Southern Oregon/Northern California Coasts Evolutionarily Significant Units. Available from the Santa Cruz Laboratory, NMFS, Santa Cruz, CA. 112 p.

NMFS. 2002a. Draft hatchery and genetic management plan for Don Clausen Fish Hatchery. Three sections plus appendices. Available from the Santa Cruz Laboratory, NMFS, Santa

NMFS. 2002b. Endangered Species Act section 7 biological opinion on the issuance of a section 10(a)(1)(A) permit to the Monterey Bay Salmon and Trout Project. Available from the Santa Cruz Laboratory, NMFS, Santa Cruz, CA. 39 p.

NOAA (National Oceanic and Atmospheric Administration) Fisheries. 2003. Draft hatchery broodstock summaries and assessments for chum, coho, and chinook salmon and steelhead stocks within evolutionarily significant units listed under the Endangered Species Act. Salmon and Steelhead Hatchery Assessment Group, Northwest Fisheries Science Center and Southwest Fisheries Science Center. May 12, 2003, 326 p.

Ramsden, G. R. 1993. Annual Report Trinity River salmon and steelhead hatchery, 1991-1992. California Department of Fish and Game, Inland Fisheries Administrative Report No. 93-3. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Ramsden, G. R. 1994a. Annual report Trinity River salmon and steelhead hatchery, 1992-1993. California Department of Fish and Game, Inland Fisheries Administrative Report No. 94-4. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Ramsden, G. R. 1994b. Annual report Trinity River salmon and steelhead hatchery, 1993-1994. California Department of Fish and Game, Inland Fisheries Administrative Report CDFG, 1416 Ninth St., Sacramento, CA 95814.

Ramsden, G. R. 1995. Annual report Trinity River salmon and steelhead hatchery, 1994-1995. California Department of Fish and Game, Inland Fisheries Administrative Report CDFG, 1416 Ninth St., Sacramento, CA 95814.

Ramsden, G. R. 1996. Annual report Trinity River salmon and steelhead hatchery, 1995-1996. California Department of Fish and Game, Inland Fisheries Administrative Report CDFG, 1416 Ninth St., Sacramento, CA 95814.

Ramsden, G. R. 1997. Annual report Trinity River salmon and steelhead hatchery, 1996-1997. California Department of Fish and Game, Inland Fisheries Administrative Report CDFG, 1416 Ninth St., Sacramento, CA 95814.

Ramsden, G. R. 1998. Annual report Trinity River salmon and steelhead hatchery, 1997-1998. California Department of Fish and Game, Inland Fisheries Administrative Report CDFG, 1416 Ninth St., Sacramento, CA 95814.

Ramsden, G. R. 2000. Annual report Trinity River salmon and steelhead hatchery, 1999-2000. California Department of Fish and Game, Inland Fisheries Administrative Report CDFG, 1416 Ninth St., Sacramento, CA 95814.

Ramsden, G. R. 2001. Annual report Trinity River salmon and steelhead hatchery, 2000-2001. California Department of Fish and Game, Inland Fisheries Administrative Report CDFG, 1416 Ninth St., Sacramento, CA 95814.

Ramsden, G. R. 2002. Annual report Trinity River salmon and steelhead hatchery, 2001-2002. California Department of Fish and Game, Inland Fisheries Administrative Report CDFG, 1416 Ninth St., Sacramento, CA 95814.

Rushton, K. W. 1996. Annual report Iron Gate salmon and steelhead hatchery, 1995-1996. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Rushton, K. W. 1997. Annual report Iron Gate salmon and steelhead hatchery, 1996-1997. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Rushton, K. W. 1998. Annual report Iron Gate salmon and steelhead hatchery, 1997-1998. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Rushton, K. W. 1999. Annual report Iron Gate salmon and steelhead hatchery, 1998-1999. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Rushton, K. W. 2001. Annual report Iron Gate salmon and steelhead hatchery, 1999-2000. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Rushton, K. W. 2002a. Annual report Iron Gate salmon and steelhead hatchery, 2000-2001. California Department of Fish and Game, Inland Fisheries Administrative Report. CDFG, 1416 Ninth St., Sacramento, CA 95814.

Streig, D. 1991. History of fish cultural activities in Santa Cruz County with special references to Scott and Waddell creeks. Monterey Bay Salmon and Trout Project. Davenport, CA. Available from the Santa Cruz Laboratory, NMFS, Santa Cruz, CA. 24 p.

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope, and R.S. Waples. 1995. Status review of coho salmon from Washington, Oregon, and California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-24, 258p.

Appendix H Recommended Guidelines for Recovery Hatcheries

Table of Contents

RECOMMENDATIONS FOR DEPARTMENT POLICY ON RECOVERY HATCHERIES FOR COHO SALMON H.2

GUIDELINES FOR ESTABLISHMENT AND OPERATION OF RECOVERY HATCHERY PROGRAMS H.5

ESSENTIAL PROGRAM ELEMENTS AND OPPORTUNITIES FOR DEVELOPMENT OF A HATCHERY RESEARCH PROGRAM H.10

PROGRAM MONITORING H.11

PROGRAM DURATION, CLOSEOUT GUIDELINES, CONTINGENCY AND EMERGENCY CLOSEOUT PLANS, AND DISPOSITION OF UNUSED BROODSTOCK H.12

REFERENCES CITED H.12

List of Figures and Tables

TABLE H-1: Decision guidelines for establishing a recovery hatchery program (after NMFS 1999 with modification) H.6

TABLE H-2: General guidelines for operation of a recovery hatchery H.8

FIGURE H-1: Flow chart depicting simplified decision rules for exploring whether a coho salmon recovery hatchery may be an appropriate recovery tool H.7

List of Attachments

ATTACHMENT 1: Glossary H.14

ATTACHMENT 2: Participants on the Hatchery Working Group of the California Coho Salmon Recovery Team and Department reviewers H.16

ATTACHMENT 3: Sections of the 2003 Fish and Game Code relevant to the establishment and operation of recovery hatcheries for anadromous salmonids H.17

ATTACHMENT 4: California Fish and Game Commission policies relevant to the establishment and operation of recovery hatcheries H.23

ATTACHMENT 5: Table 4 from Reisenbichler et al. 2003 . . . . . H.26

INTRODUCTION

Many coho salmon runs in California have experienced local extinction, fragmentation, and brood-year extinction, or are at such low apparent abundance that they are judged at high risk of extinction (Bryant 1994, Weitkamp et al. 1996, CDFG 2002, NOAA Fisheries 2003). Ideally, natural recolonization or supplementation by similar nearby stocks is preferable to using hatchery stocks to recover these runs (Reisenbichler et al. 2003). However, extremely depleted stocks and ESA and CESA listings of many California salmon populations have made it necessary for the Department to evaluate the use of specialized anadromous fish hatchery programs along with extensive monitoring to help meet certain recovery goals. In some of these extreme cases the risks posed by releasing relatively small numbers of hatchery fish from well defined programs focused on recovery are acceptable. Still, the Department considers captive broodstock and recovery supplementation projects to be unproven last-chance efforts to protect and recover severely reduced and imperiled populations. The small number of projects that exist have not shown conclusively that they are able to rehabilitate depleted runs or establish recolonized runs. The evidence of whether hatchery fish can reliably establish natural runs is mixed and the results of hatchery introductions are unpredictable (see review in CDFG 2002). Therefore, it is prudent that recovery hatcheries only be employed when all other means of coho salmon recovery have been exhausted or when extirpation is imminent. The Department does not consider recovery hatchery programs a substitute for habitat improvement and improvement of natural salmon production.

The following definitions of hatcheries are used in this section (also see Attachment 1: Glossary). These are the same definitions used in the status review of coho salmon North of San Francisco in CDFG (2002). There may be some confusion over what is intended by some terms; for example, the term “supplementation” for some people may equate to what we call “enhancement” in this section. This section deals only with recovery hatcheries (translocation of adults to spawn in another place, or of naturally produced juveniles, while they may be considered at some time, are not considered in this document[1]). Modification of existing hatcheries to include a conservation ethic will be discussed in a separate section. Note that success criteria for each of the following are different.

- *Supplementation hatcheries* are intended to contribute to the natural spawning population (primary success criterion is recruitment to spawner population).
- *Mitigation hatcheries* are intended to make up for reductions in natural spawning due to human-caused habitat loss (e.g. dam construction; primary success criterion is replacement of lost production).
- *Enhancement hatcheries* are intended to improve a fishery by increasing the number of catchable fish in the ocean or stream (primary success criterion is recruitment to a fishery).

[1] Natural colonization/supplementation, when feasible, should have priority over hatchery intervention. Recovery hatcheries should only be employed in extreme cases. Translocation of young-of-the-year coho salmon to a watershed where coho salmon have experienced extinction should be explored prior to establishment of a recovery hatchery.

- *Recovery hatcheries* are experimental programs intended to supplement depressed natural populations or provide fish for artificial recolonization of streams that have experienced local or brood-year extinctions, to maintain genetic diversity within and among stocks, and to conserve valuable or rare genes and genotypes. They may, or may not, rely on captive broodstock to accomplish these goals. Recovery hatcheries attempt to minimize or eliminate negative effects common to fish culture, resulting in as close to wild fish as possible (primary success criteria are increased abundance of spawners and/or outmigrants, lowered risk of extinction, recolonization of a self-sustaining population, and/or brood-year reconstruction, while avoiding negative hatchery impacts as much as possible).

California has only five current coho salmon artificial propagation programs (Table H-1). Two of these, Big Creek Hatchery and Don Clausen/Warm Springs Hatchery are currently operated as recovery hatchery programs for coho salmon. Only two other anadromous salmon recovery hatchery programs exist in California; both produce winter-run Chinook salmon. The USFWS operates a recovery supplementation program and, in cooperation with U.C. Davis' Bodega Marine Laboratory,[2] a captive broodstock program for winter-run Chinook salmon at Livingston Stone National Fish Hatchery located at the base of Shasta Dam on the Sacramento River. Trinity River and Iron Gate Hatcheries are mitigation facilities. Noyo Egg Taking Facility and, to a much lesser extent Big Creek Hatchery, are intended to provide fishery enhancement.

RECOMMENDATIONS FOR DEPARTMENT POLICY ON RECOVERY HATCHERIES FOR COHO SALMON

The Hatchery Working Group of the CRT and reviewers in the Department (Attachment 2) developed the following recommendations for policies that concern the establishment, operation, and closure of recovery hatcheries for coho salmon. The recommendations were developed using the best available scientific information, and are consistent with the Fish and Game Code sections relevant to hatcheries for anadromous salmonids (Attachment 3), the California Endangered Species Act (CESA), and Fish and Game Commission (Commission) and Department anadromous fish policies (Attachment 4). Although these policy recommendations are specific to coho salmon recovery, they apply equally well to any recovery hatchery for recovery of anadromous salmonids, and we recommend that they be used as guidance for any recovery hatchery.

The following policies should be applied to all coho salmon recovery hatcheries.

1. The purpose of a recovery hatchery as defined in this section is to aid and/or accelerate recovery of coho salmon by reducing risk of extinction due to one or more of a number of factors that result from low abundance, cohort failure, and/or drastic population fluctuation. The focus of a recovery hatchery is to reduce extinction risk and improve natural production in accordance with Department, Commission, and Federal Endangered Species Act (ESA) policies.
2. The Department considers recovery hatchery programs for the purpose of restoring natural runs of salmon to be unproven. The number of facilities

[2] Originally this project was done in cooperation with both U.C. Davis' Bodega Marine Laboratory in Bodega Bay, and Steinhart Aquarium in San Francisco. However, cooperative elements at Steinhart Aquarium have recently been phased out of the program.

should be limited to that which is necessary to meet identified coho salmon recovery needs. The number of facilities should be sufficient to meet recovery needs, but small enough to ensure that agencies can effectively coordinate recovery at the ESU and range-wide level, maintain connectivity and communication among programs, resource agencies, and the public, promote efficient use of resources, and avoid overproduction of hatchery-origin coho salmon. The number of facilities should be scaled to avoid redundancy and to ensure that recovery is not disproportionately reliant on hatchery-origin coho salmon.

3. In accordance with items 1 and 2 above, recovery hatchery operations will avoid excess hatchery production above that which is deemed necessary by the Department and NOAA Fisheries to meet recovery goals. The number of fish produced should be sufficient to significantly reduce the probability of extinction, accurately represent the genetic variation in the natural population, minimize random or directional genetic change in captivity, and to re-establish a self-sustaining natural run.
4. In all cases, recovery hatchery operations should be subsequent to or concomitant with active and focused habitat improvements designed to increase natural production with the ultimate objective of reaching recovery goals.
5. All recovery hatchery programs must be part of and integral to the overall plan for recovery of coho salmon at the ESU and range-wide levels.
6. All recovery hatchery programs must be consistent with CESA and ESA.
7. Recovery hatchery programs should have a planned, finite, and short-term lifespan. Ideally the life of a recovery hatchery program would be only 1-3 generations. However, the Department recognizes that unique elements of coho salmon life-history may necessitate longer-term projects on the order of 3-4 generations to accomplish difficult tasks like rebuilding missing year classes or repopulating locally extinct runs. In such cases, the life-span of the recovery hatchery should be the minimum amount of time consistent with reaching specific project goals.
8. All operations should be continually assessed and modified to avoid establishment of a hatchery-dependent run in which the hatchery persistently acts as the source in a source-sink relationship with the natural run; A comprehensive risk/benefit analysis will be prepared prior to the establishment of any new recovery hatchery operation.
9. Recovery hatcheries must be operated in a way that protects naturally recovering coho salmon populations from the possible adverse biological and monitoring effects of inadvertent hatchery influence, especially those populations specifically targeted for natural recovery and nearby populations that are not targets of hatchery-based recovery efforts.
10. Recovery hatchery operations should be done in a way that protects all existing populations of native salmonids and other native fish already living in the receiving ecosystem. An assessment (e.g., identification of species composition, size, and density measurement) should be done to determine if there will be impacts (e.g., competition, predation, niche partitioning) to fish already present.
11. Hatchery releases should be based on the receiving ecosystem's carrying capacity. Conservation/recovery hatchery programs should only be approved in

places where guideline conditions are met and habitat is not a limiting factor for the existing natural stock, where unused habitat is demonstrably available, and where competition and other negative ecological interactions between natural- and proposed hatchery-origin stock can be avoided or are minimal. Habitat availability includes demonstrably consistent connectivity of spawning habitat, rearing habitat, and corridors for migration under current conditions. In special cases, exceptions may be made for places where necessary habitat improvements are obvious, relatively easy to do in a short time, and have a high probability of substantially improving a stream's ability to support coho salmon. In these cases, recovery hatchery construction may be conditionally approved with the condition that substantial progress is made toward habitat improvement prior to releasing fish. Requiring suitable habitat increases the probability of success of supplementing natural runs and will avoid creating unwanted hatchery-dependent runs.

12. Recovery hatchery programs should be located to maximize recolonization potential of nearby depleted streams through natural metapopulation processes, while attempting to avoid circumventing natural patterns of reproductive isolation among populations.

13. Existing facilities should be used for recovery actions before constructing new ones for efficiency and to concentrate scarce resources. However, the Department recognizes that in many cases existing production facilities that were designed for a very different purpose will require substantial modification to meet recovery hatchery needs.

14. When considering the establishment of new facilities, coordinated efforts that are consistent with, and integral to, the overall recovery plan and involving active participation of State, Federal, and Tribal resource agencies, watershed groups, or stakeholder groups, will be preferred to isolated projects. Interagency and intergroup coordination is a necessary feature for establishing and operating a recovery hatchery and recovery hatchery program. Development of MOAs among participants for recovery hatchery programs should be required.

15. Guidelines presented in this section will be used by the Department along with any other appropriate information and decision-making processes to determine whether a recovery hatchery program is needed, what general kind of operation it should be, and how to operate, monitor, report, and decommission the facility. Guideline criteria should be evaluated at the population level, not on a stream or watershed basis, to ensure that hatchery operations are consistent with population viability and Federal/State recovery goals.

16. Recovery hatchery programs should have detailed operating plans, including emergency and decommission plans prior to the beginning of operations. Plans should carefully define the intended geographic scope of the project (e.g., run, watershed, region, ESU). These plans should include provisions for adaptive management.

17. Steering committees or technical advisory groups consisting of teams of technical experts and management staff should be be established to advise and assist in the operation of each facility. These committees must include at a minimum representatives of the appropriate Federal, State, and Tribal resource

agencies (including, but not limited to, NOAA Fisheries, CDFG, and, in some cases, USFWS and/or Tribal Fisheries Agencies), permitting agencies, and the permittee. Inclusion of other technical and management personnel to meet specific advisory needs should be included as necessary and appropriate. An independent committee of conservation professionals in specific areas of expertise (e.g., genetics, population viability, ecology) should be established for consultation on highly technical issues. Final decisions concerning hatchery operations are the responsibility of the Federal and State permit holder operating the facility, and will be done in accordance with permit conditions while striving to meet coordinated recovery goals.

18. Research on topics that aid or accelerate recovery is an appropriate secondary use for recovery hatchery programs and their products.
19. The Department will coordinate with NOAA Fisheries on the establishment and operation of recovery hatchery programs.
20. Appropriate Federal and State permitting is required prior to the operation of any recovery hatchery or recovery hatchery program.

GUIDELINES FOR ESTABLISHMENT AND OPERATION OF RECOVERY HATCHERY PROGRAMS

The Working Group developed guidelines for the use of captive broodstock and/or recovery supplementation as an integrated tool for coho salmon recovery. The following research and guidance documents were influential in the development of the guidelines: Hard et al. 1992, CDFG undated, Weitkamp et al. 1996, Busby et al. 1996, Myers et al. 1998, Waples 1994, NMFS 1999, Flagg and Nash 1999, CDFG/NMFS 2001, NMFS 2003, and Reisenbichler et al. 2003. For example, see Attachment 5 for relevant information from Reisenbichler et al. (2003).

Table H-1 contains guidelines for conditions under which some type of recovery hatchery program for coho salmon may be appropriate. The guidelines describe conditions regarding abundance, brood-year cycle, uniqueness relative to other populations, carrying capacity and productivity, potential for natural recolonization, and value. Meeting any of these criteria is suggestive that a recovery hatchery program may be appropriate as a component of a recovery strategy. Using these guidelines along with the policies identified in this section, the Department can decide on which programs will best address coordinated recovery needs.

Figure H-1, which also cites Table H-2, shows a simplified flow chart that can be used in the initial phases of determining whether a recovery hatchery should be contemplated as a recovery tool.

Identification of reproductively isolated populations is essential to maintaining existing patterns of diversity in coho salmon. The Department should use any and all information on patterns of reproductive isolation to identify populations including results arrived at through NOAA Fisheries Recovery planning process, population genetics data currently in development, geographic data, ocean distribution data, mark data, phenotypic data (e.g., run timing, age structure, outmigration timing, size and growth), and any other data deemed appropriate.

Establishment of a recovery hatchery should require that a coho salmon population be a component of an ESU listed as endangered, or that it meet the strict guidelines presented in this section. Recovery hatcheries should be minimally employed, if at all, in the SONCC Coho ESU, but may be more appropriate for use in the CCC Coho ESU.

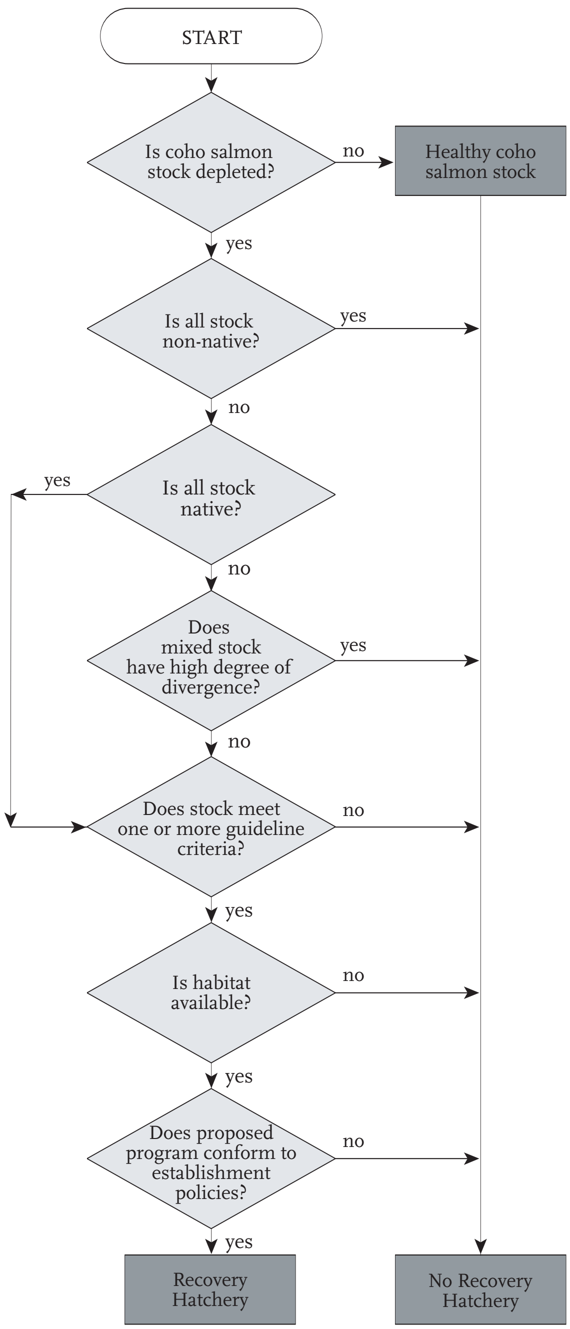
TABLE H-1: Decision guidelines for establishing a recovery hatchery program (after NMFS 1999 with modification)[1]

CATEGORY	GUIDELINES	TYPE OF PROGRAM INDICATED
Abundance [2]	Very low abundance OR Low abundance and declining OR Moderate abundance and precipitous decline OR Low to moderate average abundance and high amplitude of population fluctuation that frequently includes zero OR Little or no natural production over at least one generation (3 years)	CB, RS, G
	Low abundance relative to available habitat and production capacity	CB, RS
Brood-year cycle	Two of three brood years are consistently missing or extremely weak	CB, G
Uniqueness relative to other populations	Evidence of unique genetic qualities and meets one or more or the abundance or brood-year cycle criteria	CB, RS, G
	Unique adaptations to specific local conditions and meets one or more or the abundance or brood-year cycle criteria	CB, RS, G
Carrying capacity and productivity	Population has unrealized potential for high productivity in the currently available habitat in comparison to other populations in the ESU due to consistently lower than supportable population size or chaotic population size fluctuation	RS
Potential for natural recolonization	Historically present but currently extinct, good measured habitat is available AND Potential for natural recolonization is low	CB, G
Value	Unique social, economic, or cultural value, including unique importance to Tribal society, economy, or culture AND meets one or more of the abundance or brood-year cycle criteria	CB, RS, G

NOTES:

1. Meeting any of these criteria indicates that a captive broodstock program (CB), a recovery supplementation project (RS), a cryopreservation project (G), or some combination, as integrated elements of the recovery plan might aid or accelerate recovery. The population must have been judged to be at high risk of extinction in the immediate future as a prerequisite to establishing a captive broodstock program. Application of these guidelines assumes that there is good evidence that habitat is currently available, including viable connections between spawning areas, rearing areas, and the ocean.
2. Based on population size which may include more than one stream or watershed.

FIGURE H-1: Flow chart depicting simplified decision rules for exploring whether a coho salmon recovery hatchery may be an appropriate recovery tool



Refer to Table H-2 for specific guidelines, and to the text for specific establishment policies. (After Flagg and Nash 1999 with modifications.)

TABLE H-2: General guidelines for operation of a recovery hatchery program. Individualized operations plans for each project should be designed in consultation with resource agencies and steering committees and in accordance with permit conditions.

ISSUE	GUIDELINES
Source populations for broodstock	Best guidance is to rely on results of recent population genetic analyses and life history data to find the most similar stock (i.e., a stock with the same ancestral lineage) to the target stock. Nearby stocks are the most likely candidates for reintroductions, but genetic analyses should be used to verify their suitability. Donor stocks should be from streams that are ecologically similar to the receiving system to increase the likelihood that they are well adapted to it. Donor stocks should have similar pattern of within-population genetic diversity to extant populations to ensure a basis for adaptive response to environmental change.
	If target population is very small, consider taking all available representatives of the population into the hatchery. But, only if the risk to the population by bringing it into the hatchery is less than that in the stream with habitat restoration.
	If a portion of the adult run is collected as broodstock, collect them throughout the spawning season in proportion to the natural run.
	If a portion of the juvenile population is collected as broodstock, design the collection protocol to avoid collecting large numbers of closely related individuals, e.g., collect from several locations at several times during the natural outmigration period. Also avoid mixed collections consisting of juveniles from more than one population.
	Limit the proportion of hatchery fish contribution to broodstock to ≤10% of total OR Avoid hatchery fish contribution to broodstock.
Spawning	Spawn captive broodstock only during the natural spawning season.
	Spawn as many adults as possible using single pair matings or from 2-4 males per female.
	Attempt to equalize family size to maximize effective population size (may be best accomplished during rearing).
	Use cryopreserved sperm as appropriate to create desired effects, but take care to balance with reduced viability especially with small numbers of available eggs.
	Consider induced spawning or photoperiod manipulation to maximize the number of captive brood-stock spawners available during the natural spawning season.
	If juveniles are used as a broodstock source, determine relatedness among individuals using genetic analysis prior to spawning and use this information to avoid inbreeding.
	Use genetics data as much as possible to avoid inadvertent hybridization in the hatchery.
	Monitor readiness to spawn using best available technologies (e.g., ultrasound).
	PIT tag broodstock to individually identify them.
Fish rearing	Avoid direct human contact with fish that are to be released to the wild whenever possible, e.g., use automatic feeders instead of feeding by hand.
	Consider multiple rearing locations to spread risk in case of catastrophe.
	Control or eliminate disease outbreaks before they occur, manage if they do. Consider whether inoculations are appropriate standard operating procedure.
	Separate family groups as much as possible during rearing and carefully record the composition of groupings.
	Develop redundant systems to avoid loss of broodstock or their progeny.
	Attempt to mimic natural conditions as much as possible, especially for fish that will be released.
	Water supplies should be free of pathogens and predators.
	Determine whether and how both fresh and salt water should be used in the program, and carefully manage and document transitions of fish from one to the other.
	Attempt to equalize parental contribution to maximize effective population size.

(continued)

TABLE H-2: General guidelines for operation of a recovery hatchery program (continued)

ISSUE	GUIDELINES
Release protocols	Release juvenile fish as early as possible to attempt to avoid domestication. However, this issue may not be easy to resolve because other options may be more attractive for a given program. Considerations should be given to the tradeoffs between return rate, release size, and fitness (see Reisenbichler et al. 2003, Table 4, in Attachment 2 for a review). A combination of life-stage release strategies is also worth considering, although combinations may significantly complicate monitoring.
	Attempt to release juveniles at the same size as the natural fish to improve the chances that the hatchery and natural fish will have similar life histories related to size at outmigration. Hatchery capacity and cost may be a factor in life stage at release (i.e., releasing smolts may cost more and use up more space for a longer time than releasing fry).
	Release into stream at the place you want them to return, possibly after an imprinting period if the release location is not in the same place as the rearing location Release number should be scaled with carrying capacity to avoid possible increases in density dependent mortality of both natural and hatchery fish when carrying capacity is approached.
	Releasing juveniles in one location may be preferable to scattered releases to exploit the functional response of predators and to assure adequate returns to at least one location. However, scattered releases may be better for stocks that tend to hold in place for a while or residualize.
	Minimize stress associated with handling and transportation.
	Screen all fish for disease before release.
	Transport fish for release in more than one truck, or transport in more than one trip, to spread the risk in case of accident.
	Release protocols should avoid or minimize negative ecological interactions with conspecific natural fish and with other species.
	Develop a monitoring system for hatchery produced juvenile holding, rearing, and outmigration.

The hatchery working group identified two types of recovery hatchery operations for purposes of this Recovery Strategy: recovery supplementation and captive broodstock. These are best thought of as hatchery program components that can be used together or separately depending on the situation and goals of the recovery project. Recovery supplementation would typically involve spawning returning adults and releasing the progeny to the stream in stages from egg to early-smolt. In most cases, fish would be held only for a short time as adults before spawning and then, possibly, for a short time as juveniles before release. Early release (egg, fry, or fingerling) is preferred because it increases opportunities for natural selection to occur in the stream and decreases the opportunity for domestication selection to occur in the hatchery. Smolt releases should only be employed if the benefit of improved survival (e.g., to offset winter mortality) outweighs the risk of extended hatchery rearing. Recovery supplementation programs would differ from other supplementation programs by the high level of genetic management and monitoring involved, and the goal of producing fish that are as genetically, morphologically, behaviorally, and ecologically similar to naturally produced fish as possible.

Captive broodstock programs would involve capturing fish at one of several points in the life cycle, raising them or their progeny to maturity as broodstock, and spawning them as they mature. Captive broodstock can be implemented purely as insurance against cohort failure or the loss of the entire run, in which fish would not be released unless special conditions were met. Alternatively, captive broodstock could be a component of a recovery supplementation program, in which fish would be regularly released. Cryopreservation of gametes (sperm) provides some needed spawning flexibility, and may allow rebuilding missing year classes. It should be a part of either type of program. Some programs may choose to use all three elements to meet their goals.

Guidelines for operation of a recovery hatchery are shown in Table H-2. The guidelines address four issues: source populations for broodstock, spawning, fish rearing and release protocols. These are general guidelines that can be developed in greater detail based on the specific needs of each project.

Population genetics data (e.g., amount of within-population diversity, patterns of between-population diversity, and relationships among ancestral lineages) and other information on life history are essential to determine which populations are most similar to one another for broodstock selection. If stock transfers have occurred or if hatchery influence is suspected, then these analyses are even more important. The short-term goals of recovery hatcheries are to stabilize or increase population size (hatchery-origin + natural origin) while at the same time preserving within-population genetic diversity, between-population diversity patterns, and adaptive variation, with the long-term goal of establishing self-sustaining viable populations. Knowledge of population genetic structure is critical to establishment of an effective program.

ESSENTIAL PROGRAM ELEMENTS AND OPPORTUNITIES FOR DEVELOPMENT OF A HATCHERY RESEARCH PROGRAM

Although each program will be somewhat different due to differing needs and means to achieve them, we identify a suite of essential program elements that every hatchery recovery program should contain. In this section we also explore the need for dissemination of research.

Every recovery hatchery program should have the following elements.

1. The program should have a written plan that identifies well-defined program goals and management actions to achieve them. The program should be justified by an evaluation of the relative benefits and risks of alternative hatchery practices, alternative non-hatchery means to achieving the program goals, and a no action alternative. This evaluation should be included in the plan. The plan should also include research goals, a monitoring and evaluation plan, contingency and emergency plans, and a decommission plan.
2. A steering committee should be in place even before the hatchery begins operation to advise and provide technical expertise (see Policies). The steering committee should meet quarterly to discuss adaptive management of the program.
3. Genetic monitoring and broodstock management are the cornerstones of a successful recovery hatchery and should be included in the operations plan.
4. Recovery hatchery programs should have appropriate levels of redundancy and safeguards to secure broodstock and production (e.g., redundant water supplies and electricity, secure areas away from the general public for holding fish).
5. Recovery hatchery programs are unproven for recovery purposes. Therefore, any information or experience gained is of tremendous value to adaptive management of them. Sharing information and regular reporting, both written reports and presentations, are critical to effective management of these programs, and will be required.
6. Thresholds should be identified as triggers for adaptive management.
7. Recovery hatchery programs should develop written plans that clearly document the program. This report should be annual while the program is in place, with a final report that evaluates the entire program when it is completed.
8. A monitoring component should be outlined that assesses the effectiveness of the recovery hatchery program and its ability to aid in the recovery of native, natural-spawning coho salmon.

9. Research components could be identified that address questions relevant to improving conservation/hatchery technology, hatchery-natural interactions, and use of hatchery fish in species recovery.
10. Provisions should be in place for troubleshooting and problem solving. This is an important part of the work of the steering committee. Adaptive management should be an integral part of the program.
11. Very early in the development of the project, each project should write an emergency interruption plan (if one does not already exist) in case of emergency disruption of the project (e.g., due to loss of water availability or quality, catastrophes and accidents, staff or budget cuts, disease outbreaks). The plan should detail what will happen to broodstock, production, staff, and how to maintain the project off site if necessary. All existing California hatcheries currently have such plans already.
12. Multiple facilities should be considered for housing broodstock and production to spread the risk of catastrophes. This is especially important for listed species but is important for any valuable broodstock.
13. Program monitoring and reporting is an essential feature of the program (see the following section).

PROGRAM MONITORING

Each program should have a schedule for interim evaluation of program success in relation to program goals and to document program activities. Because these programs rely on adaptive management and are relatively “new” and experimental, the timely documentation of results is crucial to program success. Written annual reports will be required that document both captive breeding statistics (e.g., number spawned, spawning matrix, percent eye-up, life-stage specific mortality, problems that arose and their solutions, number of fish released, size of release, growth rate, genetic analysis of broodstock and production), and field related statistics (e.g., number of returning adults, effect of releases on effective population size of the combined hatchery and natural population, carrying capacity and habitat availability as it relates to release size, ecological interactions among hatchery and natural fish, outmigration timing of hatchery and natural fish, contribution of hatchery stock to natural spawning, ocean impacts (e.g., effects of Pacific Decadal Oscillation, El Niño/La Niña events, changes in upwelling indexes), fishery impacts on hatchery stocks). A periodic reevaluation of risks should also be included in progress reports. The Department should develop a standard data reporting format that would simplify and streamline the reporting process for recovery hatcheries.

In order to effectively monitor the hatchery population, each fish released should receive a unique tag and an external mark. Typically this unique tag will be a coded wire tag, but other tagging methods (e.g., PIT tags) are possible depending on funding, hatchery logistics, new techniques, and need. Projects should plan on 100 percent tagging of releases and subsequent monitoring to determine their fate.

Each program should also make provisions for a comprehensive final report that documents the program’s history and activities and interprets the results of the program over its life span. This report should include recommendations on ways to improve recovery hatchery programs in the future.

Programs should clearly delineate procedures for disseminating research results generated by the facility. Permits should contain language that connects resource agencies with regular reporting of research results pertaining to the project. Reporting must be regular, informative, and in a format usable by the resource agencies for adaptive management of the program.

PROGRAM DURATION, CLOSEOUT GUIDELINES, CONTINGENCY AND EMERGENCY CLOSEOUT PLANS, AND DISPOSITION OF UNUSED BROODSTOCK

Recovery hatchery programs are envisioned to be short term projects with lifespans on the order of 1-4 coho salmon generations (3-12 years). A closed recovery hatchery would represent a successful effort that was able to substantially contribute to recovery of the species. Because of this built in short lifespan, it is essential that each program develop early in its life a close-out plan. The close-out plan should at minimum contain the following.

1. The expected life of the program and conditions under which the facility should initiate close-out. These should be tied to reaching recovery goals specific to the program as well as overall recovery goals. Performance standards should be evaluated for years 1-3 and if met, 4-6, 7-9, etc. Failure to meet performance standards in two generations should, in most cases, trigger initiation of close-out procedures.
2. Provisions for closing the facility, including a possible end use.
3. Provisions for disposition of unused broodstock and any other fish on-site at the time of close-out.
4. Provisions for staff transition.
5. Production and dissemination of a final documentation report.

A second plan should be produced that describes how the facility will deal with an emergency close-out that might occur with little or no warning due to accident or catastrophe, or a funding shortfall. These plans should contain the provisions above, but should take into account that the implementation time may be very short.

REFERENCES CITED

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. www.nwfsc.noaa.gov/publications/techmemos/tm27/tm27.htm *Status review of west coast steelhead from Washington, Idaho, Oregon, and California*. U.S. Dep. Commer., NOAA Tech. Memo. NMFS- NWFSC-27, 261 p.

Bryant, G.J. 1994. Status review of coho salmon populations in Scott and Waddell Creeks, Santa Cruz County, California. National Marine Fisheries Service, Southwest Region/Protected Species Management Division, Santa Rosa, California, 102 p.

CDFG. Undated. California salmon and steelhead artificial propagation program.

CDFG. 2002. Status review of California coho salmon North of San Francisco: Report to the California Fish and Game Commission, Candidate Species Status Review Report 2002-3, April 2002.

CDFG/NMFS (California Department of Fish and Game and National Marine Fisheries Service). 2001. California Department of Fish and Game/National Marine Fisheries Service, Southwest Region Joint Hatchery Review Committee, Final Report on Anadromous Salmonid Fish Hatcheries in California. December 3, 2001.

Flagg, T.A., and C.E. Nash (editors). 1999. A conceptual framework for conservation hatchery strategies for Pacific salmonids. Dep. Commer., NOAA Technical Memo. NMFS-NWFSC-38.

Hard, J.J, R.P. Jones, Jr., M.R. Delarm, and R.S. Waples. 1992. Pacific salmon and artificial production under the Endangered Species Act. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-2, 56p.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-35, 443 p.

NOAA Fisheries. 2003. Preliminary conclusions regarding the updated status of listed ESUs of West Coast salmon and steelhead. West Coast Salmon Biological Review Team Comanager Draft.—Coho Salmon. Northwest Fisheries Science Center, 2725 Montlake Boulevard, East Seattle, WA 98112 and Southwest Fisheries Science Center Santa Cruz Laboratory, 110 Shaffer Road, Santa Cruz, CA 95060.

NMFS. 1999. Interim standards for the use of captive propagation technology in recovery of anadromous salmonids listed under the Endangered Species Act. National Marine Fisheries Service, Sustainable Fisheries Division, Hatchery and Inland Fisheries Branch, 525 N.E. Oregon Street, Suite 500, Portland, Oregon, 97232.

Reisenbichler, R.R., F.M. Utter, and C.C. Krueger. 2003. Genetic concepts and uncertainties in restoring fish populations and species. In Strategies for Restoring River Ecosystems: Sources of Variability and Uncertainty in Natural and Managed Systems, p. 149-183. American Fisheries Society.

Waples, R.S. 1994. Genetic considerations in recovery efforts for Pacific salmon. Conservation Biology 8(3): 884-886.

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope, and R.S. Waples. 1995. Status review of coho salmon from Washington, Oregon, and California. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSC-24, 258p.

ATTACHMENT 1: GLOSSARY

Artificial propagation: Human assistance in the reproduction of an organism. In Pacific salmon, artificial propagation may include spawning and rearing in hatcheries, stock transfers, creation of spawning habitat, egg bank programs, captive broodstock programs, and cryopreservation of gametes.

Captive broodstock program: A form of artificial propagation involving the collection of individuals or gametes from a natural population and rearing of these individuals to maturity in captivity.

Carrying capacity: The maximum equilibrium number of individuals of a particular species that can be supported indefinitely in a given environment. *Abbr.: K.*

CESA: California Endangered Species Act.

Cohort failure: Extinction of a cohort (year-class) of fish due to either a lack of spawning in that year or to failure of any offspring of a spawning event to survive. Also called brood-year extinction.

Cryopreservation: Preservation of living gametes at very low temperature. Typically, freezing sperm in liquid nitrogen for later use in spawning.

Domestication selection: Natural selection operating on a population during artificial propagation that encourages adaptation to the hatchery environment at the expense of adaptation to the natural environment.

Effective population size: Used in management of genetic resources to express information about expected rates of random genetic change due to inbreeding and/or genetic drift. The size of a hypothetical ideal population with the same amount of random genetic change as the actual population experiences. Typically the effective population size is lower than the census population size. *Abbr.:* N_e.

ESA: Federal Endangered Species Act.

Evolutionarily Significant Unit (ESU): A population or group of populations that is considered distinct, and hence a species, for purposes of the Endangered Species Act. An ESU must be reproductively isolated from other populations of the same species and must represent an important component in the evolutionary legacy of the species.

Extinction: In evolutionary biology, the failure of groups of organisms of varying size and inclusiveness (e.g., local geographic or temporally-defined groups to species) to have surviving descendants.

Extinction risk: In this document, the probability that a given population will become extinct within 100 years. Low probability of extinction is arbitrarily defined for this purpose as 5% over 100 years.

Hatchery-origin fish: Also, "hatchery fish." Fish that have spent some portion of their lives, usually their early lives, in a hatchery. (See natural-origin fish.)

Metapopulation: A set of largely isolated subpopulations connected by some degree of migration among them.

Monitoring: Scientific inquiry focused on evaluation of a program in relation to its goals (see Research).

Natural-origin fish: Also, "natural fish." Fish that are offspring of parents that spawned in the wild.

Natural-origin fish spend their entire lives in the natural environment. (See hatchery-origin fish.)

Population: A group of individuals of the same species that live in the same place at the same time and exhibit some level of reproductive isolation from other such groups. In some contexts, a randomly mating group of individuals that is reproductively isolated from other groups. A population may consist of a single isolated run or more than one connected run. Synonymous with "stock" in this document.

Population size: In this document, the number of, usually adult, fish in the population. Also known as census size of the population. Abundance.

Recovery: The re-establishment or rehabilitation of a threatened or endangered species to a self-sustaining level in its natural ecosystem.

Recovery supplementation: Short-term artificial propagation designed to reduce the risk of extinction of a small or chaotically fluctuating recovering population in its natural habitat by temporarily increasing population size using recovery hatchery fish, while maintaining available genetic diversity and avoiding genetic change in the natural and hatchery populations.

Research: Scientific inquiry focused on answering original questions. May consist of experiments or original descriptions of structures, relationships, and processes (See Monitoring).

Run: The spawning adults of a given species that return to a stream during a given season.

Self-sustaining population: A population that perpetuates itself without human intervention, without chronic decline, and in its natural ecosystem, at sufficient levels that listing under CESA is not warranted.

Source-sink relationship: Metapopulation structure in which subpopulations in the source areas have vastly different productivities than those is the sink areas, and characterized by one-way movement of migrants from the source area to the sink area.

Stock: See "population."

Stock transfer: Human-caused transfer of fish from one location to another, typically in the context of out-of-basin or out-of-ESU transfers.

ATTACHMENT 2: PARTICIPANTS ON THE HATCHERY WORKING GROUP OF THE CALIFORNIA COHO SALMON RECOVERY TEAM AND DEPARTMENT REVIEWERS

HATCHERY WORKING GROUP:

Michael Lacy, DFG (Chair)
Jean Baldrige, Entrix
George Kautsky, Hoopa Tribal Fisheries
Greg Bryant, NOAA Fisheries
Daniel Logan, NOAA Fisheries
Shirley Witalis, NOAA Fisheries
Ruth Sundermeyer, Entrix
Paul Siri, Private Consultant to Sonoma County Water Agency

DFG REVIEWERS:

Chuck Knutsen
Royce Gunter
Brett Wilson
Bob Coey
Larry Preston
Gary Stacey
Bob McAllister
Kevan Urquhart
Jennifer Nelson
Gail Newton
Dennis McEwan

ATTACHMENT 3: SECTIONS OF THE 2003 FISH AND GAME CODE RELEVANT TO THE ESTABLISHMENT AND OPERATION OF RECOVERY HATCHERIES FOR ANADROMOUS SALMONIDS

FISH AND GAME CODE §§1120-1126

1120. The commission shall establish fish hatcheries for stocking the waters of this State with fish. The department shall maintain and operate such hatcheries.

1121. In any lease entered into whereby the State leases from any county, city, irrigation district, or other public agency in this State, real property for the purpose of establishing or maintaining a fish hatchery, the State may agree to indemnify and hold harmless the lessor by reason of the uses authorized by such lease. Insurance may be purchased by the Department of General Services to protect the State against loss or expense arising out of such an agreement.

1122. Any claim for damages arising against the State under Section 1121 shall be presented to the State Board of Control in accordance with Section 905.2 of the Government Code, and if not covered by insurance as herein provided shall be payable only out of funds appropriated by the Legislature for such purposes. If the State elects to insure its liability under Section 1121, the State Board of Control may automatically deny any such claim.

1123. The department may purchase and import spawn or ova of fish suitable for food, and stock with such spawn or ova the waters of this State.

1123.5. Notwithstanding Section 1120 or any other provision of law, all funds allocated for fish purchases for the department's urban fishing program shall be used to purchase all fish and aquatic organisms by contract, pursuant to the requirements of the Public Contract Code, from private registered aquaculture facilities within the State unless the department determines one of the following conditions exists:

(a) After reasonable notice, the private facilities are unable to provide the specified fish or aquatic organism.

(b) The fish or aquatic organism is infected or diseased.

1124. It is unlawful to take any fish in any pond or reservoir belonging to or controlled by the department and used for propagating, protecting, or conserving fish.

1125. The Secretary of the Interior of the United States and his duly authorized agents may conduct fish cultural operations and scientific investigations in the waters of this State in such a manner and at such times as may be jointly considered necessary and proper by the secretary and his agents, and the commission.

1126. Notwithstanding any other provision of law, department personnel may construct or repair bird exclosures at State owned or operated fish hatcheries. These activities shall not be subject to review by the Public Works Board. Nothing in this section exempts the department from complying with any provision of law governing services performed under contract by noncivil service employees.

FISH AND GAME CODE §1150

1150. The boards of supervisors of the several counties may establish and maintain fish hatcheries, and may purchase the spawn or ova of fish.

FISH AND GAME CODE §§1170-1175

1170. The commission may issue a permit, subject to such restrictions and regulations as the commission deems desirable, to a nonprofit organization to construct and operate an anadromous fish hatchery.

1171. The commission shall not issue a permit unless it determines the nonprofit organization has the financial capability to successfully construct and operate the hatchery and will diligently and properly conduct the operation authorized under the permit.

1172. No permit will be issued which may tend to deplete the natural runs of anadromous fish, result in waste or deterioration of fish, or when the proposed operation is located on a stream or river below a State or Federal fish hatchery or egg-taking station.

1173. All fish handled under authority of this article during the time they are in the hatchery or in the wild are the property of the State and when in the wild may be taken under the authority of a sport or commercial fishing license as otherwise authorized for wild fish.

1174. Any permit granted by the commission pursuant to this article shall contain all of the following conditions:

(a) If after a hearing the commission finds that the operation described in the permit and conducted pursuant to this article is not in the best public interest, the commission may alter the conditions of the permit to mitigate the adverse effects, or may cause an orderly termination of the operation under the permit. An orderly termination shall not exceed a three-year period and shall culminate in the revocation of the permit in its entirety.

(b) If the commission finds that the operation has caused deterioration of the natural run of anadromous fish in the waters covered by the permit, it may require the permittee to return the fishery to the same condition as was prior to issuance of the permit. If the permittee fails to take appropriate action, the commission may direct the department to take the action, and the permittee shall bear any cost incurred by the department.

(c) Prior to release into State waters and at any other time deemed necessary by the department, the fish may be examined by the department to determine that they are not diseased or infected with any disease which, in the opinion of the department, may be detrimental to the State fishery resources.

1175. The State shall assume no responsibility for the operation of a hatchery pursuant to this article and shall not be in any manner liable for its operation.

FISH AND GAME CODE §§1200-1206

1200. The department is authorized to enter into agreements with counties, nonprofit groups, private persons, individually or in combination, for the management and operation of rearing facilities for salmon and steelhead. All such agreements shall be in accordance with the policies of the commission and the criteria of the department which govern the operation under such agreements. The purpose for operating such facilities shall be to provide additional fishing resources and to augment natural runs.

1201. An applicant who wishes to enter into an agreement to operate a rearing facility shall demonstrate, to the satisfaction of the department prior to executing such agreement, such applicant's financial ability to properly operate the rearing facility. The department shall develop and specify the means for an applicant to make such a demonstration.

1202. All fish handled or released under authority of this article are the property of the State and may be taken only after their release into the wild and under the authority of a sport or commercial fishing license.

1203. The release of fish reared in facilities pursuant to this article shall be made in accordance with the policy of the commission.

1204. The department shall fund the agreements provided for in Section 1200 only on a matching basis with the persons or entities who enter into such agreements. Funds appropriated for the purposes of this article shall not be used to purchase equipment or for construction. The department shall be reimbursed from funds appropriated for the purposes of this article for administrative costs, legal costs, and supervisorial costs relating to the execution and supervision of such agreements by the department.

1205. The department shall, subject to the limitations of appropriate egg sources and funding, make available fish of appropriate size and species to persons or entities who enter into agreements pursuant to this article.

1206. Salmon and steelhead raised pursuant to this article shall be released in streams, rivers, or waters north of Point Conception and upon release shall have unimpeded access to the sea.

FISH AND GAME CODE §6100

6100. Notwithstanding any provision of Article 3 (commencing with Section 5980) and Article 4 (commencing with Section 6020), on or after the effective date of this article, any new diversion of water from any stream having populations of salmon and steelhead which is determined by the department to be deleterious to salmon and steelhead shall be screened by the owner. The construction, operation, or maintenance costs of any screen required pursuant to this article shall be borne by the owner of the diversion.

The department within 30 days of receipt of a notice of such diversion, or within the time determined by mutual written agreement, shall submit to the owner its proposals as to measures necessary to protect the salmon and steelhead. The department shall notify the owner that it shall make onsite investigation and shall make any other investigation before it shall propose any measure necessary to protect fishlife.

The department, or any agency of the State, shall provide the owner of the diversion any available information which is required by such owner in order to comply with the provisions of this article. The diversion shall not commence until the department has determined that measures necessary to protect fishlife have been incorporated into the plans and construction of such diversion.

FISH AND GAME CODE §§6900-6903.5

6900. This chapter shall be known and may be cited as the Salmon, Steelhead Trout, and Anadromous Fisheries Program Act.

6901. The Legislature, for purposes of this chapter, finds as follows:

(a) According to the department, the natural production of salmon and steelhead trout in California has declined to approximately 1,000,000 adult chinook or king salmon, 100,000 coho or silver salmon, and 150,000 steelhead trout.

(b) The naturally spawning salmon and steelhead trout resources of the State have declined dramatically within the past four decades, primarily as a result of lost stream habitat on many streams in the State.

(c) Much of the loss of salmon and steelhead trout and anadromous fish in the State has occurred in the central valley.

(d) Protection of, and an increase in, the naturally spawning salmon and steelhead trout resources of the State would provide a valuable public resource to the residents, a large statewide economic benefit, and would, in addition, provide employment opportunities not otherwise available to the citizens of this State, particularly in rural areas of present underemployment.

e) Proper salmon and steelhead trout resource management requires maintaining adequate levels of natural, as compared to hatchery, spawning and rearing.

(f) Reliance upon hatchery production of salmon and steelhead trout in California is at or near the maximum percentage that it should occupy in the mix of natural and artificial hatchery production in the State. Hatchery production may be an appropriate means of protecting and increasing salmon and steelhead in specific situations; however, when both are feasible alternatives, preference shall be given to natural production.

(g) The protection of, and increase in, the naturally spawning salmon and steelhead trout of the State must be accomplished primarily through the improvement of stream habitat.

(h) Funds provided by the Legislature since 1978 to further the protection and increase of the fisheries of the State have been administered by the Department of Fish and Game in a successful program of contracts with local government and nonprofit agencies and private groups in ways that have attracted substantial citizen effort.

(i) The department's contract program has demonstrated that California has a large and enthusiastic corps of citizens that are eager to further the restoration of the stream and fishery resources of this State and that are willing to provide significant amounts of time and labor to that purpose.

(j) There is need for a comprehensive salmon, steelhead trout, and anadromous fisheries plan, program, and State government organization to guide the State's efforts to protect and increase the naturally spawning salmon, steelhead trout, and anadromous fishery resources of the State.

6902. The Legislature, for purposes of this chapter, declares as follows:

(a) It is the policy of the State to significantly increase the natural production of salmon and steelhead trout by the end of this century. The department shall develop a plan and a program that strives to double the current natural production of salmon and steelhead trout resources.

(b) It is the policy of the State to recognize and encourage the participation of the public in privately and publicly funded mitigation, restoration, and enhancement programs in order to protect and increase naturally spawning salmon and steelhead trout resources.

(c) It is the policy of the State that existing natural salmon and steelhead trout habitat shall not be diminished further without offsetting the impacts of the lost habitat.

6903. It is the policy of the State and the department to encourage nonprofit salmon release and return operations subject to this code operated by, or on behalf of, licensed commercial salmon fishermen for the purpose of enhancing California's salmon populations and increasing the salmon harvest by commercial and recreational fishermen. The department shall, to the extent that funds and personnel are available, cooperate with fishing organizations in the siting and establishment of those operations to ensure the protection of natural spawning stocks of native salmon. The organizations conducting the operations may receive salmon eggs and juvenile salmon for the purposes of the operation, and, where appropriate, shall have priority to receive salmon eggs and juvenile salmon for those purposes after the needs of habitat mitigation efforts, and State hatcheries are met.

6903.5. The department shall encourage other nonprofit hatcheries and nonprofit artificial propagation operations, operated by, or on behalf of, licensed fishermen, for the purpose of rebuilding or enhancing marine fish populations, including, but not limited to, those for Dungeness crab, sea urchin, and California halibut, consistent with the protection of these species in the wild, in order to provide sustainable marine fish populations for harvest by commercial and recreational fishermen. The department shall, to the extent funds and personnel are available, cooperate with these nonprofit hatcheries and nonprofit artificial propagation operations in determining the feasibility, siting, and establishment of those activities and sharing technical information to ensure the protection of the marine environment.

6920. (a) The department shall, with the advice of the Advisory Committee on Salmon and Steelhead Trout and the Commercial Salmon Trollers Advisory Committee, prepare and maintain a detailed and comprehensive program for the protection and increase of salmon, steelhead trout, and anadromous fisheries.

(b) The department shall consult with every public agency whose policies or decisions may affect the goals of this program to determine if there are feasible means for those public agencies to help the department achieve the goals of this program.

6921. The program shall identify the measures the department will carry out to achieve the policies set forth in Section 6902.

6922. The program shall include, but is not limited to, all of the following elements:

(a) Identification of streams where the natural production of salmon and steelhead trout can be increased primarily through the improvement of stream and streambank conditions without effect on land ownership, land use practices, or changes in streamflow operations.

(b) Identification of streams where the natural production of salmon and steelhead trout can be increased only through the improvement of land use practices or changes in streamflow operations.

(c) Identification of streams where the protection of, and increase in, salmon and steelhead trout resources require, as a result of significant prior loss of stream habitat, the construction of artificial propagation facilities.

(d) A program element for evaluating the effectiveness of the program.

(e) Recommendations for an organizational structure, staffing, budgeting, long-term sources of funding, changes in State statutes and regulations and Federal and local government policy and such other administrative and legislative actions as the department finds to be necessary to accomplish the purposes of this chapter.

(f) Identification of measures to protect and increase the production of other anadromous fisheries consistent with policies set forth in Section 6902.

(g) Identification of alternatives to, or mitigation of, manmade factors which cause the loss of juvenile and adult fish in California's stream system.

6923. Measures which are the responsibility of other agencies or persons, such as the repair or replacement of dysfunctional fish screens, are not eligible for funding under the program.

6924. The department shall determine the initial elements of the program and transmit a report describing those elements to the Legislature and the Advisory Committee on Salmon and Steelhead Trout within six months of the effective date of this chapter.

ATTACHMENT 4: CALIFORNIA FISH AND GAME COMMISSION POLICIES RELEVANT TO THE ESTABLISHMENT AND OPERATION OF RECOVERY HATCHERIES

CALIFORNIA FISH AND GAME COMMISSION POLICY ON COOPERATIVELY OPERATED REARING PROGRAMS FOR SALMON AND STEELHEAD

It is the policy of the Fish and Game Commission that:

I. The State's salmon and steelhead resources may be used to support cooperative rearing programs. Rearing programs may be of two types: (1) those that grow fish for use in accelerating the restoration/rehabilitation of depleted wild populations in underseeded habitat and (2) those that are dedicated solely to growing fish for harvest. The following constraints apply to both types:

A. Only those fish surplus to the needs of the Department's programs shall be utilized for such programs and allocation shall be based on past performance and the Department's evaluation of the potential of proposed new programs.

B. The suitability and acceptance or rejection of proposed programs shall be determined by the Department, after reviewing a written proposal. A written project and management plan providing for evaluation and covering a period of five years must be evaluated and approved by the Department. Prior to reauthorization the Department must determine that the project is in compliance with the approved plan and continuance of the program is in the best interest of the State's fishery resources.

C. Routine care and food costs shall be the financial responsibility of the sponsoring entity. The Department shall provide technical advice and special assistance as appropriate.

D. Fish raised in these programs shall not be stocked in, or broodstock captured from, waters where the Department has determined that adverse effects to native fish populations or other aquatic species may result.

II. The bulk of the State's salmon and steelhead resources shall be produced naturally. The State's goals of maintaining and increasing natural production take precedence over the goals of cooperatively operated rearing programs.

(Amended 6/18/93)

CALIFORNIA FISH AND GAME COMMISSION POLICY ON SALMON

It is the policy of the Fish and Game Commission that:

I. Salmon shall be managed to protect, restore and maintain the populations and genetic integrity of all identifiable stocks. Naturally spawned salmon shall provide the foundation for the Department's management program.

II. Salmon streams shall be inventoried for quantity and quality of habitat, including instream flow requirements. Restoration plans shall identify habitats for restoration and acquisition and opportunities to protect or guarantee future instream flows. Commercial Salmon Trollers Stamp and other funding shall be directed to implement the plans.

III. Existing salmon habitat shall not be diminished further without offsetting the impacts of the lost habitat. All available steps shall be taken to prevent loss of habitat, and the Department shall oppose any development or project which will result in irreplaceable loss of fish. Artificial production shall not be considered as appropriate mitigation for loss of wild fish or their habitat.

IV. Salmon shall be rescued only when they will be returned to the stream system of origin. Rescue of juvenile salmon shall be limited to circumstances where fish can be held until habitat conditions improve, or where immediate release can be made in understocked areas of their natal stream system.

V. In coastal streams without Department hatcheries, artificial rearing shall be limited to areas where the Department determines it would be beneficial to supplement natural production to re-establish or enhance the depleted wild population. In the Sacramento, American, Feather, San Joaquin, Klamath, and Trinity river systems, hatchery production shall be used to meet established mitigation goals. At the discretion of the Department excess eggs and fish from State, Federal, or cooperative hatcheries may be used to provide additional fish for the commercial and sport fisheries.

VI. Resident fish will not be planted or resident fisheries developed in drainages of salmon waters, where, in the opinion of the Department, such planting or development will interfere with salmon populations. Exceptions to this policy may be authorized by the Commission (a) where the stream is no longer adaptable to anadromous runs, or (b) during the mid-summer period in those individual streams considered on a water-by-water basis where there is a high demand for angling recreation and such planting or development has been determined by the Department not to be detrimental to salmon.

(Amended 6/18/93)

CALIFORNIA FISH AND GAME COMMISSION POLICY ON STEELHEAD RAINBOW TROUT

It is the policy of the Fish and Game Commission that:

I. Steelhead rainbow trout shall be managed to protect and maintain the populations and genetic integrity of all identifiable stocks. Naturally spawned steelhead shall provide the foundation of the Department's management program.

II. Steelhead shall be rescued only when they will be returned to the stream system of origin. Rescue of juvenile steelhead shall be limited to circumstances where fish can be held until habitat conditions improve, or where immediate release can be made in understocked areas of their natal stream system.

III. Restoration and acquisition plans shall be developed and implemented to safeguard such critical habitats as estuaries, coastal lagoons, and spawning and rearing areas, and to protect or guarantee future instream flows. All steelhead streams shall be inventoried for quantity and quality of habitat, including stream flow conditions. Steelhead Restoration Card and other funding shall be directed to implement the plans.

IV. Existing steelhead trout habitat shall not be diminished further without offsetting mitigation of equal or greater long-term habitat benefits. All available steps shall be taken to prevent loss of habitat, and the Department shall oppose any development or project which will result in irreplaceable losses. Artificial production shall not be considered appropriate mitigation for loss of wild fish or their habitat.

V. Sport fishing for sea-run steelhead shall be encouraged where the Department has determined that harvest will not harm existing wild populations. Harvest of juveniles shall only be permitted where such harvest does not impair adequate returns of adults for sport fishing and spawning. Special restrictions on the harvest of wild juvenile steelhead may be necessary when a fishery includes both wild and hatchery stocks.

VI. Resident fish will not be planted or resident fisheries developed in drainages of steelhead waters, where, in the opinion of the Department, such planting or development will interfere with steelhead populations.

VII. Exceptions to this policy may be made by the Commission (a) where the stream is no longer adaptable to anadromous runs, or (b) during the midsummer period in those individual streams considered on a water-by-water basis where there is a high demand for angling recreation and such planting or development has been determined by the Department not to be detrimental to steelhead.

The following waters are excepted:

Nacimiento River San Luis Obispo County
North Fork Battle Creek Shasta County, (upstream from Manton)
Cow Creek Shasta County, (upstream from Fern Road and Ingot)
Antelope Creek Tehama County, (upstream from Ponderosa Way)
Deer Creek Tehama County, (upstream from upper Deer Creek Falls)
American River Sacramento County, (only in Arden Pond)

(Amended 6/18/93)

TABLE 4. Alternative developmental stages for fish used to initiate populations in restored streams.

Stage	Advantages	Disadvantages	Comments
Adult	Naturalization begins immediately and occurs over the first cohort's entire life. Low cost.	Spawning success may be low owing to egress or suboptimal spawning distribution (because spawners did not imprint within the "new" stream as juveniles) or stress from handling and transporting (Shreck et al. 2001), and – for hatchery adults – ineffective mating and spawning behavior (e.g., Leider et al. 1990; Fleming and Gross 1994).	Reproductive success and juvenile survival are likely to be greater with translocated adults from nearby, environmentally similar streams than with hatchery adults. In some situations low spawning success, in conjunction with subsequent low survival of progeny due to poor genetic adaptedness to the new stream, may result in few if any progeny surviving to reproduce, and low effective population size.
Embryo or fry (incubated in a hatchery, steam-side incubator or artificial redd)	Naturalization occurs in the first cohort over nearly the entire period of freshwater rearing. Avoids possible low spawning success from releases of (F_0) adults. Low cost.	Often requires manipulation of water temperatures at a hatchery to mimic those in various parts of the watershed so as to achieve appropriate timing of development.	The increased survival from conception or incubation in a hatchery should result in many more fish surviving to maturity than from natural spawning of translocated adults. Despite some failed fry releases, often due to inappropriate time or condition at release into streams already seeded with wild fish or into streams with poor habitat (e.g., McGie 1980; Lestelle et al. 1993), our experience and that of others (e.g., Close and Anderson 1992) suggest that fry releases can be very effective in establishing populations.
Juvenile, after a period of feeding in a hatchery	High survival while in the hatchery which presumably leads to increased production of (F_1) adults.	Early rearing in the hatchery (domestication) probably retards naturalization. Intermediate cost due to extended hatchery rearing and transport of large fish at outplanting. Once natural reproduction occurs, releases of "fed-fry" can result in severe competition and suppression of juveniles from natural spawning (Nickelson et al. 1986).	The net results of domestication (Reisenbichler and Rubin 1999; Waples 1999) during early freshwater rearing and then naturalization during subsequent freshwater rearing is unknown; however, the naturalization of such a cohort should be substantially less than that of a cohort released as fry. Fed fry must not be larger than F_1 or later juveniles from natural spawning; otherwise, naturalization will be delayed as the latter are displaced or suppressed by the former.
Smolt, reared in a hatchery	High survival to returning (F_1) adult.	Cohort experiences domestication; naturalization is delayed until the F_1 generation, which also suffers from poor reproductive success of returning F_0 fish as discussed above for adult releases. High cost due to "full-term" hatchery rearing and transport of large fish at outplanting.	Probably produces the greatest number of adults spawning in the F_1 generation, but delays naturalization and probably restoration because of genetic bottlenecks (when many matings of adult F_0 fish are unsuccessful) and domestication. Some stakeholders nevertheless favor this strategy because it is most consistent with conventional hatchery protocol, has been highly successful in augmenting harvest, and gives the illusion of rapid restoration when large numbers of (hatchery) adults spawn naturally.

Appendix I
Cost and Socioeconomic Impacts of Implementing the California Coho Salmon Recovery Strategy

January 2004

SUBMITTED TO

California Department of Fish and Game

PREPARED BY

David Sunding and Alix Peterson Zwane

Table of Contents

I.1 INTRODUCTION I.1
I.2 METHODOLOGY CONSIDERATIONS FOR DEVELOPMENT OF ECONOMIC IMPACTS OF COMMON RECOVERY RECOMMENDATIONS I.2
I.2.1 DEVELOPMENT OF AGGREGATE COST ESTIMATES I.3
I.2.2 TIMING OF RECOVERY RECOMMENDATIONS I.5
I.2.3 FISCAL COSTS VS. SOCIOECONOMIC IMPACTS I.5
I.3 BARRIERS TO FISH PASSAGE I.7
I.3.1 FISCAL COSTS I.8
I.3.1.1 Dams I.8
I.3.1.2 Non-structural Sites I.10
I.3.1.3 Stream Crossings I.11
I.3.1.4 Fish Passage Facilities I.14
I.3.1.5 Water Diversions I.15
I.3.2 SOCIOECONOMIC IMPACTS I.16
I.4 RIPARIAN REVEGETATION AND STREAM-BANK IMPROVEMENTS I.16
I.4.1 FISCAL COSTS I.16
I.4.1.1 Riparian Revegetation I.16
I.4.1.2 Stream-bank Improvements I.18
I.4.1.3 Fencing I.20
I.4.2 SOCIOECONOMIC IMPACTS I.21
I.4.2.1 Riparian Revegetation and Stream-bank Improvements I.21
I.4.2.2 Fencing I.22
I.5 PLACEMENT OF LWD/INSTREAM COMPLEXITY I.23
I.5.1 FISCAL COSTS I.23
I.5.2 SOCIOECONOMIC IMPACTS I.25

I.6 ROAD TREATMENT AND DECOMMISSIONING I.25
I.6.1 FISCAL COST I.26
I.6.1.1 Road Treatment I.26
I.6.1.2 Road Decommissioning I.28
I.6.2 SOCIOECONOMIC IMPACTS I.29
I.7 RESTORING WETLANDS AND OFF-CHANNEL AREAS I.30
I.7.1 FISCAL COSTS I.30
I.7.2 SOCIOECONOMIC IMPACTS I.30
I.8 WATER ACQUISITIONS I.30
I.8.1 FISCAL COST I.31
I.8.2 SOCIOECONOMIC IMPACTS I.31
I.9 BIOLOGICAL STUDIES I.33
I.9.1 FISCAL COSTS I.33
I.9.2 SOCIOECONOMIC IMPACTS I.33
I.10 WATERSHED PLANNING AND OTHER NON-BIOLOGICAL STUDIES I.34
I.10.1 FISCAL COSTS I.34
I.10.2 SOCIOECONOMIC IMPACTS I.34
I.11 EDUCATION AND OUTREACH I.34
I.11.1 FISCAL COSTS I.34
I.11.2 SOCIOECONOMIC IMPACTS I.35
I.12 HSA/HU SPECIFIC RECOMMENDATIONS I.35
I.13 TIMBERLAND MANAGEMENT I.37
I.13.1 ALTERNATIVE RECOMMENDATIONS I.37
I.13.1.1 Alternative A I.37
I.13.1.2 Alternative B I.38
I.13.1.3 Alternative C I.40
I.13.2 SOCIOECONOMIC IMPACTS I.41
I.14 SHASTA-SCOTT PILOT PROGRAM I.42
I.14.1 WATER MANAGEMENT I.43
I.14.2 WATER AUGMENTATION I.43
I.14.3 HABITAT MANAGEMENT AND RESTORATION I.43
I.14.4 PROTECTION I.44
I.14.5 WATER USE EFFICIENCY I.44
I.14.6 MONITORING AND ASSESSMENT I.44
I.14.7 EDUCATION AND OUTREACH I.44
I.15 AGGREGATE COSTS AND ECONOMIC IMPACTS I.44
I.16 IMPACTS IDENTIFIED BUT NOT QUANTIFIED: PERMITTING AND ENFORCEMENT I.46

LIST OF FIGURES AND TABLES

FIGURE I-1 Marginal cost of annual water rights acquisition I.32
FIGURE I-2 Socioeconomic impacts of water rights acquisition I.32
TABLE I-1 Average 2002 construction industry wages by county I.4
TABLE I-2 California unemployment rates by county I.6
TABLE I-3 Construction unit costs for treatment of non-structural sites in Oregon . . I.10

TABLE I-4 Construction unit costs for treatment of stream crossing barriers to passage in California I.11
TABLE I-5 Illustrative project costs for treatment of stream crossing barriers to passage in Washington State I.12
TABLE I-6 Estimated cost of culvert treatment by road type ($ '000) I.12
TABLE I-7 Cost per project to provide fish passage/mitigate barrier at stream crossings I.13
TABLE I-8 Construction unit costs for fish screen installation in California I.15
TABLE I-9 Construction unit costs for stream-bank improvement activities in California I.18
TABLE I-10 Labor requirements for stream-bank improvements I.19
TABLE I-11 Construction unit cost of fencing project elements in California I.21
TABLE I-12 Illustrative unit values of the social cost of forest land acquisition, selected California counties ($/acre) I.22
TABLE I-13 Timberland value assessment for tax purposes in California, 2002 . . . . I.23
TABLE I-14 Construction unit cost of in-channel habitat improvement elements in California I.24
TABLE I-15 Construction unit costs for road treatment activities in California I.26
TABLE I-16 Illustrative unit and project costs for road-related erosion control (San Mateo County, CA) I.27
TABLE I-17 Illustrative unit costs for road decommissioning activities I.28
TABLE I-18 Illustrative project costs for road decommissioning I.29
TABLE I-19 Construction unit costs for wetlands restoration activities in California I.30
TABLE I-20 HSA/HU-specific recommendations for which costs are implemented individually I.35
TABLE I-21 Previously estimated costs of elements of Recovery Strategy, which include those associated with Alternative C I.41
TABLE I-22 Economic cost and impact of implementation of Shasta-Scott Pilot Program I.42
TABLE I-23 Summary of cost and impacts of coho salmon recovery I.45

LIST OF ATTACHMENTS

ATTACHMENT 1 Estimated Cost and Socioeconomic Impacts of Barrier Assessment, Prioritization, and Treatment I.48
ATTACHMENT 2 Estimated Cost and Socioeconomic Impacts of Riparian Revegetation, Stream-bank Restoration, and Fencing I.66
ATTACHMENT 3 Estimated Cost and Socioeconomic Impacts of LWD Placement and Restoring In-channel Complexity I.74
ATTACHMENT 4 Estimated Cost and Socioeconomic Impacts of Road Decommissioning and Road Treatment I.78
ATTACHMENT 5 Economic Data for Agricultural Activities I.81
ATTACHMENT 6 Estimated Cost and Socioeconomic Impacts of Habitat Restoration I.82

I.1 INTRODUCTION

This report measures the cost of implementing the Coho Salmon Recovery Strategy (Recovery Strategy) for the Central California Coast (CCC) Coho Evolutionary Significant Unit (ESU) and the California portion of the Southern Oregon-Northern California Coasts (SONCC) Coho ESU. An estimate of the cost of implementing the strategy is required by California statute governing the Recovery Strategy Pilot Program (Fish and Game Code (FGC) §§2105-2116). To respond to this requirement, at the request of the Department of Fish and Game (Department) and in cooperation with the Range-wide Coho Salmon Recovery Team (CRT) and the Shasta-Scott Recovery Team (SSRT), economists developed quantitative estimates of both the fiscal cost and the socioeconomic impacts of implementing the Recovery Strategy. Implementing the Recovery Strategy will provide benefits for multiple species, watershed health, water quality, and the environment generally. It will also result in benefits to recreational and commercial fishing and related industries.

The report begins by describing the method used to develop aggregate costs and socioeconomic impacts of recommendations at the hydrologic unit (HU) level that are common to many HUs and hydrologic subareas (HSAs). The conceptual distinction between fiscal costs and socioeconomic impacts is then discussed and this methodology is then applied. Estimates of the aggregate cost of recovery by ESU are presented. These aggregate cost estimates do not reflect the full cost of Recovery Strategy implementation, because some costs cannot be quantified at this time. Detailed cost estimates at the HU level are provided in Attachments 1 to 5. At this time, there is limited information available about the quantity of each recovery action that will be undertaken and these cost estimates can be revised as additional information becomes available. However, these aggregate cost estimates may overestimate the cost of Recovery Strategy implementation because some of the costs may be incurred even if the Recovery Strategy were not implemented. In addition, these aggregate cost estimates include costs that may be incurred as a result of actions taken to avoid take of coho salmon or to fully mitigate impacts of authorized take of coho salmon once the species is listed.

The aggregate cost estimates presented here include not only the cost of implementing recommendations that are common to many HU/HSAs, but also the cost of specific recommendations that respond to the unique circumstances of a single HU or HSA. Cost estimates for these specific recommendations, are included in estimates of the aggregate cost of recovery. Some of these items are a significant portion of the costs estimated here. For example, restoring coarse sediment transport near Iron Gate Dam may cost as much as $500 million. Implementing the Trinity Record of Decision is estimated to cost about $12 million per year.

The aggregate cost estimates do not include specific line items for the range-wide recommendations because the majority of these recommendations cannot be assigned an estimated cost at this time. In addition, the cost of many of the range-wide recommendations is captured by estimating the cost of the HU/HSA-specific recommendations. The economists suspect that, given the magnitude of the measured recovery costs, failure to measure the costs of the range-wide recommendations explicitly does not impact qualitatively the recovery cost calculations.

The aggregate cost estimates also include the cost of implementing recommendations regarding timberland management. In accordance with a request by the Fish and Game Commission (Commission) for a range of alternatives regarding recommendations for timberland management, three alternative sets of recommendations were presented in the November 2003 Public Review Draft of the Recovery Strategy. Cost estimates were developed for these alternatives. They are presented in section I.13. When considering the cost of implementing recommendations regarding timberland management, one must consider the estimated costs presented in section I.13 in light of the recommendations that were finally approved for inclusion into the Recovery Strategy.

Some items included in the estimate of the aggregate cost of the Recovery Strategy are costs that may be incurred even if the Recovery Strategy were not implemented. For example, the cost of implementing the Trinity River Record of Decision (about $12 million per year) and the cost of the Fisheries Restoration Grant Program ($20-25 million per year) are included as costs associated with coho salmon recovery. The decision to include these costs was made in consultation with the Department. To the extent that these costs would be incurred in the absence of this plan, the cost estimates presented here overstate the cost of Recovery Strategy implementation. Costs that would be incurred as a result of the Clean Water Act or other related statutes and regulations were excluded. While TMDL regulations, for example, are quite relevant to coho salmon recovery, costs attributable to this process are not counted as a cost of coho salmon recovery; however, tasks enacted as part of this Recovery Strategy that address sediment may also help meet TMDL targets.

Separate cost and socioeconomic impact estimates have been developed for the Shasta Valley and Scott Valley HSAs. These cost estimates are described and presented in section I.14.

Section I.16 discusses impacts that have been identified but not quantified at this time. The magnitude of these costs will likely be an important determinant of the total cost and socioeconomic impact of the Recovery Strategy.

I.2 METHODOLOGY CONSIDERATIONS FOR DEVELOPMENT OF ECONOMIC IMPACTS OF COMMON RECOVERY RECOMMENDATIONS

This section of the report provides estimates of the unit cost of recommendations at the HU/HSA level that are common to many HU/HSAs and the aggregate cost of these recommendations. While coho salmon recovery in Central and Northern California will require many actions that are unique to particular watersheds, the recommendations in the Recovery Strategy include several actions that are common to many HSAs. This section includes discussions of (1) the fiscal or budgetary cost of implementing these common recommendations and (2) the socioeconomic impacts of implementing these recommendations. Specific recommendations cover:

1. Removing or reducing barriers to fish passage;
2. Implementing riparian revegetation and other stream-bank improvements;
3. Improving instream complexity, including the placement of large woody debris (LWD);
4. Road treatment and/or decommissioning;
5. Restoring wetlands and off-channel areas;
6. Water acquisitions;
7. Undertaking biological studies to understand and monitor salmon behavior;

8. Watershed planning and other non-biological studies;
9. Education and outreach efforts (including improvements in coordination); and
10. Changes in timberland management.

The primary focus is the unit cost of these activities. In some cases the recommendations in the Recovery Strategy do not provide guidance on the scale at which recommended activities should be undertaken because this kind of detailed information is not currently available. For example, at the HU- and HSA-level the recommendations do not specify the amount of water acquisition required to meet recovery goals. This precludes the comprehensive measurement of the cost of coho salmon recovery under the strategy. Nonetheless, it is possible to provide cost estimates for many recovery actions, and to characterize unit costs in even more cases.

I.2.1 DEVELOPMENT OF AGGREGATE COST ESTIMATES

Aggregate cost estimates were developed with a series of spreadsheet models that have been provided to the Department. These models are designed to combine unit cost estimates with information on the potential scale at which recommended activities could be undertaken. At this time, there is limited information available about the quantity of each recovery action that will be undertaken. As discussed later in the report, there is also limited information about the extent to which each class of recovery recommendation will be achieved through increased enforcement or voluntary actions (in which case the fiscal cost of the action is born by private actors), and the extent to which each class of recovery action will be achieved through payments to landowners and other resource managers (in which case the fiscal cost of the action is born by the public sector). Maximum flexibility has been built into these spreadsheet models so that, as additional information about the scale at which recovery recommendations will be undertaken becomes available, more accurate estimates of the aggregate cost of recovery can be made easily and quickly.

The calculation of aggregate costs from unit costs also requires identification of ways in which unit costs are likely to vary systematically across HU/HSAs. A major source of variation is likely to come from regional differences in wage rates since labor costs form a large part of the total unit cost of most recovery recommendations.[1] Data on average wages paid to construction workers in California counties were used to identify how recovery costs are likely to vary across HSAs as a result of labor costs. The economists mapped the county-level wage data to HSAs using GIS results provided by the Department.[2]

Table I-1 reports average construction wages, by county, in regions covered by the Recovery Strategy. These data show that wages vary by as much as 25 percent across counties, and thus across HSAs in which coho salmon recovery activities will take place. Wages are higher in more urbanized counties located near the Bay Area or the Central Coast than they are in more rural counties in Northern California.

To calculate the aggregate fiscal cost of each type of recovery action, by HU, ESU, and range-wide, the following steps were taken:

Step 1: Illustrative project costs for each class of recovery action were identified by examining unit costs of activities that must be undertaken as part of the recovery action and by surveying evidence on historical project costs;

1 The remoteness of the job site is another factor that influences the cost of a particular recovery project. In some cases, we are able to use cursory information about the distance of a project from a road to incorporate this factor into the analysis.

2 For HSAs that fall in more than one county, wages are assumed to be a simple average of the wages in all counties covered.

Step 2: As appropriate, ways in which recovery action costs are likely to vary systematically were identified (e.g., in-channel restoration is likely to be more costly at more remote streams);

Step 3: The extent to which differences in wage rates will affect recovery action costs in each HSA was identified using the wage information presented in Table I-1;

Step 4: Base-case assumptions about the quantity of each type of recovery action that will be required in each HSA (e.g., the fraction of stream miles needing riparian revegetation or LWD placement, or the fraction of roads needing decommissioning) were made drawing on information received from the Department, members of the recovery team, and previous literature as appropriate;

Step 5: Using the HSA-specific unit costs developed in steps 1-3, unit costs were multiplied by the HSA-specific recovery action quantities developed in step 4;

Step 6: Total costs for each recovery action by HSA were summed to develop aggregate cost estimates for each HU, ESU and the State as a whole.

TABLE I-1: Average 2002 construction industry wages by county

County	Average Construction wage ($/hour)	County wage as percentage of California average wage (%)
Alameda	23.72	120
Contra Costa	23.72	120
Del Norte	18.06	92
Glenn	18.06	92
Humboldt	18.06	92
Lake	18.06	92
Marin	24.80	126
Mendocino	19.03	97
Napa	22.89	116
San Francisco	24.80	126
San Mateo	24.80	126
Santa Clara	23.13	117
Santa Cruz	20.29	103
Siskiyou	18.06	92
Sonoma	20.53	104
Solano	22.89	116
Trinity	18.06	92
All CA counties	19.69	

Source: California Office of Employment Statistics, employment and wages by occupation. Available: http://www.calmis.ca.gov/file/occup$/oes$.htm

I.2.2 TIMING OF RECOVERY RECOMMENDATIONS

Fiscal cost impacts of the various recovery recommendations are presented in the simplest possible terms: the current dollar cost of completing the action now. Absent information about the specific sequencing of recovery recommendations over the coming decades, and lacking information on how State obligations would be financed, it is impossible to calculate financing costs, or to convert actions over some period of time into current dollar equivalents. Instead, costs were calculated as if all recovery recommendations would be completed immediately.

Stretching recovery recommendations over some time period would have at least three effects on current dollar costs of the Recovery Strategy. First, inflation would drive up the nominal costs of all actions. Second, discounting to present values would decrease the lump-sum amount of money needed to finance recovery over some period of time. Third, if recovery were financed by a bond issued up front, then the State would incur financing costs since bondholders would have to be paid yields in excess of the return on allowable investments.

The cost of achieving interim recovery goals is likely to include the cost of most of the biological and non-biological studies and watershed planning exercises called for in the Recovery Strategy. Other interim costs will include the cost of implementing restoration recommendations in the highest priority watersheds. While these watersheds have been identified, the most important recovery recommendations within these watersheds have not been identified at a sufficiently disaggregated level to separately identify these costs. Thus, further quantification of the cost of achieving interim recovery goals is not possible at this time.

I.2.3 FISCAL COSTS VS. SOCIOECONOMIC IMPACTS

For each of the classes of recovery recommendations considered in this section, the fiscal cost of the action and, separately, the socioeconomic impacts of the action are addressed. The fiscal or budgetary cost of a recovery action is the expenditure needed to physically perform the action. The socioeconomic impact of a recovery action includes income foregone because the recovery action is undertaken, and transfers to the local region (in this case, the HSA) from outside the region because the recovery action is undertaken.

Consider the example of riparian revegetation. The fiscal cost of this action is the expenditure required to purchase, plant, and maintain appropriate vegetation in streamside areas. Income may be foregone as a result of this action because land is now devoted to recovering salmon populations. If riparian areas that once provided income from timber harvesting are left to maintain riparian cover for coho salmon, the stream of foregone profits from timber harvesting is an element of the social cost of this recovery action. Tax revenue is also forgone because land is now devoted to maintaining salmon populations. The benefits to landowners of avoiding the loss of land to ongoing erosion is not accounted for.

The welfare costs of recovery recommendations are distinct from the regional transfers associated with recovery recommendations that complete the calculation of socioeconomic impacts. Regional transfers arise when employment or other economic activity occurs in a particular region as a result of a recovery action that otherwise would have taken place in another region. To continue with the example of riparian revegetation, undertaking this recovery action in a particular HSA generates jobs and other economic activity in that HSA, but this activity is not a net gain for the State of California; it is a transfer of economic activity from one region to another. Resources dedicated to riparian revegetation would have been put to another use if the Recovery Strategy were not implemented. Each class of recovery action has analogous socioeconomic impacts, though the magnitude of these transfers varies.

Socioeconomic impacts, in the form of employment effects and other changes in regional economic activity, can be positive or negative. An example of negative socioeconomic impacts arises in the case of water acquisitions. If water is purchased from willing sellers of water rights to increase instream flows for coho salmon, the seller of the water rights is at least no worse off than she would have been if her water rights had been used for production of irrigated agriculture. However, if, as a result of the sale of water rights, agricultural land is left fallow that otherwise would have been used in production, there is an associated decline in demand for agricultural inputs (e.g., fertilizer or pesticide) and a decline in demand for agricultural labor. This economic activity will not take place in the region as a result of the implementation of the Recovery Strategy.

If the State of California, or individual regions covered by the Recovery Strategy, were in a State of full employment, the generation of economic activity as a result of Recovery Strategy implementation could increase the demand for labor and increase equilibrium, or prevailing, wage rates. In general, the economists consider this to be unlikely in the case of the Recovery Strategy. The cost of the Recovery Strategy is small relative to total economic output in the State, and, more importantly, most of the regions in which the bulk of the recovery recommendations will take place face structural unemployment.

Table I-2 summarizes California unemployment rates in 2002 by county and also presents information on whether particular counties have been identified as labor surplus areas by the US Department of Labor. With the exception of urbanized counties in the Bay Area, the unemployment rates in counties containing coho salmon HSAs are above the State average. Almost one-half of these counties have been identified to be labor surplus areas by the US Department of Labor.

TABLE I-2: California unemployment rates by county

County	Unemployment rate (%)	Labor surplus area?
Alameda	6.8	
Contra Costa	5.2	San Pablo City only
Del Norte	9.2	YES
Glenn	10.2	YES
Humboldt	6.5	YES
Lake	8.4	YES
Marin	4.0	
Mendocino	7.2	YES
Napa	4.3	
San Francisco	7.3	
San Mateo	5.0	
Santa Clara	8.4	
Santa Cruz	8.0	Watsonville City only
Siskiyou	9.8	YES
Sonoma	4.5	
Solano	5.5	
Trinity	9.6	YES
All CA counties	6.7	

Source: California Office of Employment Statistics, monthly labor force for counties, 2002 benchmark. Available: www.calmis.ca.gov/file/lfhist/02aacou.txt. Labor surplus areas 2003 defined by US Dept. of Labor as areas with unemployment rates above 6 percent for Jan. 2000-Dec. 2001. Available: www.uses.doleta.gov/pdf/lsajurisdictions03.pdf.

Labor surplus areas are defined as areas with unemployment rates above six percent for two years. Thus, this designation is a good indicator of long-term unemployment. Increasing economic activity in a labor surplus area by transferring resources from outside the region to area will be unlikely to increase wages at the margin.[3] By the same logic, wages are also unlikely to be affected by transferring resources from the area (as in the water acquisition example above) to another region.

To calculate the aggregate socioeconomic impacts of commonly-recommended recovery recommendations, steps similar to those outlined for aggregate fiscal costs above were followed. This implies that limited information about the scale or quantity of each recovery action is an important constraint in making this calculation, just as it is in the case of the calculation of aggregate fiscal costs.

The following steps summarize the calculation of socioeconomic impacts in each HSA, HU and range-wide:

Step 1: The fraction of illustrative project costs (identified in the course of calculating the fiscal cost of recovery recommendations) attributable to permitting, planning, and mobilization were estimated. These expenditures do not generate appreciable economic activity or employment in local regions;

Step 2: Regional transfers were estimated as total fiscal costs for each recovery action by HSA less the fraction of these costs identified in Step 1;

Step 3: Welfare impacts associated with each class of recovery action were identified; where possible, these impacts were quantified by multiplying unit social costs (or benefits) by the amount of each recovery action that would be undertaken;

Step 4: Tax impacts associated with each class of recovery action were identified; where possible, these impacts were quantified by multiplying unit costs (or benefits) by the amount of each recovery action that would be undertaken; and

Step 5: Impacts calculated in Steps 2-4 were summed to develop aggregate socioeconomic impact estimates for each HU, ESU and the State as a whole.

I.3 BARRIERS TO FISH PASSAGE

In many HUs and HSAs, assessment, prioritization, and treatment of barriers to fish passage have been identified as recovery priorities. Assessing the cost of these activities requires information about (1) the inventory of barriers in each HSA, (2) the location of barriers in HSA, and (3) the size or complexity of all barriers. In this section the cost of projects to treat each of these types of barriers is discussed. To estimate the cost of treating barriers, the Department supplied an inventory of potential barriers by HSA. This inventory database includes a description of the barrier, information (if known) about whether the barrier constitutes a total, partial, or temporal (seasonal) barrier to fish passage, and information, developed using GIS, about whether the barrier is located in a forested, agricultural, suburban, or urban area. It is important to note that this database contains potential barriers and that not all of these potential barriers have been field verified. The Department has identified the following types of potential barriers:[4]

3 Note that if volunteer labor is used for restoration activities this can reduce the fiscal costs of these activities. It does not change the way the socioeconomic impacts are calculated. These are still correctly calculated using market wage rates on the assumption that this wage is foregone when volunteers supply their labor for restoration, just as it is foregone when leisure is chosen over labor.

4 Barriers information provided by the Department comes from the California Coastal Conservancy. 2003. Assessment of Potential Barriers to Fish in California Coastal Watersheds.

- Dams;
- Non-structural sites (e.g., log jams);
- Fish passage facilities;
- Stream crossings (e.g., culverts);
- Unknown/Other barriers; and
- Water diversions.

I.3.1 FISCAL COSTS

I.3.1.1 Dams

The Department has identified by HU dams that could act as potential barriers to fish passage in the coho salmon ESUs. There are at least two major actions that can be taken to improve fish passage at dams; the dam can be removed (more likely to be feasible in the case of small dams) or ladders, screens, and pumps can be installed to allow fish to pass over the dam.[5] The fiscal cost of either of these actions varies widely and depends on (1) the physical location of the barrier, (2) the height of the barrier, and (3) the width of the barrier. The barrier inventory supplied by the Department does not include information about these physical characteristics of dams; information on the height of about 250 of the dams was collected from the National Inventory of Dams[6] and matched with the Department's data using reported dam names.

To estimate the fiscal cost of dam treatment, surveys previously performed by other authors of the cost of fish passage improvement at dams were considered, and indicative project costs were based on similar project costs in California and, to a lesser extent, in Oregon and Washington.

The cost of removing dams varies fairly regularly with the height and width of the dam, but project-specific factors, such as structure type, sediments, water rights, easements, and the need for monitoring can greatly impact the total cost of treatment (Rhode Island Habitat Restoration Portal (2001).[7] Friends of the Earth et al. (1999)[8] performed case studies of more than 30 dam removal projects in the United States and found that some small dams can be removed for under $10,000. The removal of a larger dam (e.g., 15-20 feet in height) can cost as much as $1 million. In neither case do these cost estimates include the important considerations of the cost of permits, easements, design, or monitoring. The median cost of dam removal in this study was about $100,000. However, this finding cannot be interpreted to suggest that this will be true in California or elsewhere in the future. Previous dam removals were not the result of a random selection; it is likely that relatively inexpensive removal projects have been undertaken first and that average removal costs will rise over time.

As in the case of dam removal, the cost of constructing an artificial fishway is proportional to the height of the dam or other obstruction. Rhode Island Habitat Restoration Portal (2001) and Connecticut River Watershed Council, Inc. (2000)[9] show illustrative fishway construction

[5] New fish ladders may be installed or modified to replace poorly functioning ladders that cannot pass fish easily during certain flow conditions. Modified or new fish ladders may have wider flow ranges for passing fish. Locations for new fish ladders would be where construction, operation, and maintenance access are most efficient, usually at stream edges. Potential designs of fish ladders include pool and weir, vertical slot, and roughened channel types. Source: http://www.delta.dfg.ca.gov/afrp/documents/DeerPEA.pdf.

[6] Available: http://crunch.tec.army.mil/nid/webpages/nid.cfm.

[7] Rhode Island Habitat Restoration Portal. 2001. Restoring coastal habitats for Rhode Island's future: Costs of restoration. Available: http://www.edc.uri.edu/restoration/html/tech_sci/socio/costs.htm.

[8] Friends of the Earth, American Rivers, Trout Unlimited. 1999. Dam Removal Success Stories: Restoring Rivers Through Selective Removal of Dams that Don't Make Sense. Available: http://www.americanrivers.org/damremovaltoolkit/ssoverview.htm.

[9] Connecticut River Watershed Council, Inc. 2000. Providing fish passage around dams in the Northeast: a fishway for your stream. The Connecticut River Watershed Council, Inc., Easthampton, Massachusetts.

costs for two commonly used fishways, steeppass and denil. These findings show that installation of steeppass fishways, which can be used for dams up to 12 feet in height, costs about $10,000 for every vertical foot of dam height. When dam height exceeds eight or nine feet, a resting pool should be added, which costs another $5,000. A denil fishway, used for larger dams, costs about $20,000 for every vertical foot for dams up to six feet in height. For higher dams, denil fishways cost about $25,000 to $30,000 for every vertical foot. These costs also apply to projects to improve passage at the 37 fish passage facilities identified by the Department in its barrier inventory.

A survey of recent expenditures on projects to remove dams or improve fish passage at dams in California undertaken by the authors is broadly consistent with the findings of surveys in other parts of the United States. For example, removal of the four water diversion dams, varying in height from six to twelve feet, along Butte Creek cost about $9.18 million in 1998 (12 unscreened diversions were also treated). This suggests an average dam removal cost of about $2 million. Removal of the Lake Christopher dam (10 feet in height and 400 feet in length) cost about $100,000 in 1994. At the time, repair costs to improve fish passage were estimated at $160,000 to $180,000. Both of these projects are described in detail by American Rivers (1999).[10] The Fife Creek Check Dam Removal and Habitat Enhancement Project in Sonoma County, which was funded by the Department in 1999, cost about $54,000.[11] The economists reviewed the projects recently funded by the Department to improve fish passage at dams by installing ladders and pumps and they found that costs ranged from $150,000 to $1.6 million, with a mean cost of about $900,000.[12]

Based on this information about recent projects, the following assumptions were made in calculating the total expected cost of dam removal and treatment in the coho salmon ESUs:

1. Dams smaller than 15 feet in height will be removed if treated;
2. The average cost of removing a small dam (less than 15 feet) in this region is $500,000;
3. For dams of known height greater than 15 feet, treatment costs will be $15,000 per foot;
4. For dams of unknown height that have been identified as complete barriers to fish passage, the cost of treatment will be $900,000;
5. For dams of unknown height that have been identified as partial and/or temporal barriers to fish passage, or barriers of unknown magnitude, the cost of treatment will be $450,000.

The Bureau of Reclamation (BOR) assumes that indirect costs, including permitting, account for about 40 percent of total project costs for upgrading and installing fish screens (Hudson 2002).[13] The assumption was made that this fraction of project costs will be spent on permitting and other indirect costs for all barriers projects except culvert treatment. This fraction of total unit costs is not expected to vary by HSA. Of the remaining costs, the assumption

10 American Rivers. 1999. Completed Dam Removals in California. Available: http://www.americanrivers.org/damremovaltoolkit/sscalifornia.htm.

11 State of California Department of Fish and Game Native Anadromous Fish and Watershed Branch. 2000. Summary of projects funded in 1999. Available: http://www.dfg.ca.gov/nafwb/1999grants.htm.

12 State of California Department of Fish and Game Native Anadromous Fish and Watershed Branch. Summary of projects funded in various years. Available: http://www.dfg.ca.gov/nafwb. See also California Department of Water Resources, Bulletin 250-2002, Fish passage improvement. Available: http://www.isi.water.ca.gov/fish/ChapterFront/Front%20Matter.pdf.

13 Hudson, R.D. 2002. Upgrading and installing fish screens: Developing cost estimates. In S. Allen, R. Carlson, and C. Thompson, eds. Proceedings of the salmon habitat restoration cost workshop. Pacific States Marine Fisheries Commission. Gladstone, OR.

was made that 15 percent are attributable to labor, consistent with the other culvert replacement itemized budgets (see the discussion of stream crossings in section I.3.1.3). This fraction of costs (about nine percent of project costs) will vary by HSA according to local wage rates.

Based on advice received from the Department, the assumption was made that approximately 50 percent of the potential barriers to fish passage that are dams will require treating except in those HUs where the Department has more precise information about the number of dams that act as barriers. Attachment 1 summarizes the estimated aggregate cost of dam treatment by HU.

I.3.1.2 Non-structural Sites

Non-structural barriers such as log-jams, boulder jams, and other barriers of natural materials can impede fish passage in ways similar to dams. The Department has identified over 3,000 non-structural barriers and almost 100 other sites that are similar (e.g., trash or tires blocking streams). Unlike many dams, most non-structural sites can be removed or altered to allow fish passage. The cost of barrier removal can vary depending on the location of the barrier, permitting requirements, and sediment impacts of removal. Direct removal costs generally depend on the sheer size of the site to be altered reports. Table I-3 presents illustrative unit costs for activities to be undertaken when non-structural sites are treated. These costs reflect range-wide averages as calculated by the United States Department of Agriculture (USDA) in Oregon as part of its Environmental Quality Incentives Program (EQIP) program.[14]

TABLE I-3: Construction unit costs for treatment of non-structural sites in Oregon

Activity	Unit cost ($)	Unit
Rock excavation	7.5	CY
Wet excavation	1.75	CY
LWD removal	125	ton
Log removal	100	ton
Rock clearing	25	ton
Root wad removal	100	ton

Source: USDA EQIP Program (2002)
Units: LF: linear foot, CY: cubic yard, SF: square foot.

The Department's inventory of potential non-structural barriers to passage does not include information on the size of the barriers. Thus, to estimate the approximate size of the non-structural barriers to passage that will be removed, information about the cost of previous Department-funded non-structural barrier removal projects was reviewed and a range of relevant projects funded by the Department since 1999 was identified. These projects ranged in cost from $1,600 to $28,000. Based on this information, an average project cost was assumed to be $10,000 for purposes of calculating the total cost of non-structural barrier removal.

BOR calculates that indirect costs, including permitting, account for about 40 percent of total project costs for upgrading and installing fish screens (Hudson 2002). The assumption was made that this is indicative of the fraction of project costs that will be spent on permitting and other indirect costs for all barriers projects. This fraction of total unit costs will not vary by HSA. Of the remaining costs, 15 percent were assumed to be attributable to labor, consistent with some actual itemized budgets for culvert replacement (see the discussion of stream cross-

[14] It appears that this class of recovery action has not been funded by EQIP in California yet. Project costs are likely to be similar.

ings in section I.3.1.3). This fraction of costs (about 9 percent of project costs) will vary by HSA according to local wage rates.

On the advice of the Department, impact calculations assumed that approximately 50 percent of the potential barriers to fish passage that are non-structural sites will require treating. Attachment 1 summarizes the estimated aggregate cost of non-structural site treatment by HU.

I.3.1.3 Stream Crossings

Many existing culverts, built at a time when concerns about fish passage were less prevalent than they are currently, are now recognized as potentially important targets of the Recovery Strategy because older culverts can block access to reaches of potential habitat. Replacing culverts involves removal of old-style culverts (often large pipes) at stream crossings and replacing them with structures that fish can pass through more easily, such as concrete arch or box culverts. The surrounding road segment must be rebuilt. Table I-4 presents information on the unit cost of construction elements of culvert treatment in California.

Culvert replacement can be a complex and costly activity. Non-construction activities, not included in Table I-4, can account for a significant fraction of the total costs. As an illustration of the non-construction costs that are important parts of culvert replacement activities, Table I-5 presents itemized budgets for several culvert replacement and repair projects in Washington State.[15] Notably, traffic control and pre-project mobilization, (which includes permitting) are major elements of total project costs. This is likely to be less important for forest roads, but at least 20 percent of the culverts potentially needing replacement in the coho salmon ESUs are not associated with forest roads, but other more heavily trafficked county and city roads. Costs are also likely to differ depending on whether private landowners or the public sector performs culvert replacement. Costs may be higher for the public sector.

TABLE I-4: Construction unit costs for treatment of stream crossing barriers to passage in California

Activity	Unit Cost ($)	Units
Arch culverts	32.8	LF-Diameter/LF
Non-structural non-reinforced concrete	150	CY
Non-structural reinforced concrete	250	CY
Earthwork excavation	1.5	CY
Geoweb/Geocell soil cellular confinement system	5	SF
Gravel, in place	18	CY
Rock, in place	100	CY
Constructing step-pool/ weir below culvert	2,000	LF

Source: USDA EQIP Program (2002) Available: http://waterhome.brc.tamus.edu/NRCSdata/Costs/, California Department of Transportation (Caltrans) pers. comm. (step-pool/ weir construction).
Units: LF: linear foot, CY: cubic yard, SF: square foot.

15 These cost estimates come from winning bidders responding to requests from the Department of Transportation. In Caltrans' experience, item-by-item cost data are skewed by the bidding process. Bidders have incentives to present estimated costs that differ from their actual costs as part of the effort to be the lowest bidder (pers. comm. Recovery Team). Thus, these figures must be interpreted with care.

TABLE I-5: Illustrative project costs for treatment of stream crossing barriers to passage in Washington State

Project:	Culvert replacement ($ '000)			Culvert repair ($ '000)
County: Activity	King (suburban)	Snohomish (rural)	Whatcom (rural)	Chelan (rural)
Mobilization	46	50	8	16
Structure/obstruction removal	7	8	1	1
Grading	8	23	3	
Culvert drainage	259	128	8	150
Surfacing	14	20	1	
Pavement	21	11	2	
Erosion control/ planting	38	16	24	1
Traffic control	236	250	15	40
Other miscellaneous	8	24	13	12
Total cost	637	530	75	220

Washington State Dept of Transportation Bid Check Reports, engineering estimates. http://www.wsdot.wa.gov/biz/contaa/BIDTAB/. Snohomish culvert replacement project included an additional pavement installation element costing about $228,000 not included here. Thus, traffic control costs associated with culvert replacement only are likely less than the costs reported here.

The total fiscal cost of culvert replacement activities depends on (1) the type of the road that crosses the stream, (2) the size of the waterway crossed, and (3) whether the land where the culvert is located is privately or publicly owned. Evergreen Funding Consultants (2003) surveyed culvert replacement projects and found that while culvert replacement on forest roads costs between $15,000-$40,000 on a small waterway less than ten feet wide, it can cost as much as $100,000 to replace a forest road culvert at a tributary between ten and 20 feet wide and $150,000 to replace a forest road culvert at a tributary over 20 feet wide. These project cost estimates include the cost of construction, permitting, and traffic control.[16] For non-forest roads, Table I-6 summarizes Evergreen Funding Consultants' findings.

Information provided by Caltrans to the CRT is consistent with the information provided in Table I-6. Caltrans reports that culvert replacement, with no change in flow capacity, can range in cost from $20,000 to over $1 million. Replacement with an upgrade in flow capacity and improvements in culvert slope ranges in cost from about $30,000 to $2 million. Caltrans projects an average cost of about $400,000 for replacement in the coho salmon range since most fish culverts are either box culverts or large circular culverts. For culvert rehabilitation,

TABLE I-6: Estimated cost of culvert treatment by road type ($000)

	Road Type		
Size of waterway	Two-lane road (minor)	Two-lane road (major)	Highway
Less than 10 feet	50-100	100-200	200-350
10-20 feet	140-240	200-350	300-450
20-30 feet	180-280	250-450	600-800

Source: Evergreen Funding Consultants (2003)

16 According to the Highway Construction Cost Comparison Survey performed by the Washington State DOT (2002), preliminary engineering costs are about 5 percent higher in California than they are in Washington. However, environmental mitigation costs are generally lower in California. In total, illustrative highway construction costs (for a Diamond interchange) are about 40 percent higher in California than they are in Washington. The survey does not identify the source of this variation.

Caltrans estimates that costs range from $15,000 to $500,000; with an average cost of about $100,000 if no added effort is made to improve fish passage. If rehabilitation addresses fish passage concerns only, project costs average about $80,000. Caltrans cost estimates are probably indicative of the costs that counties will face as well.

In the event that culverts are to be replaced with span bridges, project costs will likely be much higher (Caltrans pers. comm. Evergreen Funding Consultants 2003). This depends on the span of the waterway in question; for larger waterways, culverts may have to be cast in place; in that event the cost of bridges and culverts will be similar. If bridges are used in instances in which a pre-cast culvert might be available, the incremental cost associated with the choice of a bridge can be on the order of $300,000 (Caltrans pers. comm.).[17]

When estimating the cost of culvert treatment in practice, it will be important to consider local labor costs, since traffic control is a labor-intensive activity, as well as the location of culverts and waterway size. The itemized budgets for the culvert replacement projects in Washington State reviewed by the economists suggest that traffic control labor represents about 20 percent of total traffic control costs. Itemized budgets from Oregon suggest that construction labor costs are about 12 percent of total construction costs (Medford District Resource Advisory Committee Project number 118-409).

Based on estimates made by Evergreen Funding Consultants (2003) and review of culvert replacement and repair projects in California, Washington, and Oregon, the costs of culvert treatment are expected to vary according to the geographic location of culverts, the extent to which stream crossings constitute partial/temporal or total barriers, and waterway size as summarized in Table I-7. To estimate the cost of treating stream crossings in the coho salmon ESUs, it is necessary to contend with the fact that no data are available in the Department's inventory of potential barriers about the size of the culverts that have been identified as potential barriers to fish passage. The barrier inventory does identify whether the culvert occurs at a tributary (a relatively smaller waterway) or a stream (a relatively larger waterway). This information was used to predict how the cost of culvert treatment will vary among barriers. Data were provided by the Department about land use in the area in which culverts have been identified. As discussed above, it is likely that culverts in forest regions are smaller and less costly to treat than culverts in other regions. The traffic control costs in project budgets reviewed by the economists suggest that culverts in suburban and urban areas are likely to be more costly

TABLE I-7: Cost per project to provide fish passage/mitigate barrier

Stream Crossing	Land-use where stream crossing located			
	Forest	Agriculture	Suburban	Urban
Tributary:				
Total barrier	56	140	280	490
Partial/ temporal barrier	28	70	140	245
Stream:				
Total barrier	140	336	490	700
Partial/ temporal barrier	70	168	245	350

Source: See text. Some potential barriers are of unknown severity. The conservative assumption has been made that these constitute total barriers to passage.

17 Whether a culvert receives remediation treatment vs. a full replacement not only depends on type and timing of impediment, but most importantly on size and condition of original culvert and ease of full replacement. For example, a large box culvert on Sir Francis Drive Road in West Marin, with another 30 years of wear, and huge costs and inconveniences associated with traffic control, would more likely receive an interior structural fix (e.g. baffles and step pool construction), vs. a full replacement. Often, the Capital Improvements Projects schedule and budget of a government entity such as a county or city, highly influences the type of project (FishNet 4C Program public comment).

to treat than stream crossings in less-traveled rural or agricultural areas. No data are available about whether culverts that will be treated are on public or private roads. Thus, the explicit costs calculations cannot take potentially higher public sector costs into account. However, unit cost estimates are informed by surveys of both public and private costs.

BOR assumes that indirect costs, including permitting, account for about 40 percent of total project costs for upgrading and installing fish screens. (Hudson 2002). It was assumed that this is indicative of the fraction of project costs that will be spent on permitting and other indirect costs for all barriers projects. This fraction of total unit costs will not vary by HSA. Of the remaining costs, the assumption was made that 15 percent are attributable to labor, consistent with the culvert replacement itemized budgets that were reviewed. This fraction of costs (about nine percent of total project costs) will vary by HSA according to local wage rates.

Based on advice provided by the recovery team, a review of the Marin County Stream Crossing Inventory and Fish Passage Evaluation (Ross Taylor and Associates 2003) and a review of the Inventory of Select Migration Barriers in the San Geronimo sub-watershed,[18] this analysis assumes that approximately 50 percent of the potential barriers to fish passage that are stream crossings will require treatment for coho salmon recovery. For each HSA, the fraction of treatment that will be culvert rehabilitation, as opposed to replacement, depends on whether the barriers identified in the HSA are partial and/or temporal barriers as opposed to total or unknown barriers. With no basis to identify when span bridges may be appropriate, the assumption was made that culvert rehabilitation and treatment will be used. Attachment 1 summarizes the estimated aggregate cost of stream crossing treatment by HU.[19]

I.3.1.4 Fish Passage Facilities

The Department has identified 45 fish passage facilities in the coho salmon ESUs that may constitute barriers to passage, presumably because the pumps, fish ladders, and screens at these facilities require repair or upgrades.

To estimate the cost of improving fish passage at these facilities, the economists reviewed the cost of projects funded by the Department recently to repair and upgrade fish ladders and install pumps and screens. For these eight recent projects, costs for repairing and upgrading fish passage at facilities ranged from around $60,000 to over $1.6 million. On average, the cost of treatment for this type of barrier was $760,000.[20] The assumption was made that costs on larger waterways (streams) will be slightly greater than this ($900,000) and costs on smaller waterways (tributaries) will be lower ($500,000).

BOR assumes that indirect costs, including permitting, account for about 40 percent of total project costs for upgrading and installing fish screens (Hudson 2002). The assumption was made that this is indicative of the fraction of project costs that will be spent on permitting and other indirect costs for all barriers projects. This fraction of total unit costs will not vary by HSA. Of the remaining costs, the assumption was made that 15 percent are attributable to labor, consistent with the culvert replacement itemized budgets that have been reviewed. This fraction of costs (about nine percent of total project costs) will vary by HSA according to local wage rates.

On the advice of the Department, the assumption was made that approximately 50 percent of the potential barriers to fish passage that are fish passage facilities will require treatment for

18 Prepared by the Salmon Protection and Watershed Network. 2002. Available: http://www.spawnusa.org/reports/Mig_Bar_Rpt_10-10-02.pdf.

19 For a limited number of culverts, precise treatment cost estimates have been provided by the Department. These culverts are in the Klamath River HU, Eel River HU and Scott River HA.

20 State of California Department of Fish and Game Native Anadromous Fish and Watershed Branch. Summary of projects funded in various years. Available: http://www.dfg.ca.gov/nafwb. See also California Department of Water Resources, Bulletin 250-2002, Fish passage improvement. Available: http://www.isi.water.ca.gov/fish/ChapterFront/Front%20Matter.pdf.

coho salmon recovery. Attachment 1 summarizes the estimated aggregate cost of stream crossing treatment by HU.

I.3.1.5 Water Diversions

The Department has identified approximately 1,100 locations where water is diverted from streams for agriculture, domestic, or industrial uses through unscreened intakes in the coho salmon ESUs. The majority of these diversions are for irrigation purposes. Fish screening devices can be placed at these diversions to prevent fish from entering the diversion and being lost. Water continues to pass as needed, but fish cannot leave the stream. USDA has estimated the average cost of fish screen installation in California as relatively modest. These cost estimates are summarized in Table I-8.

TABLE I-8: Construction unit costs for fish screen installation in California

Device	Units	Unit cost ($)
Fish Screen - Passive	Each	1,000
Fish Screen - Self Cleaning	Each	3,000
Fish Screen - Large	Each	40,000
Fish Screen - Small	Each	10,000

Source: USDA EQIP Program (2002)
http://waterhome.brc.tamus.edu/NRCSdata/Costs/

Actual projects undertaken or proposed in Washington State report costs that are similar to these average cost estimates provided by USDA. For example, a proposal submitted to the Columbia Basin Fish and Wildlife Authority in 2001 proposed to install passive fish screens at all Walla Walla Basin irrigation diversions (197 diversions in total) at a total cost of about $1 million. The physical cost of the screens was estimated to be about $2,300 each, including a 15 percent cost share from land owners.[21] Field assessments were estimated to cost about $30,000 or about $150 per diversion. There are likely to be significant economies of scale associated with the assessment requirements of water diversions. That is, these associated costs are likely to be lower on a per unit basis when many diversions are to be screened.

To take another example, a project proposal for the fabrication and installation of two new fish screening facilities and the rehabilitation of one existing screening facility on irrigation diversions on the Wentachee River in 2003 estimated a construction cost of $45,000.[22] Screening costs are higher on larger bodies of water than small ones. Based on this review, when the aggregate costs of water diversion treatment is calculated, the assumption was made that barriers on relatively small tributaries can be treated at a cost of $10,000, and barriers on relatively larger stream can be treated at a cost of $40,000.

BOR assumes that indirect costs, including permitting, account for about 40 percent of total project costs for upgrading and installing fish screens (Hudson 2002). The assumption was made that this is indicative of the fraction of project costs that will be spent on permitting and other indirect costs for all barriers projects. This fraction of total unit costs will not vary by HSA. Of the remaining costs, the assumption was made that 15 percent are attributable to labor, consistent with the culvert replacement itemized budgets reviewed by the economists (see the discussion of stream crossings in section I.3.1.3). This fraction of costs (about nine percent of total project costs) will vary by HSA according to local wage rates.

21 CBFWA FY 2001 Project ID 23048. Available: http://www.cbfwf.org/2001/highpriority/projects/23048.htm.

22 CBFWA FY 2001 Project ID 29028. Available: http://www.cbfwf.org/files/province/cascade/projects/29028.htm.

On the advice of the Department, the assumption was made that approximately 50 percent of the potential barriers to fish passage that are diversions will require treating. Attachment 1 summarizes the estimated aggregate cost of diversion treatment by HU.

I.3.2 SOCIOECONOMIC IMPACTS

As discussed in section I.3.1, for each category of barriers, a review of historical barrier treatment projects provides the information necessary to estimate the fraction of project costs attributable to permitting, planning, and mobilization. The socioeconomic impact in the form of regional transfers that will occur as a result of barrier treatment was calculated to be total fiscal costs less that fraction. Estimated socioeconomic impacts as a result of these transfers are summarized in Attachment 1.

Other welfare impacts associated with barrier removal are more difficult to quantify because of the limited information available about which potential barriers will actually be treated as a result of implementation of the Recovery Strategy. These impacts can only be discussed qualitatively at this time.

Dam removal may result in third-party impacts if dams currently serve a useful economic or recreational purpose. The benefits that these dams currently provide would be lost in the event that dams were removed to improve passage for coho salmon. Culvert replacement or treatment may increase or reduce flooding and associated costs. Screening water diversions and improving fish passage facilities should result in few substantive social costs, though maintenance requirements will result.

I.4 RIPARIAN REVEGETATION AND STREAM-BANK IMPROVEMENTS

One of the most common recommendations in the Recovery Strategy is riparian revegetation, accomplished by planting trees along stream and tributary banks to provide shade over the water that coho salmon use. These efforts are often part of larger projects to improve the condition of stream banks, including fencing and channel stabilization. This section considers the cost of riparian revegetation and more general stream-bank improvements.

The recommendations of the CRT with respect to riparian revegetation are fairly general in nature. Currently, information is not available as to the size of the buffer zones that the CRT believes are required at different types of streams. Similarly, information is not available to estimate the number of stream miles that require revegetation or other types of stream-bank improvements and the physical location of sites needing treatment. Given the general nature of the recommendations, the estimates of aggregate costs and socioeconomic impacts are necessarily sensitive to assumptions made about the values of these parameters.

I.4.1 FISCAL COSTS

I.4.1.1 Riparian Revegetation

The fiscal costs of riparian revegetation or planting depend on (1) the complexity of the project to be undertaken (e.g., the materials to be used), (2) the remoteness of the parcel of land to be treated, and (3) the degree of site preparation that is needed. Evergreen Funding Consultants (2003) suggest a budget of between $5,000 per acre and $135,000 per acre, with higher costs for projects that involve larger trees, more heavy machinery, and limited accessibility. These estimates include the cost of permitting and several years of maintenance. Notably, Federal government support for riparian revegetation projects in California under the EQIP program provides 50 percent cost-sharing assuming a cost of implementation of $2,000 per acre, significantly lower than the cost of typical programs in Washington State surveyed by Evergreen Funding Consultants.[23]

The complexity of riparian revegetation projects depends on whether planting is part of a larger set of stream-bank protection and improvement activities, which can vary widely in cost depending on site-specific goals and needs. The next subsection discusses the average unit cost of typical stream-bank improvement activities in California.

Site preparation costs depend significantly on the slope of the land being planted and the amount of clearing required. Evergreen Funding Consultants (2003) report that for medium-cost projects, as defined by materials used and site accessibility, revegetation on flat and fairly clear sites cost between $10,000 and $30,000 per acre. Projects on steep sites where significant clearing is required will cost around $100,000 per acre. Clearly, determining whether a riparian revegetation project will be cost-effective depends significantly on the site type. Determining the aggregate cost of riparian revegetation also depends on the site types in each HSA, but no information is available about this in the Recovery Strategy.

High-cost riparian revegetation projects, in terms of materials used and site accessibility, have certainly been undertaken in other regions with endangered salmonid populations. If regulators and/or landowners want to provide drastic and rapid improvements in shade at streams and creeks, one option is to transplant large trees. For example, at the Stables Creek reconstruction project in Snohomish County, Washington, 15-20 foot high trees were planted at the stream bank. Using volunteer labor and donated material is more likely to make this sort of project cost-effective from the perspective of public agencies.

Riparian revegetation projects also vary in cost according to site accessibility. The Department has provided information about the distance of streams in each HSA from roads. Riparian revegetation at sites further from roads is likely to be more costly than at sites near roads. Evergreen Funding Consultants (2003) estimate that projects on an average slope, and requiring average clearing and materials, vary in cost from about $20,000 to $80,000 per acre. For this analysis, the assumption was made that the average cost of riparian revegetation projects will vary as follows:

- Projects at stream area located less that 0.25 miles from a road cost $30,000 per acre;
- Projects at stream area located between 0.25 and 0.5 miles from a road cost $35,000 per acre;
- Projects at stream area located between 0.50 and 1 mile from a road cost $45,000 per acre;
- Projects at stream area located between 1 and 2 miles from a road cost $50,000 per acre;
- Projects at stream area located between 2 and 3 miles from a road cost $55,000 per acre; and
- Projects at stream area located more than 3 miles from a road cost $60,000 per acre.

The assumption was also made that at any stream mile that needs riparian revegetation, the width of the buffer created will be 50 feet. These assumptions result in fairly conservative cost estimates, but this is appropriate in the absence of additional information about the cost of materials required at sites. These parameters can easily be changed when the spreadsheet models provided to the Department are updated.

23 The cost estimates discussed in this section do not include the potential cost of conservation easements in riparian zones. See section I.4.2.1 for a discussion of the data required to estimate the cost of easements.

Riparian revegetation is a fairly labor intensive activity. As discussed in section I.2.1, labor costs largely determine how the cost of recovery actions will vary spatially, controlling for topographical differences among potential project sites. Thus, the labor requirements for projects will partially determine where riparian revegetation is relatively cost-effective. Typical restoration costs estimates reported by Bair (2002) suggest that about three percent of total project costs are due to labor. Because permitting and planning account for 53 percent of total costs, this is a fairly large fraction of total implementation costs. In calculations to estimate the aggregate cost of riparian revegetation, the assumption was made that three percent of unit costs will vary by HSA.

Attachment 2 summarizes the estimated aggregate cost of riparian revegetation by HU. These cost estimates are developed using estimates of the amount of riparian planting work that will be needed that were provided by the Department, and, in the case of the CCC Coho ESU, total cost estimates by HSA provided by the Department. Where the Department has provided this information at the HU level, the assumption was made that needs are divided among HSAs within an HU equally.[24]

I.4.1.2 Stream-bank Improvements

While riparian revegetation can be undertaken in isolation, these planting efforts may also be part of larger projects intended to stabilize and improve stream banks to reduce erosion. Table I-9 summarizes the average unit cost of various stream-bank improvement activities in California as reported by USDA.

TABLE I-9: Construction unit costs for stream-bank improvement activities in California

Stream bank improvement activities	Units	Unit cost ($)
Compacted Fill	CY	2.5
Cut and filling	CY	130
Geotextile Fabric	SF	1.25
Grading and Shaping	AC	200
Mobilization	Each	1250
Rock, In Place	CY	100
Rock/fill	CY	50
Seedbed preparation	AC	50
Stream tree revetment	Each	22
Wildlife Repellant (chemical)	AC	100
Stream bank protection, general	LF	125

Source: USDA EQIP Program (2002) Available: http://waterhome.brc.tamus.edu/NRCSdata/Costs/
Units: LF: linear foot, CY: cubic yard, SF: square foot, AC: acre.

USDA cost estimates report that stream-bank protection projects in general cost about $125 per square foot in California. However, these cost estimates do not include the cost of maintenance or permitting. Evergreen Funding Consultants (2003) provide project cost estimates that include the cost of permitting and short-run maintenance and range from $30 per

24 In the SONCC Coho ESU, the Department provided estimates of the quantity of riparian revegetation and stream-bank improvements needed that was not disaggregated by distance of streams from roads. Thus, while the spreadsheet model allows the analyst to vary the percentage of stream miles treated by distance from the road, in practice we calculate the aggregate cost of this class of recovery action as though all treated stream miles are less than 0.25 miles from roads. This assumption was made because in practice 60 percent of stream miles in the coho salmon range are within 0.25 miles of a road and over 90 percent are within one mile.

foot to $1,000 per foot. More complex projects in more remote areas will be more costly. In addition, projects needing significant excavation and grading will be more costly, as will those located in areas where the width of the stream is greater.

Besides depending on project complexity, the cost of stream-bank improvement projects will also depend on the productivity of labor hired for the project and local wage rates. Table I-10 summarizes approximate labor requirements for typical stream-bank improvement activities. In general, the larger the vegetation products being planted, the more labor that will required for each stream mile treated. Seeding is much less costly than planting containerized plants or larger trees.

To calculate the aggregate cost of stream-bank improvements, the assumption was made that stream-bank improvement projects cost including permitting and maintenance are higher than the construction-only costs reported by USDA, and roughly in the middle of the cost estimates reported by Evergreen Funding Consultants (2003). As discussed in the previous subsection, it is difficult to determine, based on limited available information, how to vary stream-bank improvement costs within HSAs except on the basis of site remoteness.[25] The estimated cost of this class of recovery action is about $200 per lineal foot for stream-bank area that is less than 0.25 miles from a road. As the distance of the stream bank from a road increases, unit costs are assumed to increase in the following manner:

- Projects at stream area located between 0.25 and 0.5 miles from a road cost $250 per lineal foot;
- Projects at stream area located between 0.50 and 1 mile from a road cost $275 per lineal foot;
- Projects at stream area located between 1 and 2 miles from a road cost $300 per lineal foot;
- Projects at stream area located between 2 and 3 miles from a road cost $325 per lineal foot; and
- Projects at stream area located more than 3 miles from a road cost $350 per lineal foot.

TABLE I-10: Labor requirements for stream-bank improvements

Activity	Per person labor required
Brush layering	6-17 LF/hr
Brush mattress	0.2-1.2 SY/hr
Plant Roll	20 LF/hr
Fascine placement	5 LF/hr
Sprig planting	5-24 SY/hr
Seedling planting	30-120 plants/hr
Ball and Burlap shrubs	1-158 plants/hr
Containerized plants	20-100 plants/ hr
Seeding	0.05-0.5 AC/hr
Hydroseeding	0.12-0.37 AC/ hr

Source: Hoag (2000).
Units: LF: linear foot, SY: square yard, SF: square foot, AC: acre.

25 Lack of information about site characteristics across HSAs may explain why these cost estimates are significantly higher than those reported by Hampton (2002) from a survey of 12 erosion control projects in California. He reports average unit costs that are very low compared those that we use here, on the order of $8 per lineal foot.

Costs vary across HSAs according to wage rates. The assumption was made that planning and permitting costs account for 53 percent of total unit costs and do not vary by HSA, just as in the case of riparian revegetation. Ideally, costs would also vary by the size of the waterway and extent of excavation needed, but with no information on the number of stream miles where stream-bank improvements are needed, there is no basis on which to introduce variation in costs by project complexity. As in the case of riparian revegetation, the assumption was made that three percent of total costs are attributable to labor and that these costs vary across HSAs according to local wage rates.

Attachment 2 summarizes the estimated aggregate cost of stream-bank improvements by HU. These cost estimates are developed using estimates of the amount of stream-side restoration work that will be needed that were provided by the Department. Where the Department provided information only about riparian planting (about two-thirds of SONCC Coho ESU HUs), the assumption was made that about one-half the number of stream miles would need stream-bank improvement work as well.[26] In addition, where the Department has provided this information at the HU level, the assumption was made that needs are divided equally among HSAs within an HU.

I.4.1.3 Fencing

A common recovery recommendation that is suggested to limit the access of livestock to streams and creeks is fencing. Livestock use of natural water channels stresses stream banks and can cause erosion. Associated sediment can harm salmon. Fencing is often an element of larger riparian revegetation projects, but unit costs of this activity in isolation are also available.

The unit cost of fencing depends on the type of fencing used. More elaborate fencing, with many gates or posts is more expensive to install than simple barbed wire fences. Fencing on steep slopes where significant clearing is required will also be more expensive than projects implemented on flatter ground or with minimal pre-existing vegetation. Evergreen Funding Consultants (2003) suggest budgeting between $3 and $12 per lineal foot for fencing projects. Table I-11 summarizes the average unit cost of various elements of fencing installation projects as calculated by USDA.

To calculate the aggregate cost of fencing activities in the coho salmon ESUs, an average cost of $8 per lineal foot was assumed. Costs are also assumed to vary across HSAs according to the local average construction wages.[27]

Attachment 2 summarizes the estimated aggregate cost of fencing by HU. These cost estimates are developed using estimates of the amount of fencing that will be needed that were provided by the Department. Where the Department has provided this information at the HU level, the assumption was made that needs are divided among HSAs within an HU equally.[28]

---

26 The Department provided estimates of the quantity of riparian revegetation and stream-bank improvements needed that was not disaggregated by distance of streams from roads. Thus, while the spreadsheet model allows the analyst to vary the percentage of stream miles treated by distance from the road, in practice we calculate the aggregate cost of this class of recovery action as though all treated stream miles are less than 0.25 miles from roads. This assumption was made because in practice 60 percent of stream miles in the coho salmon range are within 0.25 miles of a road and over 90 percent are within one mile.

27 Ideally, costs would also vary according to the sort of materials that would be used, with the simplest fencing projects costing about $3 per lineal foot and the most complex projects costing about $12 per lineal foot. However, at this time we have no basis on which to make inferences about the sort of material that would be used in different HSAs. In the spreadsheet model, this is an option for future analysis.

28 The Department has provided specific fencing costs for the Davenport HSA in Big Basin, which are incorporated into the analysis.

TABLE I-11: Construction unit cost of fencing project elements in California

Element of fencing project	Units	Unit cost ($)
Fence - Gate - 12ft	Each	75
Fence - Gate - 14ft	Each	85
Fence - Gate - 16ft	Each	100
Fence "T" posts	Each	1.5
Fence Posts (metal)	Each	8
Fence Posts (wood)	Each	5
Fencing, Conventional	LF	3.5
Fencing, Suspension	LF	2
Fencing, Electrical	LF	1.5
Fencing (smooth) without power	LF	1.5
Fencing (woven) 4 inch squares	LF	3
Fencing (woven) 5 inch squares	LF	3.25
Cattle Guard (Large)	Each	4,000
Cattle Guard (Small)	Each	3,000
Concrete, In Place	CY	350

Source: USDA EQIP Program (2002)
http://waterhome.brc.tamus.edu/NRCSdata/Costs/
Units: LF: linear foot, CY: cubic yard, SF: square foot, AC: acre.

I.4.2 SOCIOECONOMIC IMPACTS

I.4.2.1 Riparian Revegetation and Stream-bank Improvements

As discussed in section I.4.1.1, information from historical riparian revegetation projects and stream-bank restoration projects provides a basis for estimating the fraction of project costs that are attributable to permitting, planning, and mobilization. The socioeconomic impact in the form of regional transfers that will occur as a result of riparian revegetation and stream-bank restoration is calculated to be total fiscal costs less that fraction. Estimated socioeconomic impacts by HU as a result of these transfers are summarized in Attachment 2.

Other welfare impacts associated with this class of recovery recommendations are more difficult to quantify because of the limited information available about projects that will actually be undertaken as a result of implementation of the Recovery Strategy. These impacts can only be discussed qualitatively at this time.

The full social costs of riparian revegetation and stream-bank restoration depend on how the riparian land affected will be treated. If the Department or another entity purchases riparian land for salmon restoration, this land will no longer generate income for its previous owner. The land price that will be paid reflects this foregone income if land markets are competitive. Table I-12 shows illustrative unit values for forest land, which might be purchased for habitat conservation, particularly in riparian areas. These unit values suggest that the social cost of forest land acquisition may be lower in the SONCC Coho ESU than in the CCC Coho ESU, though costs range widely within all counties for which data are available.

If land is not purchased outright for salmon habitat conservation, the Department or other entities may elect to purchase conservation easements on riparian land. Conservation easements pay landowners to restrict development. The per-acre cost of easements is generally lower than the full market price of land; the easement price should reflect the difference between the amount of income that could be earned on a parcel without development restrictions, and the income that can be earned once the easement is in place. For narrow riparian buffers, little income may be available in light of the listing of coho salmon as a threatened or

TABLE I-12: Illustrative unit values of the social cost of forest land acquisition, selected California counties ($/acre)

	Unit prices of forest land		
County	Average ($/acre)	Minimum ($/acre)	Maximum ($/acre)
Sonoma	3,128	1,089	5,392
Santa Cruz	7,347	3,167	11,063
San Mateo	7,360	1,656	15,857
Mendocino	12,406	3,000	24,750
Humboldt	7,181	625	56,471
Del Norte	5,914	2,417	16,204

Source: Save the Redwoods League (pers. comm. 2003). Prices reflect current dollar actual payments made 1990-2002 for properties larger than ten acres.

endangered species, but for larger parcels this would not necessarily be the case. The unit price of easements for coho salmon depends on (1) the extent to which listing of coho salmon reduces development options in riparian areas, (2) the area where easements would be sought, and (3) which development rights would be sold.

The cost of conservation easements can vary widely across locations and depends heavily on the precise terms of the easement. Without further information on the terms at which easements would be sought, and where they would be desirable, the impacts of this class of potential recovery actions cannot be estimated at this time. Illustrative values for easement costs have been provided by California Cattleman's Association for the case of rangeland. Easement costs for rangeland in the North Coast can be expected to cost in the range of $400 to $600 per acre. Pacific Forest Trust has provided information about the cost of forest easements in the coho salmon range. They suggest a rule of thumb that easement costs should be about 40 percent of market value given development restrictions that would likely address coho salmon recovery needs. Lower values will be appropriate in more remote regions where development pressures are lower.

Currently, the Department has identified the cost of two recommendations that propose conservation easements (ER-FE-02 and ER-SF-02). The Department estimates that the cost of these recommendations will be $60 million over 10 years, or a present value cost of $51 million, assuming a discount rate of three percent. This amount is included in the estimate of total cost of Recovery Strategy implementation, though additional funds may be required for easements.

In the event that forest land is purchased outright in riparian areas for salmon restoration, or riparian conservation easements are purchased, there may be several associated tax implications. One of these is highlighted, the implications of the title transfer for the property tax paid to the State government on this land. Currently, for the purposes of taxation, timberland in the Redwood Region is assessed according to the schedule presented in Table I-13. According to the California State Board of Equalization, in the event that a timberland parcel is designated as inoperable, as it may well be if purchased for salmon habitat restoration or use is restricted as a result of an easement, it will be valued as if it is Site V (the lowest level of potential forestry productivity). If the parcel was previously assessed at a higher value, the property tax associated with the land may fall, with associated implications for public budgets.

I.4.2.2 Fencing

As discussed in section I.4.1.3, review of average fencing project costs provides a basis for estimating the fraction of project costs that are attributable to permitting, planning, and mobilization. The socioeconomic impact in the form of regional transfers that will occur as a result of

TABLE I-13: Timberland value assessment for tax purposes in California, 2002

Site class	Assessed value ($/acre)
Site I	279
Site II	227
Site III	198
Site IV	172
Site V	54

Source: State of California Board of Equalization, November 2002). Site class is classification of the potential productivity of forest land.

fencing is calculated to be total fiscal costs less that fraction. Estimated socioeconomic impacts by HU as a result of these transfers are summarized in Attachment 2.

Other welfare impacts associated with this class of recovery recommendations are more difficult to quantify because of the limited information available about projects that will actually be undertaken as a result of implementation of the Recovery Strategy. These impacts can only be discussed qualitatively at this time.

If fencing projects deprive landowners of a place to water their animals, the cost of tanks and/or troughs may be included as an element of the full cost of fencing projects. Tanks for livestock watering cost about $2 per gallon, and troughs cost about $1 per gallon (USDA 2002). Labor will also be required to service these tanks that may be greater than the labor requirements associated with watering animals prior to the installation of the fence. Whether the cost of water to service these tanks is a social cost of these projects depends on pre-existing water rights allocations and landowners' obligations as a result of the listing of the coho salmon as endangered or threatened.

I.5 PLACEMENT OF LWD/INSTREAM COMPLEXITY

I.5.1 FISCAL COSTS

Riparian revegetation is intended to create a stock of biomass that will fall into streams and rivers over time, creating pools and other essential salmon habitat. Other projects can be undertaken to speed up the process of generating instream complexity. LWD can be placed in waterways, and other activities can be undertaken to improve in-channel habitat. Evergreen Funding Consultants (2003) estimate that LWD placement costs about $20,000 per stream mile; costs rise as the width of water bodies increase and as the size of the material to be placed in channels grows. Engineered log jams can cost as much as $80,000 per structure. Engineered log jams also require significant design and logistic preparation; for example, a series of engineered log jams created on the North Fork Stillagumish River in Washington cost $550,000 to implement and three years of preparation.

Other activities to improve in-channel habitat can be undertaken as part of LWD projects. The average unit cost of these activities in California, as estimated by USDA, is presented in Table I-14. Many of these activities are closely related to erosion control measures and fencing activities discussed previously.

Project costs for in-channel restoration have been developed by the Office of Spill Prevention and Response (OSPR) at the Department. Based on cost estimates reported by Bair (2000)[29] and

[29] Bair, B. 2000. Stream restoration cost estimates. In S. Allen, R. Carlson, and C. Thompson, eds. Proceedings of the salmon habitat restoration cost workshop. Pacific States Marine Fisheries Commission. Gladstone, OR.

TABLE I-14: Construction unit cost of in-channel habitat improvement elements in California

Activity	Units	Unit cost ($)
Clearing and Snagging	LF	25
Compacted Fill	CY	2.5
Critical Area Planting	AC	1,000
Cut and filling	CY	130
Fence	LF	4
Geotextile Fabric	SF	1.25
Grading and Shaping	AC	200
Rock/fill	CY	50
Stream Tree Revetment	Each	22
Water Control Structure	Each	15,000

Source: USDA EQIP Program (2002)
http://waterhome.brc.tamus.edu/NRCSdata/Costs/
Units: LF: linear foot, CY: cubic yard, SF: square foot, AC: acre.

Hampton (2000)[30], OSPR allocates about $60,000 per stream mile for restoration in a small rocky stream and $140,000 per stream mile in a large rocky stream. These cost estimates each include five years of monitoring and maintenance and a ten percent administration fee.

To estimate the aggregate cost of LWD placement and in-channel restoration in the coho salmon ESUs, the estimates developed by Evergreen Funding Consultants (2003) for LWD placement and the estimates developed by OSPR for in-channel restoration were used. While no systematic information is available about the width of the streams included in the Department's stream inventory by HU or HSA, information is available about the distance of streams from roads. Evidence presented by Evergreen Funding Consultants suggests that project costs rise as the restoration site becomes more remote from roads. Consistent with this experience in Washington State, the assumption was made that project costs rise as the distance of streams from roads increases. The assumption was also made that costs will vary among HSAs on the basis of construction industry wages. Thus, projects in remote areas in high wage regions will be relatively more expensive per stream mile than identical projects, in terms of materials used, in low-wage areas at easily accessible sites.

For general in-channel restoration activities, following OSPR the assumption was made that permitting costs are about $15,000 per stream mile, regardless of project location. All other costs total $25,000 per stream mile for project sites within 0.25 miles from a road. OSPR reports that labor costs generally total about eight percent of non-permitting costs. This information was used to estimate how project costs vary among HSAs according to the relative costliness of labor. As in the case of LWD projects, the assumption was made that non-permitting costs rise as streams become more distant from roads. In particular:

- Sites between 0.25 and 0.5 miles from a road have non-permitting project costs of $26,000 per mile;
- Sites between 1 and 2 miles from a site have non-permitting project costs of $27,000 per mile;
- Sites that are between 2 and 3 miles from a road have non-permitting project costs of $28,000 per mile; and

30 Hampton, S. 2000. The costs of restoring anadromous fish habitat: Results of a survey from California. In S. Allen, R. Carlson, and C. Thompson, eds. Proceedings of the salmon habitat restoration cost workshop. Pacific States Marine Fisheries Commission. Gladstone, OR.

- Sites further than 3 miles from a road have non-permitting project costs of $29,000 per mile.

For LWD placement alone, the assumption was made that for sites less than 0.25 miles from a road, project costs will be $20,000 per mile on average. The assumption was made that permitting costs account for about 38 percent of total costs and labor accounts for about eight percent of non-permitting costs, consistent with the assumptions made about instream complexity work. As sites increase in distance from roads, total unit costs rise in the following manner:

- Sites between 0.25 and 0.5 miles from a road have project costs of $21,000 per mile;
- Sites between 1 and 2 miles from a site have per mile project costs of $23,000;
- Sites that are between 2 and 3 miles from a road have per mile project costs of $25,000; and
- Sites further than 3 miles from a road have project unit costs of $30,000.

Attachment 3 summarizes the estimated aggregate cost of LWD placement and restoring in-channel complexity by HU. These cost estimates were developed using estimates, provided by the Department, of the amount of LWD placement and in-channel restoration work that will be needed, and, in the case of the CCC Coho ESU, total cost estimates by HSA. Where the Department provided information only about LWD needs (about two-thirds of HUs in the SONCC Coho ESU), the assumption was made that a similar number of stream miles would need in-channel restoration work as well.[31]

I.5.2 SOCIOECONOMIC IMPACTS

As discussed in section I.5.1, review of historical LWD placement projects and instream restoration projects provides a basis for estimating the fraction of project costs that are attributable to permitting, planning, and mobilization. The socioeconomic impact in the form of regional transfers that will occur as a result of LWD placement and instream restoration was calculated to be total fiscal costs less that fraction. Estimated socioeconomic impacts by HU as a result of these transfers are summarized in Attachment 3.

I.6 ROAD TREATMENT AND DECOMMISSIONING

The Recovery Strategy contains several broad categories of recommendations dealing with roads, which differ in their unit cost, socioeconomic impacts and, likely, in their cost-effectiveness. The broad categories of recommendations are:

1. Road decommissioning;
2. Road upgrading;
3. Relocation of roads in riparian areas;
4. Implementation of best-management practices (BMPs) in road construction; and
5. Limiting use of roads (e.g., in winter or if road is legally closed).

[31] The Department provided estimates of the quantity of in-stream restoration needed that was not disaggregated by distance of streams from roads. Thus, while the spreadsheet model allows the analyst to vary the percentage of stream miles treated by distance from the road, in practice we calculate the aggregate cost of this class of recovery action as though all treated stream miles are less than 0.25 miles from roads. This assumption was made because in practice 60 percent of stream miles in the coho salmon range are within 0.25 miles of a road and over 90 percent are within one mile.

Many road treatment actions are recommended in conjunction with culvert replacement (see the discussion of barriers to fish passage above). For most HSAs where roads are identified as a source of sediment that harm coho salmon, the CRT also urges road and sediment assessments.[32] To the economists' knowledge, little quantitative information about the number of road miles needing each of the recommended actions is available at this time, so it is impossible to calculate precisely the cost of this class of recovery recommendations.[33] This section includes a discussion of the unit cost of road decommissioning and road upgrades (many BMPs in road construction are also implemented in road treatment after initial construction). It also includes a discussion of the socioeconomic cost of limiting the use of certain roads to reduce erosion that is harmful to coho salmon.

I.6.1 FISCAL COST

I.6.1.1 Road Treatment

A variety of activities can be undertaken to reduce the sediment burden associated with previously constructed roads. Pacific Watershed Associates (2003) summarizes these as "stormproofing" activities, which remove unstable sidecast and fill materials from steep slopes and in other appropriate locations, and also apply surface drainage techniques.[34] Stormproofing can also include upgrading stream crossings.

Illustrative unit costs for typical road treatment activities in California as calculated by USDA are summarized in Table I-15. Along a given stretch of road, the number of rolling dips and water crossings that will be required to adequately treat sediment is project-specific. It depends on both the soil type and the grade of the road. Treating steeper roads with more erosive soils will require more rolling dips and waterbars per mile (Keller and Sherar 2003).[35]

The survey results reported by Weaver (2002) and the figures in Table I-16 are the basis for the unit cost estimates used to estimate the aggregate cost of road treatment in the coho salmon ESUs. The assumption was made that labor costs account for about 40 percent of total costs

TABLE I-15: Construction unit costs for road treatment activities in California

Activity	Units	Unit cost ($)
Compacted Fill	CY	2.5
Earthwork excavation	CY	1.5
Grading and Shaping	AC	200
Grading Shaping and Filling	AC	500
Road & Landing Removal	AC	2000
Rolling Dip	Each	350
Rock Ford or Crossing	Each	4,000
Waterbar	Each	150

Source: USDA EQIP Program (2002)
http://waterhome.brc.tamus.edu/NRCSdata/Costs/
Units: LF: linear foot, CY: cubic yard, SF: square foot, AC: acre.

32 There are other recommendations that are more general exhortations to control legacy sediment sources, or to avoid the creation of new sediment sources. We assume that these are related to either road upgrading or the adoption of BMP in road construction.

33 This is not surprising. Anywhere from 15 to 50 percent of roads on the landscape are not on maps maintained by large timber companies, counties and the State. Weaver, B. 2002. Road upgrading, decommissioning, and maintenance-estimating costs on small and large scales. In S. Allen, R. Carlson, and C. Thompson, eds. Proceedings of the salmon habitat restoration cost workshop. Pacific States Marine Fisheries Commission. Gladstone, OR.

34 Pacific Watershed Associates. 2003. Watershed assessment and erosion prevention planning project for the Garrapata Creek Watershed, Monterey, CA. Prepared for Department of Fish and Game, March 2003.

35 Keller G. and J. Sherar. 2003. Low-volume roads engineering: Best management practices field guide. US Agency for International Development and USDA, Forest Service. Available: http://www.zietlow.com/manual/gk1/foreword.pdf.

and that the labor element of the unit cost of road treatment varies across HSAs according to local wage rates. Since San Mateo County is a relatively high-wage region, (construction wages in this county were 126 percent of the California average in 2002), the assumption was made that the range-wide average labor cost per mile is $5,900 (74 percent of $8,000 which is the per mile cost of labor in Table I-16). The assumption was made that the range-wide average cost of the non-labor component of road treatment is $10,000 per mile (the per mile non-labor treatment cost in Table I-16). This cost is assumed to be constant across HSAs. Planning, mobilization and permitting are estimated to be about 25 percent of total project costs per mile (as they are in the example presented above). The average total per-mile cost is $15,900.

The Department has provided information about the approximate number of road miles that will need treatment or decommissioning in the Cape Mendocino, Eel River, Eureka Plain, Klamath River, Mad River, Redwood Creek, Rogue River, Smith River, Trinidad, Trinity River, and Winchuck River HUs. The assumption was made that the distribution of these road miles among the HSAs in these HUs is approximately equal to the distribution of U.S. Geological Survey (USGS) Class 4 (unpaved or unimproved) roads in rural forest regions. The Department has provided information about the approximate number of road miles that will need treatment or decommissioning in each of the HSAs in the Mendocino Coast, Marin, San Mateo, Russian River, Bodega and Big Basin HUs.

The assumption was made that 85 percent of roads identified by the Department as needing treatment will require stormproofing. This is consistent with a survey of typical findings on a watershed-by-watershed basis reported by Pacific Watershed Associates (2003).[36] The estimated cost of road treatment by HU is summarized in Attachment 4.

TABLE I-16: Illustrative unit and project costs for road-related erosion control (San Mate County, CA)

Cost element		Unit cost ($/hr)	Time commitment (hours) Treatment	Logistics	Total	Total costs ($)
Moving expenses	Excavator	110	3	0	3	330
	Dozer	85	3	0	3	255
Equipment for site treatment	Excavator	135	18	5	23	3,105
	Dozer	95	47	14	61	5,795
Equipment for drainage sites	Bobcat	95	124	37	161	15,295
	Dozer	95	3	1	4	380
	Bobcat	95	27	8	35	3,325
Laborers		35	1,142	343	1485	51,975
Foot bridges						6,000
Culvert materials						155
Rocks						1,320
Mulch etc.						275
Planning etc.						29,100
Total						117,310

Source: Pacific Watershed Associates (2003b).
Total project covers 6.5 miles of road; unit cost is $18,000 per mile.

36 In practice, the percentage of roads that will be treated will depend on the threshold level of sediment delivery that is used to define sites as treatment-worthy. This threshold can vary from 20 to 50 cubic yards (Weaver 2002). No guidance is given by the Recovery Strategy as to what the threshold will be for the purposes of coho salmon recovery.

The Recovery Strategy proposes the adoption of best management practices in new road construction. This may entail increased costs for both the public and private sectors. For example, this may require constructing more rolling dips when new roads are created than might otherwise have been the case. However, these increased up-front costs may be off-set to some degree be reduced ongoing maintenance costs. Because information is not currently available on the amount of roads that will be built over the next 25 years by HSA, the cost of these road-related recovery actions cannot be quantified at this time.

I.6.1.2 Road Decommissioning

Modern road decommissioning is a form of reverse road construction that is generally appropriate for only a portion of a road inventory slated for sediment reduction treatment. On average, about 10 to 20 percent of a problem road network will require decommissioning (Pacific Watershed Associates 2003).

Table I-17 summarizes estimates of the unit costs of typical road decommissioning activities gathered by the Environmental Protection Agency. Similar costs for ripping and decompaction are reported by Weaver (2002). While these numbers are instructive, a review of actual road decommissioning projects undertaken by Harr and Nichols (1993) suggests that decommissioning costs per mile depend crucially on whether waterbars must be constructed, and the extent of tree removal that must be undertaken prior to excavation. Harr and Nichols's widely cited findings are summarized in Table I-18. In current dollars, the results of their survey suggest that road decommissioning costs can vary from about $3,400 per mile to about $9,000 per mile. Labor requirements per mile also vary widely depending on the difficulty of the tree removal task.

Coffin (2000)-1[37] reviewed the cost of road decommissioning in the Gifford-Pinchot National Forest. He found that costs range from about $3,000 per mile to $23,000 per mile and average about $10,000 per mile. Mobilization costs, including permitting are more stable, about $4,000 per project regardless of project size. As Coffin emphasizes, since mobilization costs include permitting, these costs depend on who owns the land where the road to be decommissioned is found. Environmental permitting may be less expensive on non-Federal lands.

To calculate the cost of road decommissioning, the assumption was made that the per-mile cost will be consistent with the findings of both Harr and Nichols (1993) and Coffin (2000). The assumptions were made that the unit cost of road decommissioning is $9,000 per mile and that labor costs represent about 40 percent of total costs, just as they do in the road treatment aggre-

TABLE I-17: Illustrative unit costs for road decommissioning activities

Treatment method	Cost ($/mile)
Ripping/ scarification	
Ripping with D7 or D8 tractor	700
Scarification with D8-mounted brush blade	1,100
Scarification to 6-inch depth and installation of water bars with track hoe	2,100
Ripping and slash scattering with track hoe	600-800
Ripping, slash scattering, and water bar installation with track hoe	1,000
Ripping with track hoe	300-500

Source: EPA Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (available: www.p2pays.org/ref/04/03686/index-3.html). Cost estimates converted to 2000 dollars using price index developed by Summers and Heston (2003) and rounded to nearest 100 dollars.

[37] Coffin, B. 2000. Estimating costs of road decommissions, In S. Allen, R. Carlson, and C. Thompson, eds. Proceedings of the salmon habitat restoration cost workshop. Pacific States Marine Fisheries Commission. Gladstone, OR.

TABLE I-18: Illustrative project costs for road decommissioning

Project number	Description of road treatment required	Length of segment (mile)	Time required (hours)	Cost ($)	Cost ($/mile)
1	Minimal removal of small trees, pre-existing water-bars	7	232	23,700	3,400
2	Extensive clearing of large trees	1.6	135	14,000	8,800
3	Extensive clearing, pulling sidecase, constructing sidebars	0.8	77	7,300	9,200

Source: Harr and Nichols (1993). Authors' conversion to 2000 dollars using price index developed by Summers and Heston (2003) and rounded to nearest 100 dollars.
Decommissioning of 11 road segments in Canyon Creek, Washington in 1987-88.
Case (3) is an average of four different projects.

gate cost calculation. Mobilization/permitting costs total about $3,000 (slightly lower than the mobilization cost estimates provided by Coffin because most roads in the California range of coho salmon are on non-Federal land). Non-permitting costs are assumed to vary by HSA according to local construction wages. Mobilization/permitting costs are assumed to be constant across HSAs.

The Department has provided information about the approximate amount of road miles that will need treatment or decommissioning in the Cape Mendocino, Eel River, Eureka Plain, Klamath River, Mad River, Redwood Creek, Rogue River, Smith River, Trinidad, Trinity River, and Winchuck River HUs. In these HUs, the assumption was made that 15 percent of these road miles will ultimately require decommissioning. The assumption was made that the distribution of these road miles among the HSAs in these HUs is approximately equal to the distribution of USGS Class 4 (unpaved or unimproved) roads in rural forest regions. For other HUs, road miles requiring treatment were provided at the HSA level. The estimated cost of road treatment by HU is summarized in Attachment 4.

I.6.2 SOCIOECONOMIC IMPACTS

As discussed in section I.6.1, review of historical road treatment and decommissioning projects makes it possible to estimate the fraction of project costs that are attributable to permitting, planning, and mobilization. The socioeconomic impact in the form of regional transfers that will occur as a result of road treatment and decommissioning has been calculated to be total fiscal costs less that fraction. Estimated socioeconomic impacts by HU as a result of these transfers are summarized in Attachment 4.

Other welfare impacts associated with this class of recovery recommendations are more difficult to quantify because of the limited information available about projects that will actually be undertaken as a result of implementation of the Recovery Strategy. These impacts can only be discussed qualitatively at this time.

Limiting the use of certain roads in the winter or relocating roads imposes economic costs and more time and fuel must be spent to reach desired destinations. Given the limited data available on roads in general, and the lack of identification of which roads would in practice have access limited, it is impossible to quantify the cost of this road-related recovery recommendation.

I.7 RESTORING WETLANDS AND OFF-CHANNEL AREAS

I.7.1 FISCAL COSTS

In a limited number of HUs/HSAs wetlands restoration is mentioned as a recommended recovery activity. The unit costs of common wetlands restoration activities, as calculated by USDA for California, are summarized in Table I-19. As this table suggests, many of the activities that fall under the category of wetlands restoration are also common to the other categories of restoration activities considered in this document. For example, USDA considers culvert replacement, fencing, and critical area planting to be activities that may be undertaken as part of wetlands restoration. Because the quantities of these activities that will be undertaken in any given HSA are not generally known, the aggregate cost of wetlands restoration has not been calculated as an activity that is distinct from other, related recovery recommendations.

I.7.2 SOCIOECONOMIC IMPACTS

The analysis of the socioeconomic impacts of wetlands restoration is similar to that for riparian revegetation and conservation easements.

I.8 WATER ACQUISITIONS

Water markets are an increasingly important means of allocating scarce water supplies in California. Additionally, they have become a prime tool used by government agencies to enhance instream flows. Hanak (2003) shows that environmental water purchases by the State and Federal governments now account for the largest and fastest-growing share of water transfers in California.

Environmental water transfers can take a variety of forms. The most common is an intrayear or “spot” transaction where the landowner sells all or a fraction of his entitlement to the agency. The transaction is for one year only and there is no change underlying water rights. Typically, farmers fallow their land under such an arrangement to reduce consumptive use, but other arrangements are possible (such as a shift to groundwater pumping) when environmental conditions allow. Other potential arrangements include long-term or permanent transfers involving a reduction in the agricultural base, and intermittent or “options” transfers where there is a long-term contract between the landowners and the agency but the water is transferred only under certain conditions.

TABLE I-19: Construction unit costs for wetlands restoration activities in California

Activity	Units	Unit cost ($)
Arch culverts	Diameter-LF/LF	32.8
Concrete, Non-Structural Non-Reinforced	CY	150
Concrete, Non-Structural Reinforced	CY	250
Critical Area Planting	AC	1000
Deleveling	AC	300
Earthwork excavation normal	CY	1.5
Fence	LF	4
Mobilization	Each	1250
Riparian Herbaceous Cover	AC	500

Source: USDA EQIP Program (2002) http://waterhome.brc.tamus.edu/NRCSdata/Costs/
Units: LF: linear foot, CY: cubic yard, SF: square foot, AC: acre.

The price at which water is sold on environmental water markets is determined by negotiations between landowners and the purchasing entity. Because the transfer is voluntary, the lowest price at which a farmer will sell is called the "reservation price" and is equal to the net operating income (or revenue minus variable costs) earned per unit sold. As a rough rule of thumb, the methods used by BOR and the California Department of Water Resources were followed and the assumption was made that the market price of water is 50 percent greater than the reservation price.

The Recovery Strategy includes the recommendation of land acquisition and/or water rights acquisition in several HSAs. In practice, water rights acquisition functions very similar to land acquisition. In agricultural areas where farmed land is irrigated, loss of water rights generally means in practice that land formerly irrigated with this water will be left fallow. The seller of water rights forgoes the agricultural profits that would have been gained in the event that the water had been used for irrigation. However, as previously noted, other arrangements are possible (such as a shift to groundwater pumping) when environmental conditions allow.

I.8.1 FISCAL COST

In circumstances where potential sellers of water rights do not shift to groundwater pumping or make other arrangements such that agricultural lands are not left fallow, potential sellers of water rights may forgo the agricultural profits they would have gained from irrigating. In these circumstances, the annual cost of an acre-foot of water in a particular HSA can be predicted to be equal to the net agricultural returns (gross returns less operating costs) that water would have created.

By combining data on acre-feet of irrigation water per acre used in a particular HSA with information about net agricultural returns per acre, the price of an acre-foot of water can be estimated. Agricultural census data on irrigated pasture and crop land by county and county-level data on irrigated water withdrawals for pasture and crops provided by USGS were used to calculate acre-feet of water per acre of pasture and crops planted by county. Farm operating costs and gross agricultural returns per acre for pasture and typical crops were provided by U.C. Extension's current cost and return studies. The calculation takes the form:

$$(G_{it} / acre_{it} - C_{it} / acre_{it})*acre_{it} / W_{it} = P_{it} / W_{it} \qquad (1)$$

where, for crop i (i = pasture, crops) in county t, G is gross agricultural returns, C is agricultural operating costs, W is acre-feet of water used, and P is the price of water, measured in dollars. The variable acre measures acres planted in crop i in county t. The equation is solved for P_{it} / W_{it}, which is the minimum payment that would be made for water acquisitions. The actual values of these parameters are presented in Attachment 5. As discussed above, the assumption was made that prices paid for water acquisitions in practice will be $1.5^* P_{it} / W_{it}$.

The aggregate fiscal cost of water acquisition and agricultural land acquisition will depend on the quantity of water and/or land to be acquired and whether water rights will be permanently transferred or purchased for single periods. The marginal cost of annual water rights acquisition is summarized in Figure I-1. The curve is non-linear because costs increase sharply when acquisition of irrigation water for pasture is complete and increasingly high value cropland (e.g., winegrapes, broccoli) is left fallow.

I.8.2 SOCIOECONOMIC IMPACTS

Taking agricultural land out of production so that more water is available for coho salmon recovery has a socioeconomic cost because land that once provided private income no longer does so. Conceptually, when agricultural land formerly harvested is left fallow because irrigation water

FIGURE I-1: Marginal cost of annual water rights acquisition

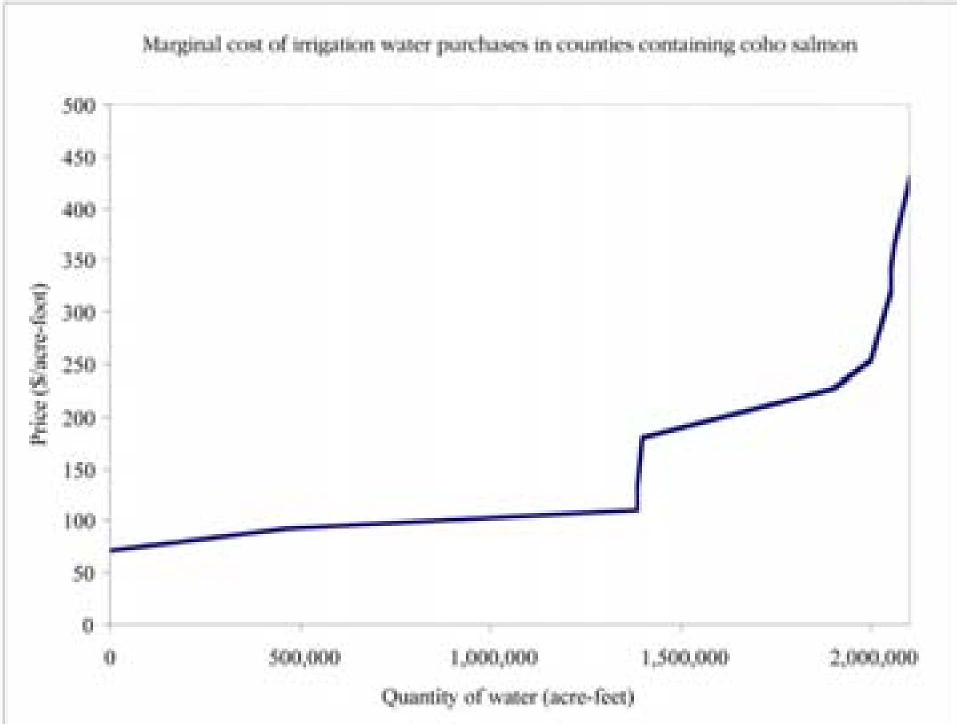
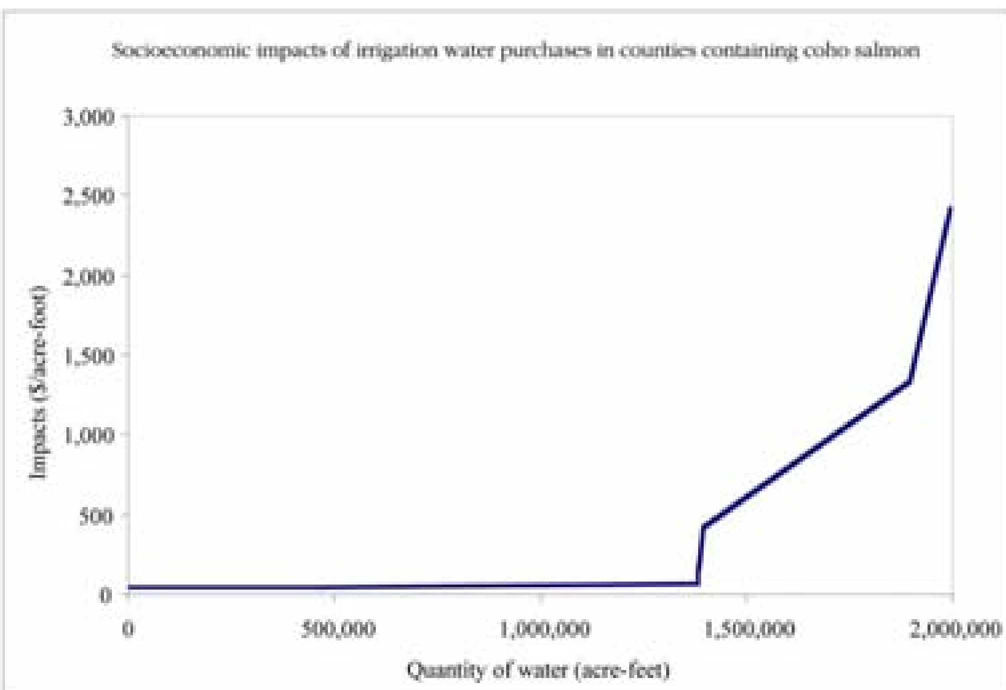


FIGURE I-2: Socioeconomic impacts of water rights acquisition



has been transferred to serving the needs of coho salmon, the farmer that sold the water right has neither lost nor gained income. She has received at least the same profit from the sale of water that she would have if the relevant parcel of land had been planted. However, the laborers that worked this land and the firms that sold the farmer inputs for this land have not been made whole. Their lost income, equal to the farmer's operating costs in the event that she had planted and harvested the parcel of land, are the socioeconomic cost of this recovery action.

Assuming that water is acquired at the lowest possible fiscal cost, it is possible to calculate and graph the socioeconomic cost of water rights acquisitions, per acre-foot of water purchased, that is implied by the price schedule shown in Figure I-1. The socioeconomic cost can be calculated with an equation similar to equation 1, which takes the form:

$$(C_{it} / acre_{it})*acre_{it} / W_{it} = SE_{it} / W_{it} \qquad (2)$$

All variables are defined as above, except the equation now calculates the socioeconomic cost, SE, of water rights acquisitions. This equation was solved for SE_{it} / W_{it}. The socioeconomic impacts of water purchases are shown in Figure I-2. Impacts are fairly low until quantity purchased exceeds 1.4 million acre feet.

I.9 BIOLOGICAL STUDIES

I.9.1 FISCAL COSTS

The Recovery Strategy recommends a range of technical studies from monitoring efforts to genetic analyses. A review of the Department's inventory of restoration activities suggests that individual monitoring projects can be expected to cost about $160,000 on average. Projects that include surveying and other research efforts that the Department has funded or partially funded have cost about $176,000 on average. These historical averages were used to estimate the cost of recovery recommendations that are technical monitoring or biological research activities.

There are about 30 recovery recommendations that recommend biological or technical scientific studies. The cost of recovery recommendations that are biological studies have been estimated to be about $7 million.[38] These costs are not discounted because this class of recovery action is generally assumed to be an interim action, occurring in the near future.

There are about 10 recovery recommendations that are clearly identifiable as monitoring efforts. The annual cost of the cost of the monitoring efforts is estimated to be about $1.4 million on the basis of the historical project costs described above. Assuming that the same amount will be spent each year on each monitoring effort, when these cost estimates are expressed in present value, assuming recovery over 25 years and a discount rate of three percent the estimated total cost of this class of recovery action is about $24 million.[39]

I.9.2 SOCIOECONOMIC IMPACTS

The socioeconomic impacts of this class of recovery recommendations are not expected to be significant.

38 For five of these recommendations, the Department has identified more precise costs estimates. These are BM-WA-04, BM-WA-07 KR-HU-05, KR-SV-03, and BB-SL-03. These are estimated to cost $500,000, $500,000, $1.5 million, $600,000, and $200,000 respectively. The estimate of the aggregate cost of this class of recovery recommendations reflects these costs.

39 For three of these recommendations, the Department has identified more precise costs estimates. These are KR-KG-18, SR-HU-17, and KR-HU-18. These are estimated to cost $200,000 $30,000, and $30,000 per year respectively. The estimate of the aggregate cost of this class of recovery recommendations reflects these costs.

I.10 WATERSHED PLANNING AND OTHER NON-BIOLOGICAL STUDIES

I.10.1 FISCAL COSTS

As mentioned throughout this section, many recommendations for specific recovery recommendations are accompanied by a recommendation that planning and prioritization efforts precede implementation. Planning recommendations may call for broad watershed planning, or more targeted exercises such as barriers or road inventories.

The Department has supplied a database that summarizes all recovery efforts that it has currently or partially funded for anadromous salmonids in the recent past. This includes approximately 60 planning efforts, for a wide variety of purposes. The average cost of these planning exercises (excluding a major coast-wide effort led by the Department itself and two very small projects that appear to be either mis-characterized or anomalous) is about $186,000. Costs of planning efforts can vary widely; even excluding the outliers mentioned above, the Department's records include efforts that cost as little as $10,000 and those that cost over $1,000,000 in total. As an initial means of estimating the cost of planning activities, the conservative assumption that each planning recovery action will cost about $200,000 was made. There are about 63 recovery recommendations that are non-biological studies or planning exercises. This implies that the total cost of this class of recovery recommendations is estimated to be about $13 million.[40] These costs do not vary systematically across HSAs.

The assessment of barriers to passage as a cost associated with treating barriers was included in that category, and not a cost that is part of this class of recovery recommendations. Assessing barriers to passage is assumed to cost about $20,000 per HSA.

I.10.2 SOCIOECONOMIC IMPACTS

The socioeconomic impacts of this class of recovery recommendations are not expected to be significant.

I.11 EDUCATION AND OUTREACH

I.11.1 FISCAL COSTS

In many different contexts and HSAs, the Recovery Strategy recommends performing education and outreach (including efforts to increase or improve inter-agency coordination) regarding salmon recovery and habitat restoration. While estimating the cost of any particular education effort would be difficult, it is possible to predict the average unit costs of education and outreach efforts.

The Department has supplied a database that summarizes all recovery efforts that it has currently or partially funded for anadromous salmonids in the recent past. This includes information about 200 education and outreach programs. The average cost of an education or outreach activity is about $67,000 according to this database. Costs are slightly lower, about $49,000 per program, when programs specifically concern coho salmon, as opposed to other anadromous salmonids.

On the basis of this survey, the economists assumed that the annual cost of education and outreach programs regarding coho salmon recovery and habitat restoration will be about

40 For four of these recommendations, the Department has identified more precise costs estimates. These are BB-HU-06, BB-HU-03, ER-OC-01, and BB-AP-02. These are estimated to cost $400,000 $250,000, $250,000, and $300,000 respectively. The estimate of the aggregate cost of this class of recovery recommendations reflects these costs.

$60,000, and, as recommended by the Recovery Strategy, about 61 education programs (including technical assistance efforts) will be undertaken.[41]

Assuming that an equal amount will be spent each year on each education and outreach program, when these cost estimates are expressed in present value, assuming recovery over 25 years and a discount rate of three percent the estimated total cost of this class of recovery action is about $31 million.

I.11.2 SOCIOECONOMIC IMPACTS

The socioeconomic impacts of this class of recovery recommendations are not expected to be significant.

I.12 HSA/HU SPECIFIC RECOMMENDATIONS

In the Recovery Strategy there are about 20 recommendations that address specific concerns in individual HSAs. In consultation with the Department, the economists have identified estimates of the cost of each of these activities.[42] These recommendations and cost estimates are summarized in Table I-20. Where possible, these cost estimates have been included in the estimates of aggregate costs.

TABLE I-20: HSA/HU-specific[1] recommendations for which costs are implemented individually

Number	Recommendation	Estimated cost ($)
KR-HU-19	Restore appropriate coarse sediment supply and transport near Iron Gate Dam. Means to achieve this could include full or partial removal of the Klamath River Project, or gravel introduction such as is done below other major dams (e.g., Trinity Dam).	500,000,000
KR-KG-22	Encourage cooperation between industrial timber land managers and tribes to restore coho salmon habitat. Use the successful Tribal/Simpson Resource Company program as an example.	none
KR-KG-26	Continue funding and technical support for the California Conservation Corps to continue their collaborative participation with the Yurok Tribe and Simpson Resource Company to implement watershed restoration throughout the lower Klamath subbasin.	1,100,000 per year
TR-HU-01	Implement the Trinity River Record of Decision (ROD). See Chapter 9 in the Recovery Strategy for the full text of the recommendation.	12,000,000 per year
EP-HU-03	Acknowledge the Arcata City Sewage Treatment Project and encourage implementation of similar projects elsewhere where possible.	none
EP-HU-11	Maintain and protect channel conditions important for all life stages of coho salmon.	14,180,000

(continued)

41 For a limited number of recommendations, the Department has supplied more precise cost estimates. These are recommendations BM-WA-02, BM-LA-11, BM-LA-12, BM-HU-02, and ER-HU-01 which are estimated to cost $50,000, $50,000, $50,000, $20,000 and $500,000 respectively. Aggregate cost estimates reflect these figures.

42 There were some recommendations for which costs cannot be assigned. These recommendations (e.g., beaver investigations; water drafting for fire suppression, expressions of encouragement) are too vague to assign costs to at this time.

TABLE I-20: HSA/HU-specific[1] recommendations for which costs are implemented individually (continued)

Number	Recommendation	Estimated cost ($)
EP-HU-12	Restore channel conditions important for all life stages of coho salmon.	Included in costs for EP-HU-11
MC-GA-06	Utilize as a model for erosion reduction and LWD placement the comprehensive approach practiced in the South Fork of the Garcia River.	none
MC-GA-08	Maintain Hathaway Creek, North Fork Garcia, Rolling Brook, Mill Creek (lower Garcia River), South Fork Garcia, Signal, Mill Creek (upper Garcia River) to continue to provide coldwater input to the mainstem Garcia.	none
MC-GA-12	Excavate a geomorphically designed channel in the lower North Fork Garcia to rectify subsurface flow during summer months and prevent coho salmon stranding.	25,000
RR-HU-09	Implement Sotoyome Resource Conservation District's Fish Friendly Farming Program within Sonoma and Mendocino counties.	60,000
RR-HU-11	Stock first priority barren streams, including Felta and Mill Creeks (tributary to Dry Creek west of Healdsburg); Freezeout, Willow and Sheephouse creeks (near Duncan Mills); and Ward Creek (tributary to Austin Creek). Identify additional streams that may be suitable for stocking as restoration occurs.	1,000,000
RR-HU-26	Review and, if appropriate, approve Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Operations and Maintenance (FishNet 4C 2004).	200,000 per year, per county
RR-GU-05	Stock Willow, Sheephouse, Freezeout, Dutchbill, and Green Valley creeks as part of the coho salmon broodstock program.	1,500,000
RR-AC-05	Stock high priority barren streams, including Ward Creek, with the coho salmon broodstock program.	1,500,000
RR-WS-07	Stock high priority barren streams, such as Mill and Felta creeks, as part of the coho salmon broodstock program.	1,500,000
BM-WA-04	Implement high priority coho salmon enhancement projects for the reduction of sediment delivery and the restoration of riparian corridors as listed in the Walker Creek Enhancement Plan (2001).	500,000
BM-BO-02	Continue restoration efforts on Bolinas and Big lagoons to benefit coho salmon during all life phases and seasons.	7,000,000
BB-HU-01	Continue to operate MBSTP Kingfisher Flat Hatchery as a conservation hatchery, following the guidelines of the Department and NOAA Fisheries.	40,000 per year
BB-HU-08	Develop a lagoon management plan that addresses the needs of coho salmon.	400,000 per county

Note:
1. The recommendations are listed in the order they appear in Chapter 9 of the Recovery Strategy.
Source: DFG.

I.13 TIMBERLAND MANAGEMENT

Three alternative sets of recommendations were developed for timberland management in areas with coho salmon. One alternative, Alternative A, was presented to the CRT by petitioner members of that team. The second and third alternatives, Alternative B and Alternative C, were developed by the Department, in part, from a recommendation that was presented to the CRT by forest landowner representatives of that team (specifically sections 1-10 of these alternatives).

This section measures the cost to forest landowners or companies from implementing these various alternatives. This is an implicit calculation of fiscal cost to companies of implementing these alternatives. Results are developed and expressed in a manner consistent with the rest of the document. First, each alternative was separated into its components with the most potential to change resource allocation. Next, for each recovery action the per-acre cost of effecting the change was calculated. Then, this per-acre cost was multiplied by the number of acres affected by the Recovery Strategy to obtain the total cost. At this stage, there are insufficient data to calculate socioeconomic costs of implementing these alternatives.

While there are at present three alternatives, we calculate costs for Alternatives A and B. There are few incremental costs associated with Alternative C. The total cost of implementation depends on what is included in the Recovery Strategy for timber management.

I.13.1 ALTERNATIVE RECOMMENDATIONS

Discussions of Alternatives A, B, and C are provided in this section.

I.13.1.1 Alternative A

Alternative A could be implemented in two different ways. The Commission could approve this alternative for inclusion in the strategy as: (1) guidelines (pursuant to FGC §2112) for issuance of Incidental Take Permits under FGC §2081(b) or consistency determinations under FGC §2080.1 where these recommended measures would fully mitigate take and at the same time contribute to the recovery of coho salmon. The effect of this would be to streamline the permitting process as an incentive for recovery. In accordance with FGC §2114, the guidelines would be part of the Commission's rulemaking for listing; or (2) a recommendation to the California Board of Forestry and Fire Protection (BOF) to implement it through a rulemaking proceeding to establish regulations that ensure that timber operations are consistent with the long-term survival of coho salmon.

The most expensive component of Alternative A is the restriction on timber companies to operate on unpaved roads in the wet season. In particular, "use of any unpaved road segments within or appurtenant to a timber harvest plan area shall cease when any of the following occur: (a) precipitation is sufficient to generate overland flow off the road surface; or (b) use of any portion of the road results in rutting of the road surface. Road use shall not resume until the road is dry. "Dry" is defined as a road surface that is well drained; and is not rutting, discharging fine sediments, or causing a visible turbidity increase in a ditch or on a road surface that drains into a Class I, II, or III watercourse. Access for road inspection and access to correct emergency situation shall be allowed at any time by a vehicles rated one ton or less." This restriction presents significant operational difficulties. Working with data from The Pacific Lumber Company (PALCO), it is estimated that the road restrictions alone could decrease the per-acre value of timberland by 5 to 10 percent.

Large per-acre impacts are also associated with the requirement in Alternative A that landowners retain the 10 largest trees along Class I watercourses. The requirement specifies that "recruitment of LWD to Class I watercourses shall be ensured by retaining the ten largest diameter confers (live or dead), on each side of the watercourse, per 330 feet of stream length, within 50 feet of the watercourse or lake transition line." This requirement will have minimal impact in some cases, but a major impact in others. PALCO data suggest that per-acre impacts range anywhere from 5 to 85 percent of value. Since Class I watercourses comprise only 3 percent of PALCO land, the diminished value across all ownership (a weighted value) is from 0.2 to 2.6 percent.

With regard to Class II watercourses, Alternative A provides that "at least 85 percent overstory canopy shall be retained within 50 feet of the watercourse or lake transition line. In an additional outer zone, overstory canopy closure shall be at least 65 percent. The overstory canopy in each zone shall be composed of at least 25 percent overstory conifer canopy post-harvest. The outer zone shall be 25 feet in width where side slope class is 30 to 50 percent. The outer zone shall be 75 feet in width where the slope class is greater than 50 percent. While attaining the canopy retention standards described in section 2.a.(5), recruitment of LWD to Class II watercourses shall be ensured by retain the five largest conifers (dead or alive) on each side of the watercourse per 330 feet of stream channel length, within 50 feet of the watercourse of lake transition line."

These requirements are estimated to reduce timber harvest in affected areas by 35 percent, resulting in a similar loss in per-acre value. In the case of PALCO, 4 percent of total ownership is of this type, implying a weighted loss in value of between 1.0 and 1.4 percent.

"Inner gorge" requirements on Class I and II watercourses are also relatively expensive. Alternative A envisions that "where an inner gorge extends beyond a Class II WLPZ and slopes are greater than 55 percent, a special management zone shall be established beyond the WLPZ where the use of even aged regeneration methods is prohibited. This zone shall extend upslope to the first major break in slope (i.e., where the slope is less than 55 percent for a distance of 100 feet or more) or 200 feet as measured from the watercourse of lake transition line, whichever is less. Within this zone, methods and retention standards shall be as described in 14 CCR §§913.2, 933.2, and 953.2."

The provision on even-age regeneration is forecasted to reduce harvest volumes by 50 percent in these areas, which account for 4 percent of PALCO lands. The implied diminution in value across all acres is between 1.6 and 2 percent.

Finally, Alternative A requires a 25-foot "protection zone" on each side of Class III watercourses for "slopes less than 30 percent and at least a 50-foot protection zone on each side of the watercourse for slopes greater than 30 percent. Retain all trees situated within the channel zone (i.e., bank-full channel) and trees that have boles that overlap the edge of the bank-full channel. Within the protection zones at least 50 percent of the understory vegetation shall be left post-harvest in an evenly distributed condition. All regeneration conifers, snags, LWD, and hardwoods shall be retained within the Class III protection zones except removal as necessary for yarding and crossings. Commercial timber operations will be allowed to "yard through" a Class III riparian management zone. Burning for purposes of site preparation shall not be initiated in the protection zones."

This provision is anticipated to have a relatively minor impact on timberland values. PALCO estimates a loss in value of between 0 and 5 percent per acre. Affected lands comprise roughly 18 percent of their total ownership, with the result that the diminished value across all lands is between 0.0 and 0.9 percent.

Taking these five main components of Alternative A together, it is estimated that the total percentage reduction in timberland value is between 7.8 and 16.9 percent.

I.13.1.2 Alternative B

There are two ways in which certain sections of Alternative B could be implemented. The Commission could approve Section 17 and 18 for inclusion in the strategy as a recommendation to the California Department of Forestry and Fire Protection (CDF) and the Department to improve within existing law and authorities the implementation and enforcement of the Forest Practices Rules to ensure that timber operations are consistent with recovery of coho salmon. If existing law and authorities are found to be inadequate to provide for such improvements, then the Commission could alternately recommend that the Department and/or CDF seek legislation to provide such authority. This means that CDF would support the Department in the Timber Harvest Plan (THP) review process if the Department determined that any of these measures, as determined on a site-specific basis should be applied to protect coho salmon. Alternatively, the Commission could approve Sections 16, 17, and 18 together as guidelines (pursuant to FGC §2112) for issuance of Incidental Take Permits under FGC §2081(b) or consistency determinations under FGC §2080.1 where these recommended measures would fully mitigate take and at the same time contribute to the recovery of coho salmon. The effect of this would be to streamline the permitting process as an incentive for recovery. In accordance with FGC §2114, the guidelines would be part of the Commission's rulemaking for listing.

The main cost difference between Alternatives B and A is that the cost of the road restrictions is much lower in the former. Alternative B requires only that "for construction, reconstruction, upgrades, maintenance, and operation of roads within and appurtenant to THPs detailed site specific recommendations will be developed consistent with the Handbook for Forest and Ranch Roads (prepared by Pacific Watershed Associates, 1994c, for the Mendocino County Resource Conservation District in cooperation with CDF and the U.S. Soil Conservation Service. Mendocino Resource Conservation District, Ukiah, California. 163 pages)." It is difficult to quantify the costs of this action item as it does not entail specific changes, and since many companies already follow these practices. Thus, while the road restrictions in Alternative B may well impose costs for some operations and at some locations, they are not quantified in this document.

Several aspects of Alternative B are identical to Alternative A. These include the requirement for Class I, II and III watercourses described above. One difference is for watercourses where an inner gorge is present. For Class II only, Alternative B requires that the landowner (1) provide 200' Watercourse and Lake Protection Zones (WLPZ); (2) require uneven-aged management; (3) prohibit tractor operations; and (4) require review of timber operations by a registered geologist. The cost of the "inner gorge" requirements is a loss in per-acre value of between 40 and 50 percent since even-age regeneration is still prohibited, but as opposed to Alternative A the loss applies only to Class II watercourses. The weighted average value of timberland is reduced between 1.2 and 1.5 percent.

One requirement that is contained in Alternative B and not Alternative A is that where a headwall swale is present, (1) utilize only single-tree selection prescriptions as per 14 CCR §913.2(a)(2)(A) that retain the diameter distribution present before timber operations or a "thinning from below" prescription as per 14 CCR §913.3(a) that retains dominant and codominant trees; and (2) require review of timber operations by a certified engineering geologist. This requirement will also prohibit even-age regeneration, resulting in a loss in land values of between 40 and 50 percent where it applies. PALCO estimates that 1 percent of its land would be affected by this provision, so that the weighted average loss in value from this provision is between 0.4 and 0.5 percent.

Taken together, Alternative B is estimated to reduce timberland values by 2.8 to 6.9 percent. The difference between the cost of this alternative and the cost of Alternative A is explained by the looser restrictions in road usage, construction and maintenance in the latter.

Using the calculated figures for percentage diminution in timberland value, it is possible to obtain a rough measure of the costs of the two alternatives. The percentage diminution in value should be applied to the value of timber harvesting rights per acre to obtain per-acre costs. Based on the advice of PALCO, we assume that the rights to harvest timber throughout the range of coho salmon habitat is valued at about $1,400 per acre on average. It follows that Alternative A amounts to a diminution in value of between $109 and $237 per acre. Alternative B will reduce values by between $39 and $97 per acre.

Since the publication of the November 2003 Public Review Draft of the Recovery Strategy new recommendations were added to Alternative B by the Department in response to public comments. Two of these recommendations require some discussion. The Department recommends in Section 19 that a "proof of concept" pilot program be developed and implemented to test a mathematical or scientific method of cumulative effects analysis as was suggested in the 2001 report, *A Scientific Basis for the Prediction of Cumulative Watershed Effects*, (otherwise known as the "Dunne Report"), by the U.C. Committee on Cumulative Watershed Effects. The pilot program would be developed and implemented by a panel of experts such as those at the University of California in cooperation with the Department, CDF, and the State Water Resources Control Board. The cost of this recommendation is approximately $900,000. In addition, the Department recommends in Section 17.b that "For Class I watercourses, within the watercourse and lake protection zone retain trees that provide direct shading to pools, consistent with the conifer retention standards in the Threatened and Impaired Watershed Rules." In discussions with PALCO and experts at the Department, it has been estimated that the impact of this additional recommendation will be negligible. In light of this minimal cost increase, the estimated total cost of implementing Alternative B has not been changed as a result of this additional recommendation. The limited impact of this additional recommendation is largely a result of the limited range of its impact; few THPs are impacted and when they are impacted the measure would affect the harvest of at most ten trees per THP. In addition, the measure generally will not result in a diminution of board feet harvested; landowners and/or companies would be allowed to substitute harvest elsewhere for the affected trees. This may increase the total costs of harvest, but not by a significant amount.

Data from CDF indicate that there are 3.84 million acres of privately owned timberland throughout the range of coho salmon habitat. Taking this acreage of Timberland Production Zones and multiplying by the weighted average per acre diminution in value, it follows that the cost of Alternative A is between $419 and $910 million. The cost of Alternative B is lower, and is estimated to fall between $151 and $373 million. These are present value calculations consistent with other fiscal cost estimates detailed in this report.

I.13.1.3 Alternative C

Alternative C does not involve incremental costs above those estimated in other sections of this report. This alternative calls for implementation of road management plans, which may imply that costs will be incurred for decommissioning or treatment of roads, treatment of watercourse crossings, riparian revegetation, watershed planning, education, and monitoring of recovery measures. We have estimated the costs of these actions in other sections of the economic report.

To illustrate which previously estimated costs include those associated with Alternative C, we took the following steps: First, HSAs with at least 75 percent of land cover in forest were identified. Second, HUs containing these HSAs were identified. Third, the estimated costs of road treatment, road decommissioning, riparian revegetation, and treatment of stream crossings in those HUs were identified. These estimated costs are summarized in Table I-21. Again, these are not new costs, but elements of previously estimated costs that include those associated with Alternative C. The total amount of these costs, excluding planning, education, and monitoring, is about $1.7 billion.

This report discusses previously that that total cost of watershed planning recommendations in the Recovery Strategy is estimated to be about $13 million.

TABLE I-21: Previously estimated costs of elements of recovery strategy which include those associated with Alternate C

HU	Road decommissioning ($)	Road treatment ($)	Riparian revegetation ($)	Stream crossings treatment ($)	Total cost of Alternative C by HU
EEL RIVER	126,822,230	190,777,692	29,858,170	11,293,206	358,751,299
KLAMATH RIVER	93,259,127	140,391,013	18,721,487	18,220,276	270,591,903
MAD RIVER	2,943,269	2,866,960	2,145,205	1,604,953	9,560,386
MENDOCINO COAST	13,291,428	133,158,247	743,507	284,571,592	431,764,775
REDWOOD CREEK	4,002,911	3,082,316	3,411,259	277,914	10,774,400
ROGUE RIVER	2,700,007	4,064,554	-	41,687	6,806,248
RUSSIAN RIVER	10,540,518	105,465,802	528,450	27,589,621	144,124,391
SAN MATEO	1,593,896	15,858,272	123,562	995,513	18,571,243
SMITH RIVER	31,529,016	47,463,350	2,468,586	3,831,737	85,292,690
TRINIDAD	8,089,361	12,177,614	103,304	548,880	20,919,159
TRINITY RIVER	124,142,457	186,882,354	3,241,052	13,791,476	328,057,338
WINCHUCK RIVER	935,637	1,408,495	35,989	138,957	2,519,078
Total cost	419,849,858	843,596,668	61,380,573	362,905,812	1,687,732,911

Assuming that an equal amount will be spent each year on education and outreach, when these cost estimates are expressed in present value, assuming recovery over 25 years and a discount rate of three percent the estimated total cost of this class of recovery action is about $31 million.

There are about 30 recovery recommendations concerning biological or technical scientific studies. We estimate that the cost of recovery recommendations that are biological studies will be about $7 million. These costs are not discounted because this class of recovery action is generally assumed to be an interim action, occurring in the near future.

There are about 10 recovery recommendations that are clearly identifiable as monitoring efforts. The annual cost of the monitoring efforts is estimated to be about $1.4 million on the basis of the historical project costs described above. Assuming that the same amount will be spent each year on each monitoring effort, when these cost estimates are expressed in present value, assuming recovery over 25 years and a discount rate of three percent the estimated total cost of this class of recovery action is about $24 million.

I.13.2 SOCIOECONOMIC IMPACTS

Socioeconomic impacts associated with this class of recovery recommendations can be partially quantified at this time on the following basis. First, lost profit to the landowner is a negative socioeconomic impact. Second, there will be lost jobs as a result of implementing either Alternative A or Alternative B. There are few incremental impacts associated with Alternative C. If either Alternative A or Alternative B is implemented as incidental take permitting guidelines then some or all of the socioeconomic impacts calculated here would be attributable to listing.

To estimate employment and payroll effects, we assume that there are 6.4 jobs in logging and sawmilling per million board feet of timber harvest and an annual payroll of $30,000 per employee. These figures are based on an economic analysis of the proposed watershed rules announced by BOF on July 23, 1999 performed by Professor William McKillop of U.C. Berkeley. These figures suggest that lost payroll per million board feet of timber lost is equal to $192,000 annually.

It is estimated that the total percentage reduction in timberland value is between 7.8 and 16.9 percent for Alternative A. Assuming that lost board feet of timber harvest is proportional to lost land value, annual payroll losses associated with this alternative range from $15 million to $32 million. Assuming recovery over 25 years and a discount rate of three percent the estimated total payroll impacts of this class of recovery action is about $261-$557 million. Total measured socioeconomic impacts equal these payroll impacts plus lost profits and so range from $680 million to $1.46 billion.

It is estimated that the total percentage reduction in timberland value is between 2.8 and 6.9 percent for Alternative B. Assuming that lost board feet of timber harvest is proportional to lost land value, annual payroll losses associated with this alternative range from $5 million to $13 million. Assuming recovery over 25 years and a discount rate of three percent the estimated total payroll impacts of this class of recovery action is about $94 million to $226 million. Total measured socioeconomic impacts equal these payroll impacts plus lost profits and so range from $244 million to $598 million.

I.14 SHASTA-SCOTT PILOT PROGRAM

The methodology used to estimate the cost of implementing the Shasta-Scott Pilot Program (SSPP) is similar to the methodology used to estimate the cost of the general Recovery Strategy. However, using detailed information from the SSRT, cost estimates were developed for nearly every recovery recommendation.[43] These cost estimates are included in the SSPP document. This approach reflects the fact that the SSPP contains many recovery recommendations related to water management and acquisition that are not found in recommendations that apply throughout the range of the coho salmon in California. Table I-22 lists the categories of recovery recommendations identified in the SSPP and their fiscal cost and socioeconomic impacts. This subsection includes a discussion about how these cost estimates were developed.

TABLE I-22: Economic cost and impact of implementation of Shasta-Scott Pilot Program

Recovery action	Fiscal costs ($)	Socioeconomic impacts ($)
1 Water management	10,334,024	
2 Water augmentation	60,217,676	(6,143,359)
3 Habitat management and restoration		
• Barriers to passage	7,059,636	4,211,782
• Instream restoration	3,797,400	2,453,750
• Streamside restoration	324,610,877	152,567,375
• Road treatment	84,764	63,439
• Other habitat restoration	36,030,892	
4 Protection	1,244,789	
5 Water use efficiency	3,200,000	2,020,000
6 Monitoring and assessment	10,604,000	
7 Education and outreach	8,832,520	
Total	**466,016,578**	**155,172,987**
Source: Authors' calculations.		

43 No cost estimates have been developed for P-6, P-7, WUE-6a, WUE-6b, and WUE-6c. These recommendations are too speculative or vague at this time to cost.

I.14.1 WATER MANAGEMENT

In close consultation with the SSRT, the economists estimated the cost of each individual recovery action related to water management. The total cost of this class of recovery action in the SSPP is estimated to be about $10 million. There are no significant socioeconomic impacts associated with this class of recovery recommendations.

I.14.2 WATER AUGMENTATION

An important category of recovery recommendation in the SSPP is water augmentation. To estimate the cost of this class of recovery recommendations, it has been necessary to make strong assumptions about (1) the extent to which instream flows will need to be augmented in the SSPP region for coho salmon recovery, and (2) the means by which this goal will be accomplished.

The Department and the SSRT have stated that, at this time, it is not possible to determine with certainty the amount of water that will be left in streams in the SSPP region for coho salmon recovery purposes. An estimate of the amount that will be needed has been made for the purposes of calculating the cost of implementing the Recovery Strategy, but neither the SSRT nor the Department endorses this number as a basis for policy action. Solely for the purposes of this illustrative calculation, it was assumed that instream flows in the SSPP region will be increased by 8,400 acre-feet per year.

The SSPP contains several recovery recommendations intended to result in increased instream flows for coho salmon. They include, but are not limited to, verifying compliance by water rights users, donation of unused water rights, substitution of groundwater for surface water for irrigation, and water acquisition. It cannot be known ex ante how much water will be procured for coho salmon through each of these strategies. To estimate the cost of securing instream flows for coho salmon, the SSRT has suggested that it is appropriate to assume that increased instream flows will be generated solely through the acquisition of water rights from willing sellers. This assumption is made only for the purposes of an illustrative calculation of the cost of coho salmon recovery and should not be taken as an endorsement of this approach to increasing instream flows in the SSPP region.

Using the assumptions about the amount of water to be acquired and the methods by which these flows are to assured, the cost of instream flows augmentation in the SSPP region was estimated using the methodology described in section I.8.1. The assumption was made that the price of an acre-foot of water will be about $100 per year. Since the SSPP specifies that a trust will be created with an endowment to be used for securing water rights, it is possible to estimate that, in present value, the cost of water augmentation in the SSPP region will be on the order of $60 million (assuming a 25-year recovery period and a 3 percent discount rate). The socioeconomic impacts associated with this acquisition of water for fish, in the form of lost jobs and other economic activity will be about $6 million in present value.

I.14.3 HABITAT MANAGEMENT AND RESTORATION

The cost of habitat management and restoration in the SSPP region was estimated using the methodology described in section I.2.1. The SSRT provided estimates of the amount of each habitat restoration activity that would be undertaken in the region for the purposes of coho salmon recovery. For other habitat management and restoration activities that do not fall into the categories listed in section I.11.1 (e.g., Scott HM-1-2c, Scott HM-2c, Scott HM-3c) specific cost estimates were developed in consultation with the SSRT. Every attempt has been made to ensure that the cost of monitoring and assessment and education and outreach activities identified as costs associated with habitat management and restoration are not double-counted in this accounting exercise. These costs are included as part of the monitoring and assessment and education and outreach activities for the purpose of developing the cost and impact estimates summarized in Table I-21.

I.14.4 PROTECTION

This class of recovery recommendations includes the development of best management practices. The assumption was made that it will cost about $60,000 to develop and disseminate (see section I.11.1 for a discussion of the development of this figure) and several recommendations for which costs cannot be estimated at this time.

I.14.5 WATER USE EFFICIENCY

The most important water use efficiency recommendation that is not a study or education effort is the proposal that ditch-lining be implemented to reduce water loss. The SSRT has stated that approximately 20 miles of ditches could be eligible for lining. Based on a review of a similar project implemented in the Oroville Wyandotte Irrigation district in 2003 (and proposed in 2001), the economists estimated that this action should cost about $161,000 per mile of ditch, or around $3.2 million for all 20 miles of ditches. Associated positive socioeconomic impacts would be on the order of $2 million.

If the water savings estimates in the Oroville Wyandotte Irrigation district are indicative of the cost-effectiveness of ditch-lining in the SSPP region, then it is possible to estimate that this recovery action would cost about $600 per acre-foot of water. This is about six times the estimated cost of water acquisitions achieved through fallowing in this region.

I.14.6 MONITORING AND ASSESSMENT

The cost of monitoring and assessment actions identified in the SSPP were estimated by (1) relying on specific cost estimates provided by the SSRT where possible, and (2) by relying on historical average costs of monitoring and assessment activities where these estimates are not available. The estimated cost of this class of recovery action in the SSPP region is about $7 million, with no significant socioeconomic impacts.

I.14.7 EDUCATION AND OUTREACH

The cost of education and outreach actions identified in the SSPP were estimated by (1) relying on specific cost estimates provided by the SSRT where possible, and (2) by relying on historical average costs of education and outreach activities where these estimates are not available. The estimated cost of this class of recovery action in the SSPP region is about $9 million, with no significant socioeconomic impacts.

I.15 AGGREGATE COSTS AND ECONOMIC IMPACTS

Table I-23 summarizes estimates of the aggregate costs and socioeconomic impact of coho salmon recovery under the strategy. These estimates include the cost of implementing the SSPP (shown on a disaggregated basis) and the mid-point estimate of the cost of implementing the timber management alternatives, but exclude the cost of water acquisition in all regions outside of the SSPP area. These figures also exclude the costs and impacts of actions that cannot be quantified at this time. Thus, these costs and impacts may only partially reflect the cost of coho salmon recovery under the strategy. On the other hand, as stated before, these aggregate cost estimates may overestimate the cost of Recovery Strategy implementation because some of the costs may be incurred even if the Recovery Strategy were not implemented. In addition, these aggregate cost estimates

TABLE I-23: Summary of cost and impacts of coho salmon recovery

Class of recovery action	Fiscal Costs ($)	Socioecon. Impacts ($)
Habitat Restoration		
SONCC Coho ESU	1,680,502,407	1,082,338,237
CCC Coho ESU	1,465,138,565	902,965,885
Total excl. SSPP	3,145,640,972	1,985,304,122
Scott	117,826,696	56,002,243
Shasta	217,725,981	103,294,103
Other SSPP restoration	36,030,892	
Total SSPP	371,583,569	159,296,346
Total incl. SSPP	3,517,224,542	2,144,600,468
Monitoring, evaluation and planning		
Total excl. SSPP	44,000,000	0
Total SSPP	10,604,000	0
Total incl. SSPP	54,604,000	0
Education and outreach		
Total excl. SSPP	31,000,000	0
Total SSPP	8,832,520	0
Total incl. SSPP	39,832,520	0
Water management		
Total excl. SSPP		
Total SSPP	10,334,024	0
Water use efficiency		
Total excl. SSPP		
Total SSPP	3,200,000	2,020,000
Water acquisition		
Total excl. SSPP		UNKNOWN
Total SSPP	60,217,676	(6,143,359)
Other (includes SSPP Protection and easements)		
Total excl. SSPP	808,553,878	
Total SSPP	1,244,789	
Timberland management		
Alternative A	419,000,000-910,000,000	(1,460,000,000)-(680,000,000)
Alternative B	151,000,000-373,000,000	(598,000,000)-(224,000,000)
Alternative C	FEW INCREMENTAL COSTS	FEW INCREMENTAL COSTS

Source: Authors' calculation. Habitat restoration includes removal of barriers to fish passage, riparian revegetation and streambank improvements, placement of LWD and improvements in instream complexity, and road treatment and decommissioning. SSPP is the Shasta and Scott River Pilot Program No cost estimates are available for water acquisition in the CCC or SONCC excluding the SSPP. Excludes impacts identified but not quantified.

may overestimate the cost of Recovery Strategy implementation to the extent that some of the costs may be incurred as a result of actions taken to avoid take of coho salmon or to fully mitigate impacts of the authorized take of coho salmon once the species is listed.

The total measured fiscal costs of implementing the Recovery Strategy are about $5 billion dollars. Of these measured costs, about $466 million, or 9 percent of total measured costs, will be incurred in the SSPP region. The actual fraction of costs incurred in the SSPP region will be less than this because the cost of water acquisition has been explicitly measured for the SSPP, but has not been measured for the rest of the range. Nonetheless, a notably large portion of costs will be incurred in these HSAs.

Restoration costs are higher in the SONCC Coho ESU than the CCC Coho ESU, likely because coho salmon are more widely distributed within the SONCC Coho ESU. Costs are especially high in the Klamath River HU, where Iron Gate Dam is located. High costs were also noted in the Mendocino Coast and Trinity River HUs. These three HUs, combined, account for over 85 percent of measured restoration costs.

Monitoring, evaluation, planning, education, and outreach costs are about $90 million dollars. This is about 2 percent of total estimated fiscal costs. There are no significant socioeconomic impacts associated with these actions.

Implementing the recommendations for timberland management could result in costs ranging from $150 million to $910 million, depending on which alternative, or combination of elements from those alternatives, is adopted. If Alternative A were adopted, costs would be in the range of $419 million to $910 million. Costs would be lower if Alternative B were adopted, in the range of $151 million to $373 million. There are few incremental costs associated with Alternative C. This report presents a total cost estimate that includes the average of timberland management Alternatives A and B, which is $463 million.

Restoration activities will generate positive socioeconomic impacts. Socioeconomic impacts generated from restoration equal about one-half of the fiscal costs of restoration or $2.1 billion. The socioeconomic impacts of water acquisition in the SONCC Coho ESU will be negative (for the SSPP these negative impacts equal about $6 million), as will the socioeconomic impacts of timberland management changes. Negative socioeconomic impacts of the timberland management changes are estimate to range from about $225 million to about $1.46 billion.

I.16 IMPACTS IDENTIFIED BUT NOT QUANTIFIED: PERMITTING AND ENFORCEMENT

An important unresolved issue with the cost of coho salmon recovery under the strategy is the role of enforcement of permits and take restrictions. There is some amount of unpermitted water diversion from streams containing coho salmon, for example, and some diverters use more than their allowable quantity. With regard to other issues like fencing, existing take restrictions may require that ranchers be fencing and constructing troughs more than is currently the case. This analysis has not attempted to parse out the total quantity of actions required for recovery as opposed to actions required by the listing of the coho salmon. Instead the costs of recovery have been calculated based on the increment of various actions relative to the status quo.

While a full treatment of enforcement is beyond the scope of this study, from an economic point of view it should be mentioned that the fiscal costs of coho salmon recovery under the strategy can be reduced, dramatically in some cases, from enforcement of existing law.

A related question arises in the area of water quality concerns. Several recommendations were directed at reducing pollutant loads (including sedimentation) that may adversely affect coho salmon recovery. The regional water quality control boards in California are formulating and implementing plans to reduce pesticide runoff. This observation raises the question about whether the costs of water quality improvement actions identified by the CRT should be all or partially attributable to coho salmon recovery, and which would be incurred as a result of the Clean Water Act or other statutes and regulations. TMDL regulations, for example, are quite relevant to coho salmon recovery. Costs attributable to this process should not be counted as a cost of coho salmon recovery if the regulations would have been enacted anyway.

ATTACHMENT 1

TOTAL ESTIMATED COST OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU	Barriers To Passage	Cost ($)
BAY BRIDGES	22	6,844,544
BIG BASIN	160	32,712,513
BODEGA	2	363,382
CAPE MENDOCINO	34	1,158,305
EEL RIVER	576	28,328,381
EUREKA PLAIN	42	3,652,731
KLAMATH RIVER (excl SSPP)	554	23,692,266
MAD RIVER	68	3,991,020
MARIN COASTAL	66	13,835,076
MENDOCINO COAST	1,980	292,909,680
REDWOOD CREEK	18	471,908
ROGUE RIVER	21	270,271
RUSSIAN RIVER	386	64,255,622
SAN MATEO	39	10,751,122
SAN PABLO	248	50,582,418
SANTA CLARA	62	23,873,536
SMITH RIVER	543	11,428,398
SOUTH BAY	88	34,545,539
SUISUN	241	21,563,281
TRINIDAD	11	742,725
TRINITY RIVER	282	26,168,024
WINCHUCK RIVER	4	173,845
Total SONCC	2,702	196,097,109
Total CCC	2,741	456,217,478
Total excl. SSPP	**5,443**	**652,314,587**
Scott	23	2,604,636
Shasta	8	4,455,000
Total SSPP	**31**	**7,059,636**
Total incl. SSPP	**5,474**	**659,374,223**

Barriers information provided by the Department comes from the State Coastal Conservancy (SCC) Report of Potential Barriers to Fish Passage (Bowen et al, Report to the Legislature, 2003).

See Section I.3.1 of this appendix for the underlying assumptions of the above calculations.

ATTACHMENT 1

TOTAL ESTIMATED COST OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY BARRIER TYPE

Barrier type	Cost ($)
Dams	213,077,622
Non-structural sites	15,526,701
Fish passage facilities	12,702,929
Stream crossings	391,932,079
Unknown/Other barriers	1,144,792
Water diversions	21,910,100
Assessment and prioritization	3,080,000
Total	659,374,223

ATTACHMENT 1

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF BARRIER ASSESSMENT PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU	Barriers to Passage	Cost ($)
BAY BRIDGES	22	4,058,726
BIG BASIN	160	19,579,508
BODEGA	2	158,029
CAPE MENDOCINO	34	646,983
EEL RIVER	576	16,769,028
EUREKA PLAIN	42	2,179,639
KLAMATH RIVER (excl. SSPP)	554	14,047,359
MAD RIVER	68	2,346,612
MARIN COASTAL	66	8,217,045
MENDOCINO COAST	1,980	175,529,808
REDWOOD CREEK	18	247,145
ROGUE RIVER	21	138,163
RUSSIAN RIVER	386	38,421,373
SAN MATEO	39	6,378,673
SAN PABLO	248	30,277,451
SANTA CLARA	62	14,264,122
SMITH RIVER	543	6,773,039
SOUTH BAY	88	20,679,324
SUISUN	241	12,793,969
TRINIDAD	11	421,635
TRINITY RIVER	282	15,544,814
WINCHUCK RIVER	4	92,307
Total SONCC	2,702	116,542,265
Total CCC	2,741	273,022,487
Total excl. SSPP	**5,443**	**389,564,752**
Scott	23	1,550,782
Shasta	8	2,661,000
Total SSPP	**31**	**4,211,782**
Total incl. SSPP	**5,474**	**393,776,534**

Barriers information provided by the Department comes from the State Coastal Conservancy (SCC) Report of Potential Barriers to Fish Passage (Bowen et al, Report to the Legislature, 2003).

See Section I.3.2 of this appendix for the underlying assumptions of the above calculations.

ATTACHMENT 1

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY BARRIER TYPE

Barrier Type	Cost ($)
Dams	127,846,573
Non-structural sites	9,316,020
Fish passage facilities	7,621,758
Stream crossings	235,159,247
Unknown/Other barriers	686,875
Water diversions	13,146,060
Assessment and prioritization	-
Total	393,776,534

TOTAL ESTIMATED COST OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
BAY BRIDGES	**43**	**22**	**6,844,544**	
Dams	17	9	5,543,167	652,137
Non-structural sites	2	1	10,234	10,234
Fish passage facilities	0	0	0	
Stream crossings	22	11	1,203,468	109,406
Unknown/Other barriers	2	1	7,675	7,675
Water diversions	0	0	0	
Assessment and prioritization			80,000	
BIG BASIN	**320**	**160**	**32,712,513**	
Dams	99	50	26,899,263	543,419
Non-structural sites	103	52	501,510	9,738
Fish passage facilities	6	3	1,708,862	569,621
Stream crossings	98	49	3,457,239	70,556
Unknown/Other barriers	10	5	45,333	9,067
Water diversions	4	2	20,307	10,153
Assessment and prioritization			80,000	
BODEGA	**3**	**2**	**363,382**	
Dams	1	1	230,255	460,511
Non-structural sites	1	1	5,019	10,038
Fish passage facilities	0	0	0	
Stream crossings	1	1	28,108	56,215
Unknown/Other barriers	0	0	0	
Water diversions	0	0	0	
Assessment and prioritization			100,000	
CAPE MENDOCINO	**67**	**34**	**1,158,305**	
Dams	0	0	0	
Non-structural sites	35	18	169,088	9,662
Fish passage facilities	0	0	0	
Stream crossings	27	14	884,347	65,507
Unknown/Other barriers	5	3	24,869	9,948
Water diversions	0	0	0	
Assessment and prioritization			80,000	

Continued...

TOTAL ESTIMATED COST OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and barrier type	No. Potential barriers	No. Actual barriers	Cost ($)	Unit cost
EEL RIVER	**1,152**	**576**	**28,328,381**	
Dams	34	17	10,126,168	595,657
Non-structural sites	859	430	4,203,345	9,787
Fish passage facilities	6	3	2,092,113	697,371
Stream crossings	226	113	11,293,206	99,940
Unknown/Other barriers	24	12	173,951	123,844
Water diversions	3	2	59,597	39,732
Assessment and prioritization			380,000	
EUREKA PLAIN	**84**	**42**	**3,652,731**	
Dams	7	4	2,009,913	574,261
Non-structural sites	51	26	253,100	9,925
Fish passage facilities	0	0	0	
Stream crossings	24	12	1,354,830	112,903
Unknown/Other barriers	2	1	14,888	14,888
Water diversions	0	0	0	
Assessment and prioritization			20,000	
MAD RIVER	**141**	**68**	**3,991,020**	
Dams	7	1	450,000	450,000
Non-structural sites	93	47	459,054	9,872
Fish passage facilities	3	2	1,339,942	893,295
Stream crossings	33	17	1,604,953	97,270
Unknown/Other barriers	1	1	7,444	7,444
Water diversions	4	2	49,627	24,814
Assessment and prioritization			80,000	
MARIN COASTAL	**132**	**66**	**13,835,076**	
Dams	42	21	10,614,771	505,465
Non-structural sites	11	6	53,726	9,768
Fish passage facilities	0	0	0	
Stream crossings	75	38	3,008,670	80,231
Unknown/Other barriers	4	2	17,909	8,954
Water diversions	0	0	0	
Assessment and prioritization			360,000	

Continued...

TOTAL ESTIMATED COST OF
BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
MENDOCINO COAST	**3,960**	**1,980**	**292,909,680**	
Dams	29	15	6,965,753	480,397
Non-structural sites	94	47	444,054	9,448
Fish passage facilities	2	1	498,492	498,492
Stream crossings	3,827	1,914	284,571,592	148,718
Unknown/Other barriers	5	3	54,834	53,339
Water diversions	3	2	14,955	9,970
Assessment and prioritization			360,000	
REDWOOD CREEK	**40**	**18**	**471,908**	
Dams	4	0	0	
Non-structural sites	27	14	126,550	9,374
Fish passage facilities	0	0	0	
Stream crossings	8	4	277,914	69,478
Unknown/Other barriers	1	1	7,444	7,444
Water diversions	0	0	0	
Assessment and prioritization			60,000	
ROGUE RIVER	**41**	**21**	**270,271**	
Dams	0	0	0	
Non-structural sites	35	18	171,215	9,784
Fish passage facilities	0	0	0	
Stream crossings	3	2	41,687	27,791
Unknown/Other barriers	1	1	7,444	7,444
Water diversions	2	1	9,925	9,925
Assessment and prioritization			40,000	
RUSSIAN RIVER	**771**	**386**	**64,255,622**	
Dams	106	53	29,311,973	553,056
Non-structural sites	34	17	162,444	9,556
Fish passage facilities	9	5	3,046,063	676,903
Stream crossings	427	214	27,589,621	129,225
Unknown/Other barriers	6	3	155,167	151,832
Water diversions	189	95	3,770,354	39,898
Assessment and prioritization			220,000	

Continued...

TOTAL ESTIMATED COST OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
SAN MATEO	**69**	**39**	**10,751,122**	
Dams	29	19	8,558,793	450,463
Non-structural sites	20	10	99,510	9,951
Fish passage facilities	3	2	972,189	648,126
Stream crossings	16	8	995,513	124,439
Unknown/Other barriers	1	1	5,117	10,234
Water diversions	0	0	0	
Assessment and prioritization			120,000	
SAN PABLO	**495**	**248**	**50,582,418**	
Dams	139	70	35,172,497	506,079
Non-structural sites	52	26	263,803	10,146
Fish passage facilities	3	2	1,166,821	777,880
Stream crossings	174	87	11,633,272	133,716
Unknown/Other barriers	32	16	299,098	275,218
Water diversions	95	48	1,926,928	40,567
Assessment and prioritization			120,000	
SANTA CLARA	**124**	**62**	**23,873,536**	
Dams	69	35	18,768,639	544,019
Non-structural sites	16	8	68,819	8,602
Fish passage facilities	4	2	1,630,310	815,155
Stream crossings	34	17	3,300,670	194,157
Unknown/Other barriers	1	1	5,098	10,195
Water diversions	0	0	0	
Assessment and prioritization			100,000	
SMITH RIVER	**124**	**543**	**11,428,398**	
Dams	14	3	1,350,000	450,000
Non-structural sites	888	444	4,354,811	9,808
Fish passage facilities	0	0	0	
Stream crossings	102	51	3,831,737	75,132
Unknown/Other barriers	1	1	163,771	163,771
Water diversions	89	45	1,588,079	35,687
Assessment and prioritization			140,000	

Continued...

TOTAL ESTIMATED COST OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
SOUTH BAY	**175**	**88**	**34,545,539**	
Dams	114	57	30,842,411	541,095
Non-structural sites	17	9	66,191	7,787
Fish passage facilities	0	0	0	
Stream crossings	37	19	3,521,293	190,340
Unknown/Other barriers	7	4	35,645	10,184
Water diversions	0	0	0	
Assessment and prioritization			80,000	
SUISUN	**482**	**241**	**21,563,281**	
Dams	40	20	11,876,006	593,800
Non-structural sites	1	1	5,073	10,146
Fish passage facilities	0	0	0	
Stream crossings	7	4	634,370	181,249
Unknown/Other barriers	0	0	0	
Water diversions	434	217	8,807,832	40,589
Assessment and prioritization			240,000	
TRINIDAD	**22**	**11**	**742,725**	
Dams	1	1	119,106	238,212
Non-structural sites	7	4	34,739	9,925
Fish passage facilities	0	0	0	
Stream crossings	14	7	548,880	78,411
Unknown/Other barriers	0	0	0	
Water diversions	0	0	0	
Assessment and prioritization				
			40,000	
TRINITY RIVER	**564**	**282**	**26,168,024**	
Dams	14	7	7,101,692	1,014,527
Non-structural sites	89	45	434,240	9,758
Fish passage facilities	1	1	248,137	496,275
Stream crossings	237	119	13,791,476	116,384
Unknown/Other barriers	6	3	24,814	13,234
Water diversions	217	109	4,307,665	39,702
Assessment and prioritization			260,000	

Continued...

TOTAL ESTIMATED COST OF
BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
WINCHUCK RIVER	**9**	**4**	**173,845**	
Dams	2	0	0	
Non-structural sites	1	1	4,963	9,925
Fish passage facilities	0	0	0	
Stream crossings	4	2	138,957	69,478
Unknown/Other barriers	0	0	0	
Water diversions	2	1	9,925	9,925
Assessment and prioritization			20,000	
Water diversions	78	39	1,344,905	34,485
Assessment and prioritization			320,000	
KLAMATH RIVER	**1,169**	**585**	**30,751,902**	
Dams	31	16	7,137,216	460,466
Non-structural sites	752	376	3,635,213	9,668
Fish passage facilities	0	0	0	
Stream crossings	291	146	18,220,276	125,225
Unknown/Other barriers	17	9	94,292	37,367
Water diversions	78	39	1,344,905	34,485
Assessment and prioritization			320,000	
SCOTT RIVER	**59**	**23**	**2,604,636**	
Dams	4	2	446,647	223,324
Non-structural sites	7	0	0	
Fish passage facilities	0	0	0	
Stream crossings	42	21	2,137,989	101,809
Unknown/Other barriers	0	0	0	
Water diversions	6	0	0	
Assessment and prioritization			20,000	
SHASTA VALLEY	**30**	**8**	**4,455,000**	
Dams	19	8	4,435,000	554,375
Non-structural sites	2	0	0	
Fish passage facilities	0	0	0	
Stream crossings	7	0	0	
Unknown/Other barriers	0	0	0	
Water diversions	2	0	0	
Assessment and prioritization			20,000	

Continued...

TOTAL ESTIMATED COST OF

BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
KLAMATH RIVER (excl. SSPP)	**1,080**	**554**	**23,692,266**	
Dams	8	6	2,255,569	
Non-structural sites	743	376	3,635,213	
Fish passage facilities	0	0	0	
Stream crossings	242	125	16,082,287	
Unknown/Other barriers	17	9	94,292	
Water diversions	70	39	1,344,905	
Assessment and prioritization			280,000	

ATTACHMENT 1

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
BAY BRIDGES	**43**	**22**	**4,058,726**	
Dams	17	9	3,325,900	391,282
Non-structural sites	2	1	6,140	6,140
Fish passage facilities	0	0	0	
Stream crossings	22	11	722,081	65,644
Unknown/Other barriers	2	1	4,605	4,605
Water diversions	0	0	0	
BIG BASIN	**320**	**160**	**19,579,508**	
Dams	99	50	16,139,558	326,052
Non-structural sites	103	52	300,906	5,843
Fish passage facilities	6	3	1,025,317	341,772
Stream crossings	98	49	2,074,343	42,334
Unknown/Other barriers	10	5	27,200	5,440
Water diversions	4	2	12,184	6,092
BODEGA	**3**	**2**	**158,029**	
Dams	1	1	138,153	276,306
Non-structural sites	1	1	3,012	6,023
Fish passage facilities	0	0	0	
Stream crossings	1	1	16,865	33,729
Unknown/Other barriers	0	0	0	
Water diversions	0	0	0	
CAPE MENDOCINO	**67**	**34**	**646,983**	
Dams	0	0	0	
Non-structural sites	35	18	101,453	5,797
Fish passage facilities	0	0	0	
Stream crossings	27	14	530,608	39,304
Unknown/Other barriers	5	3	14,921	5,969
Water diversions	0	0	0	

Continued...

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
EEL RIVER	**1,152**	**576**	**16,769,028**	
Dams	34	17	6,075,701	357,394
Non-structural sites	859	430	2,522,007	5,872
Fish passage facilities	6	3	1,255,268	418,423
Stream crossings	226	113	6,775,924	59,964
Unknown/Other barriers	24	12	104,371	74,306
Water diversions	3	2	35,758	23,839
EUREKA PLAIN	**84**	**42**	**2,179,639**	
Dams	7	4	1,205,948	344,556
Non-structural sites	51	26	151,860	5,955
Fish passage facilities	0	0	0	
Stream crossings	24	12	812,898	67,742
Unknown/Other barriers	2	1	8,933	8,933
Water diversions	0	0	0	
MAD RIVER	**141**	**68**	**2,346,612**	
Dams	7	1	270,000	270,000
Non-structural sites	93	47	275,432	5,923
Fish passage facilities	3	2	803,965	535,977
Stream crossings	33	17	962,972	58,362
Unknown/Other barriers	1	1	4,466	4,466
Water diversions	4	2	29,776	14,888
MARIN COASTAL	**132**	**66**	**8,217,045**	
Dams	42	21	6,368,863	303,279
Non-structural sites	11	6	32,236	5,861
Fish passage facilities	0	0	0	
Stream crossings	75	38	1,805,202	48,139
Unknown/Other barriers	4	2	10,745	5,373
Water diversions	0	0	0	

Continued...

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
MENDOCINO COAST	**3,960**	**1,980**	**175,529,808**	
Dams	29	15	4,179,452	288,238
Non-structural sites	94	47	266,432	5,669
Fish passage facilities	2	1	299,095	299,095
Stream crossings	3,827	1,914	170,742,955	89,231
Unknown/Other barriers	5	3	32,900	32,003
Water diversions	3	2	8,973	5,982
REDWOOD CREEK	**40**	**18**	**247,145**	
Dams	4	0	0	
Non-structural sites	27	14	75,930	5,624
Fish passage facilities	0	0	0	
Stream crossings	8	4	166,748	41,687
Unknown/Other barriers	1	1	4,466	4,466
Water diversions	0	0	0	
ROGUE RIVER	**41**	**21**	**138,163**	
Dams	0	0	0	
Non-structural sites	35	18	102,729	5,870
Fish passage facilities	0	0	0	
Stream crossings	3	2	25,012	16,675
Unknown/Other barriers	1	1	4,466	4,466
Water diversions	2	1	5,955	5,955
RUSSIAN RIVER	**771**	**386**	**38,421,373**	
Dams	106	53	17,587,184	331,834
Non-structural sites	34	17	97,466	5,733
Fish passage facilities	9	5	1,827,638	406,142
Stream crossings	427	214	16,553,773	77,535
Unknown/Other barriers	6	3	93,100	91,099
Water diversions	189	95	2,262,212	23,939

Continued...

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
SAN MATEO	**69**	**39**	**6,378,673**	
Dams	29	19	5,135,276	270,278
Non-structural sites	20	10	59,706	5,971
Fish passage facilities	3	2	583,314	388,876
Stream crossings	16	8	597,308	74,663
Unknown/Other barriers	1	1	3,070	6,140
Water diversions	0	0	0	
SAN PABLO	**495**	**248**	**30,277,451**	
Dams	139	70	21,103,498	303,647
Non-structural sites	52	26	158,282	6,088
Fish passage facilities	3	2	700,092	466,728
Stream crossings	174	87	6,979,963	80,229
Unknown/Other barriers	32	16	179,459	165,131
Water diversions	95	48	1,156,157	24,340
SANTA CLARA	**124**	**62**	**14,264,122**	
Dams	69	35	11,261,183	326,411
Non-structural sites	16	8	41,291	5,161
Fish passage facilities	4	2	978,186	489,093
Stream crossings	34	17	1,980,402	116,494
Unknown/Other barriers	1	1	3,059	6,117
Water diversions	0	0	0	
SMITH RIVER	**124**	**543**	**6,773,039**	
Dams	14	3	810,000	270,000
Non-structural sites	888	444	2,612,887	5,885
Fish passage facilities	0	0	0	
Stream crossings	102	51	2,299,042	45,079
Unknown/Other barriers	1	1	98,262	98,262
Water diversions	89	45	952,848	21,412

Continued...

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
SOUTH BAY	**175**	**88**	**20,679,324**	
Dams	114	57	18,505,447	324,657
Non-structural sites	17	9	39,714	4,672
Fish passage facilities	0	0	0	
Stream crossings	37	19	2,112,776	114,204
Unknown/Other barriers	7	4	21,387	6,111
Water diversions	0	0	0	
SUISUN	**482**	**241**	**12,793,969**	
Dams	40	20	7,125,603	356,280
Non-structural sites	1	1	3,044	6,088
Fish passage facilities	0	0	0	
Stream crossings	7	4	380,622	108,749
Unknown/Other barriers	0	0	0	
Water diversions	434	217	5,284,699	24,353
TRINIDAD	**22**	**11**	**421,635**	
Dams	1	1	71,464	142,927
Non-structural sites	7	4	20,844	5,955
Fish passage facilities	0	0	0	
Stream crossings	14	7	329,328	47,047
Unknown/Other barriers	0	0	0	
Water diversions	0	0	0	
TRINITY RIVER	**564**	**282**	**15,544,814**	
Dams	14	7	4,261,015	608,716
Non-structural sites	89	45	260,544	5,855
Fish passage facilities	1	1	148,882	297,765
Stream crossings	237	119	8,274,885	69,830
Unknown/Other barriers	6	3	14,888	7,940
Water diversions	217	109	2,584,599	23,821

Continued...

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF
BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
WINCHUCK RIVER	**9**	**4**	**92,307**	
Dams	2	0	0	
Non-structural sites	1	1	2,978	5,955
Fish passage facilities	0	0	0	
Stream crossings	4	2	83,374	41,687
Unknown/Other barriers	0	0	0	
Water diversions	2	1	5,955	5,955
KLAMATH RIVER	**1,169**	**585**	**18,259,141**	
Dams	31	16	4,282,330	276,279
Non-structural sites	752	376	2,181,128	5,801
Fish passage facilities	0	0	0	
Stream crossings	291	146	10,932,166	75,135
Unknown/Other barriers	17	9	56,575	22,420
Water diversions	78	39	806,943	20,691
SCOTT RIVER	**59**	**23**	**1,550,782**	
Dams	4	2	267,988	133,994
Non-structural sites	7	0	0	
Fish passage facilities	0	0	0	
Stream crossings	42	21	1,282,793	61,085
Unknown/Other barriers	0	0	0	
Water diversions	6	0	0	
SHASTA VALLEY	**30**	**8**	**2,661,000**	
Dams	19	8	2,661,000	332,625
Non-structural sites	2	0	0	
Fish passage facilities	0	0	0	
Stream crossings	7	0	0	
Unknown/Other barriers	0	0	0	
Water diversions	2	0	0	

Continued...

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF
BARRIER ASSESSMENT, PRIORITIZATION, AND TREATMENT BY COHO SALMON HU

HU and Barrier Type	No. Potential Barriers	No. Actual Barriers	Cost ($)	Unit Cost
KLAMATH RIVER (excl. SSPP)	**1,080**	**554**	**14,047,359**	
Dams	8	6	1,353,341	
Non-structural sites	743	376	2,181,128	
Fish passage facilities	0	0	0	
Stream crossings	242	125	9,649,372	
Unknown/Other barriers	17	9	56,575	
Water diversions	70	39	806,943	

ATTACHMENT 2

TOTAL ESTIMATED COST OF RIPARIAN REVEGETATION BY HU

HU	Riparian Revegetation Cost ($)	Stream Miles Where Riparian Revegetation Needed	Unit Cost ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	90,640	N.a.	
BODEGA	85,647	N.a.	
CAPE MENDOCINO	15,433,726	85	181,133
EEL RIVER	29,858,170	165	181,122
EUREKA PLAIN	-	-	
KLAMATH RIVER	18,721,487	103	180,993
MAD RIVER	2,145,205	12	180,993
MARIN COASTAL	1,094,358	-	
MENDOCINO COAST	743,507	-	
REDWOOD CREEK	3,411,259	19	180,993
ROGUE RIVER	-	-	
RUSSIAN RIVER	528,450	-	
SAN MATEO	123,562	-	
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	2,468,586	14	180,993
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	103,304	1	180,993
TRINITY RIVER	3,241,052	18	180,993
WINCHUCK RIVER	35,989	0	180,993
Total SONCC	75,418,779	417	
Total CCC	2,666,164		
Total	**78,084,943**	**417**	
Scott	47,782,069	264	180,993
Shasta	39,818,391	220	180,993
Total SSPP	**87,600,460**	**484**	
Total incl. SSPP	**165,685,403**	**901**	

Note: assumes buffer of 50 feet.

ATTACHMENT 2

TOTAL ESTIMATED COST OF STREAMBANK RESTORATION BY HU

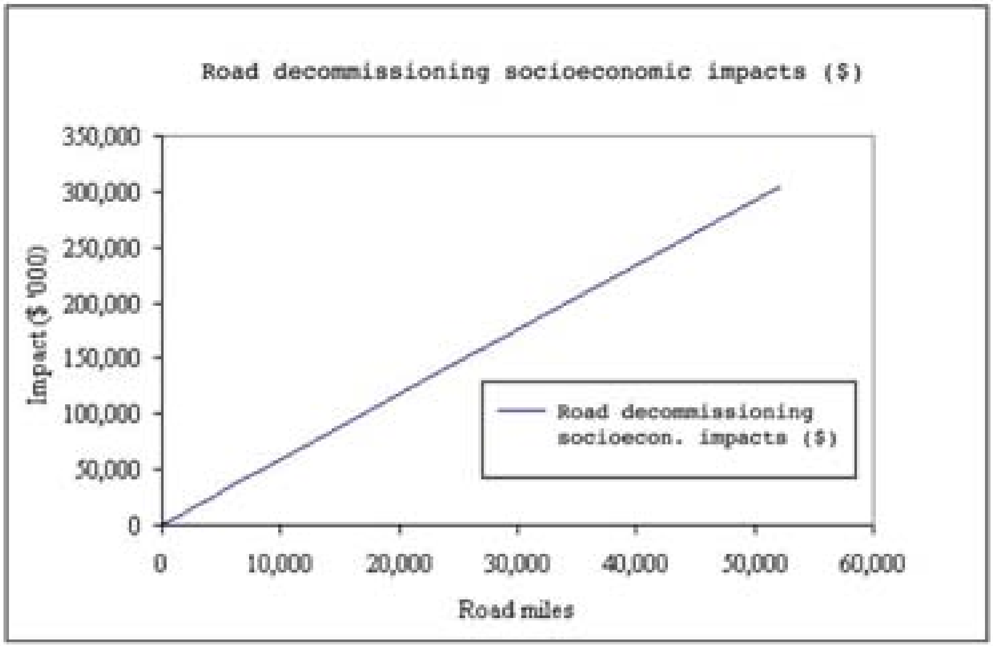
HU	Riparian Revegetation Cost ($)	Stream Miles Where Riparian Revegetation Needed	Unit Cost ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	61,164,203	46	1,323,974
BODEGA	1,685,832	1	1,325,214
CAPE MENDOCINO	56,140,177	43	1,317,744
EEL RIVER	181,015,158	137	1,317,661
EUREKA PLAIN	-	-	
KLAMATH RIVER	25,893,312	20	1,316,722
MAD RIVER	7,803,184	6	1,316,722
MARIN COASTAL	8,139,193	8	1,072,867
MENDOCINO COAST	222,331,325	169	1,319,017
REDWOOD CREEK	12,408,455	9	1,316,722
ROGUE RIVER	-	-	
RUSSIAN RIVER	32,999,164	25	1,319,932
SAN MATEO	-	-	
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	8,979,483	7	1,316,722
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	751,536	1	1,316,722
TRINITY RIVER	11,789,327	9	1,316,722
WINCHUCK RIVER	261,820	0.20	1,316,722
Total SONCC	305,042,453	400	
Total CCC	326,319,717	80	
Total	**631,362,170**	**480**	
Scott	65,836,089	50	1,316,722
Shasta	171,173,832	130	1,316,722
Total SSPP	**237,009,922**	**180**	
Total incl. SSPP	**868,372,091**	**660**	

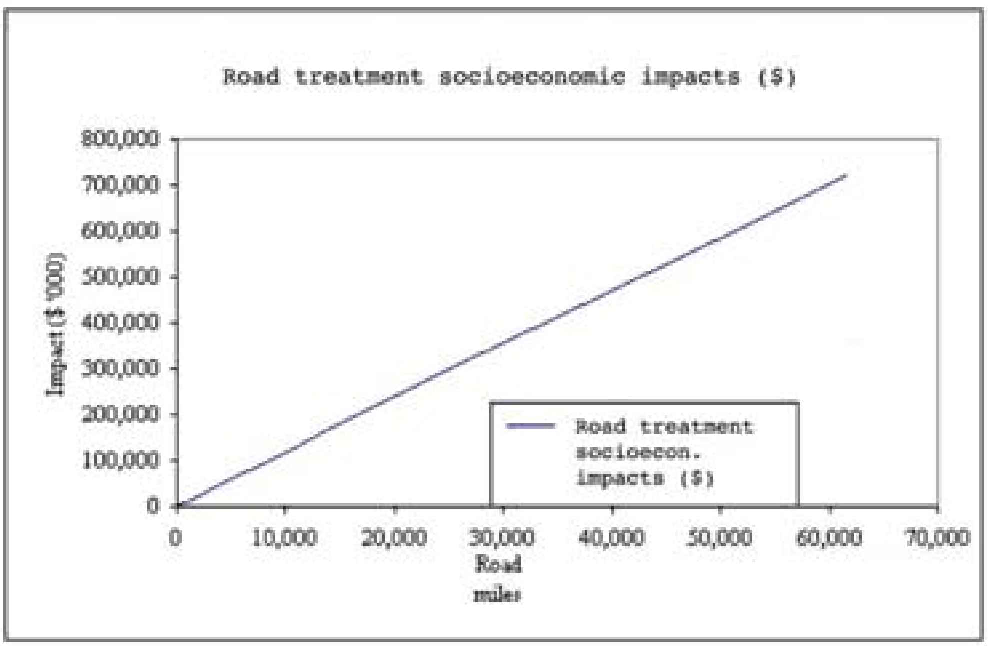
ATTACHMENT 2

TOTAL ESTIMATED COST OF FENCING BY HU			
HU	Fencing Cost ($)	Stream Miles Where Fencing Needed	Unit Cost ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	225,030	N.a.	N.a.
BODEGA	29	3	9
CAPE MENDOCINO	-	-	
EEL RIVER	421	56	8
EUREKA PLAIN	142	19	7
KLAMATH RIVER	12,830	1,748	7
MAD RIVER	-	-	
MARIN COASTAL	105	10	10
MENDOCINO COAST	1,805	231	8
REDWOOD CREEK	-	-	
ROGUE RIVER	-	-	
RUSSIAN RIVER	15	2	8
SAN MATEO	-	-	
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	1	0	7
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	3	0	7
TRINITY RIVER	-	-	
WINCHUCK RIVER	-	-	
Total SONCC	13,397	2,071	
Total CCC	226,983		
Total	**240,380**	**2,071**	
Scott	138	50	3
Shasta	358	130	3
Total SSPP	**495**	**180**	
Total incl. SSPP	**240,875**	**2,251**	

Notes: Fencing miles needed not provided by DFG for Big Basin; total costs provided instead.

ATTACHMENT 2





ATTACHMENT 2

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF RIPARIAN REVEGETATION BY HU

HU	Riparian Revegetation Socioecon. Impact ($)	Stream Miles Where Riparian Revegetation Needed	Unit Impact ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	42,601	-	
BODEGA	40,254	-	
CAPE MENDOCINO	7,253,851	85	85,133
EEL RIVER	14,033,340	165	85,127
EUREKA PLAIN	-	-	
KLAMATH RIVER	8,799,099	103	85,067
MAD RIVER	1,008,246	12	85,067
MARIN COASTAL	514,348	-	
MENDOCINO COAST	349,448	-	
REDWOOD CREEK	1,603,292	19	85,067
ROGUE RIVER	-	-	
RUSSIAN RIVER	248,372	-	
SAN MATEO	58,074	-	
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	1,160,236	14	85,067
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	48,553	1	85,067
TRINITY RIVER	1,523,295	18	85,067
WINCHUCK RIVER	16,915	0	85,067
Total SONCC	35,446,826	417	
Total CCC	1,253,097		
Total excl. SSPP	**36,699,923**	**417**	
Scott	22,457,572	264	85,067
Shasta	18,714,644	220	85,067
Total SSPP	**41,172,216**	**484**	
Total incl. SSPP	**77,872,139**	**901**	

Note: assumes buffer of 50 feet.

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF STREAMBANK RESTORATION BY HU

HU	Restoring Streambank Socioecon. Impact ($)	Stream Miles Where Streambank Restoration Needed	Unit Impact ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	28,747,175	46	622,268
BODEGA	792,341	1	622,850
CAPE MENDOCINO	26,385,883	43	619,340
EEL RIVER	85,077,124	137	619,301
EUREKA PLAIN	-	-	
KLAMATH RIVER	12,169,857	20	618,859
MAD RIVER	3,667,496	6	618,859
MARIN COASTAL	3,825,421	8	504,247
MENDOCINO COAST	104,495,723	169	619,938
REDWOOD CREEK	5,831,974	9	618,859
ROGUE RIVER	-	-	
RUSSIAN RIVER	15,509,607	25	620,368
SAN MATEO	-	-	
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	4,220,357	7	618,859
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	353,222	1	618,859
TRINITY RIVER	5,540,984	9	618,859
WINCHUCK RIVER	123,055	0	618,859
Total SONCC	143,369,953	400	
Total CCC	153,370,267	80	
Total excl. SSPP	**296,740,220**	**480**	
Scott	30,942,962	50	449,151
Shasta	80,451,701	130	143,959
Total SSPP	**111,394,663**	**180**	
Total incl. SSPP	**408,134,883**	**660**	

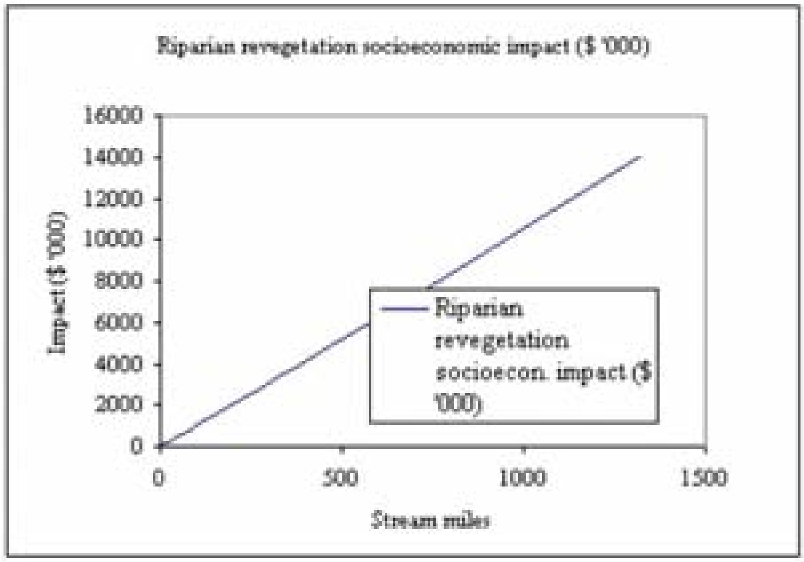
ATTACHMENT 2

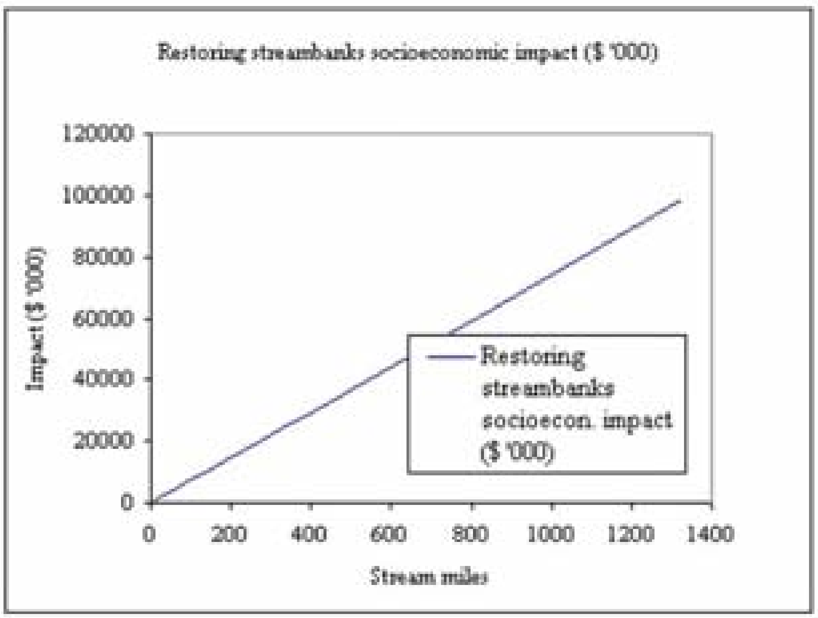
TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF FENCING BY HU

HU	Present Value Of Fencing Socioecon. Impact ($)	Stream Miles Where Fencing Needed	Unit Impact ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	225,030		N.a.
BODEGA	29	3	9
CAPE MENDOCINO	-	-	
EEL RIVER	421	56	8
EUREKA PLAIN	142	19	7
KLAMATH RIVER	12,830	1,748	7
MAD RIVER	-	-	
MARIN COASTAL	105	10	10
MENDOCINO COAST	1,805	231	8
REDWOOD CREEK	-	-	
ROGUE RIVER	-	-	
RUSSIAN RIVER	15	2	8
SAN MATEO	-	-	
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	1	0	7
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	3	0	7
TRINITY RIVER	-	-	
WINCHUCK RIVER	-	-	
Total SONCC	13,397	2,071	
Total CCC	226,983		
Total excl. SSPP	**240,380**	**2,071**	
Scott	138	50	449,151
Shasta	358	130	143,959
Total SSPP	**495**	**180**	
Total incl. SSPP	**240,875**	**2,251**	

Notes: Fencing miles needed not provided by DFG for Big Basin; total costs provided instead.

ATTACHMENT 2





ATTACHMENT 3

TOTAL ESTIMATED COST OF LWD PLACEMENT BY HU

HU	LWD Placement Cost ($)	Stream Miles Where LWD Placement Needed	Unit Cost ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	38,994,078	N.a.	
BODEGA	1,539,521	N.a.	
CAPE MENDOCINO	665,474	33	19,941
EEL RIVER	-	-	
EUREKA PLAIN	-	-	
KLAMATH RIVER	8,924,026	448	19,914
MAD RIVER	2,141,958	108	19,914
MARIN COASTAL	6,699,179	N.a.	
MENDOCINO COAST	48,885,118	N.a.	-
REDWOOD CREEK	163,097	8	19,914
ROGUE RIVER	-	-	
RUSSIAN RIVER	20,501,402	N.a.	
SAN MATEO	13,438,759	N.a.	
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	-	-	
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	-	-	
TRINITY RIVER	-	-	
WINCHUCK RIVER	3,776	0.19	19,914
Total SONCC	11,898,330	597	
Total CCC	130,058,058	N.a.	
Total excl. SSPP	**141,956,388**	**597**	
Scott	1,500,000	N.a.	
Shasta	758,400	40	18,960
Total SSPP	**2,258,400**		
Total incl. SSPP	**144,214,788**	**N.a.**	

ATTACHMENT 3

TOTAL ESTIMATED COST OF RESTORING IN-CHANNEL COMPLEXITY BY HU

HU	Restoring In-Channel Complexity Cost ($)	Stream Miles Where In-Channel Complexity Restoration Needed	Unit Cost ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	58,192,502	N.a.	
BODEGA	2,113,118	N.a.	
CAPE MENDOCINO	3,341,909	84	39,886
EEL RIVER	4,724,764	118	39,885
EUREKA PLAIN	715,873	18	39,834
KLAMATH RIVER	17,851,019	448	39,834
MAD RIVER	4,284,628	108	39,834
MARIN COASTAL	8,743,467	N.a.	
MENDOCINO COAST	68,435,890	N.a.	
REDWOOD CREEK	326,248	8	39,834
ROGUE RIVER	-	-	
RUSSIAN RIVER	24,902,591	N.a.	
SAN MATEO	21,504,958	N.a.	
SAN PABLO	-	-	
SANTA CLARA	1	-	
SMITH RIVER	-	-	
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	-	-	
TRINITY RIVER	3,211,482	81	39,834
WINCHUCK RIVER	7,554	0.19	39,834
Total SONCC	34,463,477	865	
Total CCC	183,892,527	N.a.	
Total excl. SSPP	**218,356,004**	**865**	
Scott	19,000	1	38,000
Shasta	1,520,000	40	38,000
Total SSPP	**1,539,000**	**41**	
Total incl. SSPP	**219,895,004**	**N.a.**	

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF LWD PLACEMENT BY HU

HU	LWD Placement Impacts ($)	Stream Miles Where LWD Placement Needed	Unit Cost ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	25,346,151	N.a.	
BODEGA	1,000,689	N.a.	
CAPE MENDOCINO	431,866	33	12,941
EEL RIVER	-	-	
EUREKA PLAIN	-	-	
KLAMATH RIVER	5,787,113	448	12,914
MAD RIVER	1,389,031	108	12,914
MARIN COASTAL	4,354,467	N.a.	
MENDOCINO COAST	31,775,326	N.a.	
REDWOOD CREEK	105,766	8	12,914
ROGUE RIVER	-	-	
RUSSIAN RIVER	13,325,912	N.a.	
SAN MATEO	8,735,194	N.a.	
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	-	-	
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	-	-	
TRINITY RIVER	-	-	
WINCHUCK RIVER	2,449	0.19	12,914
Total SONCC	7,716,225	597	
Total CCC	84,537,738	N.a.	
Total excl. SSPP	**92,253,963**	**597**	
Scott	975,000	-	
Shasta	478,400	40	18,960
Total SSPP	**1,453,400**	**40**	
Total incl. SSPP	**93,707,363**	**N.a.**	

ATTACHMENT 3

TOTAL ESTIMATED SOCIOECONOMIC IMPACT OF RESTORING IN-CHANNEL COMPLEXITY BY HU

HU	Restoring In-Channel Complexity Cost ($)	Stream Miles Where In-Channel Complexity Restoration Needed	Unit Cost ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	37,825,126	N.a.	
BODEGA	1,373,527	N.a.	
CAPE MENDOCINO	2,172,241	84	25,926
EEL RIVER	3,071,097	118	25,925
EUREKA PLAIN	465,317	18	25,892
KLAMATH RIVER	11,603,162	448	25,892
MAD RIVER	2,785,008	108	25,892
MARIN COASTAL	5,683,254	N.a.	
MENDOCINO COAST	44,483,329	N.a.	
REDWOOD CREEK	212,061	8	25,892
ROGUE RIVER	-	-	
RUSSIAN RIVER	16,186,684	N.a.	
SAN MATEO	13,978,223	N.a.	
SAN PABLO	-	-	
SANTA CLARA		-	
SMITH RIVER	-	-	
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	-	-	
TRINITY RIVER	2,087,463	81	25,892
WINCHUCK RIVER	4,910	0.19	25,892
Total SONCC	22,401,260	865	
Total CCC	119,530,142	N.a.	
Total excl. SSPP	**141,931,402**	**865**	
Scott	12,350	1	38,000
Shasta	988,000	40	38,000
Total SSPP	**1,000,350**	**41**	
Total incl. SSPP	**142,931,752**	**N.a.**	

ATTACHMENT 4

TOTAL ESTIMATED COST OF ROAD DECOMMISSIONING BY HU

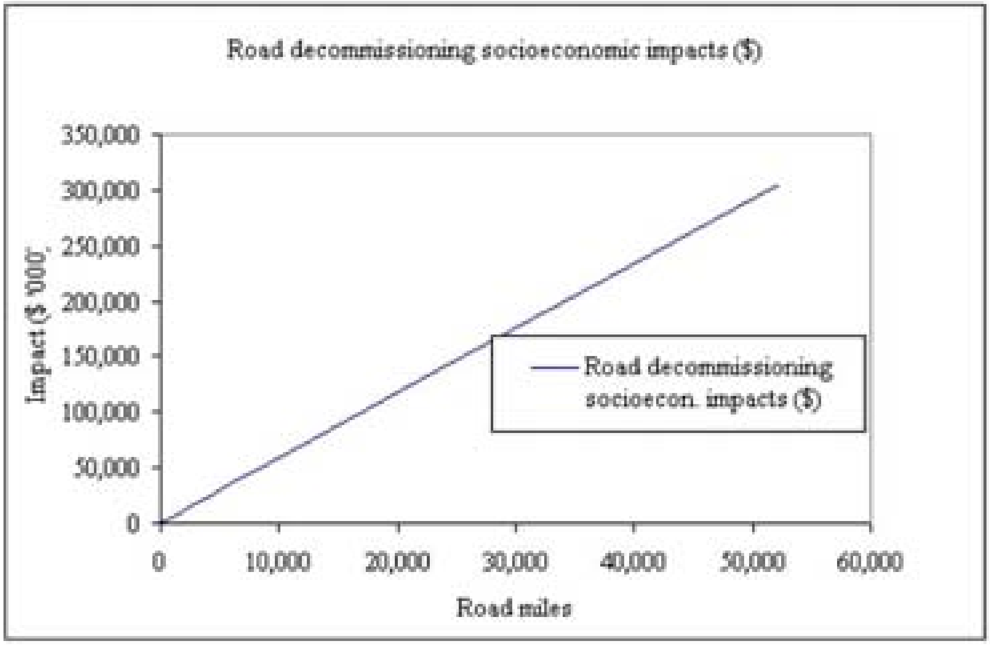
HU	Road Decommissioning Socioecon. Impacts ($)	Road Miles Where Decommissioning Needed	Unit Impacts ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	3,749,590	610	6,149
BODEGA	286,507	47	6,102
CAPE MENDOCINO	18,682,068	3,187	5,862
EEL RIVER	84,548,153	14,432	5,858
EUREKA PLAIN	1,025,673	177	5,801
KLAMATH RIVER	62,172,751	10,717	5,801
MAD RIVER	1,962,179	338	5,801
MARIN COASTAL	1,175,225	177	6,623
MENDOCINO COAST	8,860,952	1,492	5,941
REDWOOD CREEK	2,668,607	460	5,801
ROGUE RIVER	1,800,005	310	5,801
RUSSIAN RIVER	7,027,012	1,163	6,045
SAN MATEO	1,062,597	162	6,559
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	21,019,344	3,623	5,801
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	5,392,908	930	5,801
TRINITY RIVER	82,761,638	14,266	5,801
WINCHUCK RIVER	623,758	108	5,801
Total SONCC	282,657,085	52,198	
Total CCC	22,161,884		
Total excl. SSPP	**304,818,969**	**52,198**	
Scott	-	-	
Shasta	-	-	
Total SSPP	**-**	**-**	
Total incl. SSPP	**304,818,969**	**52,198**	

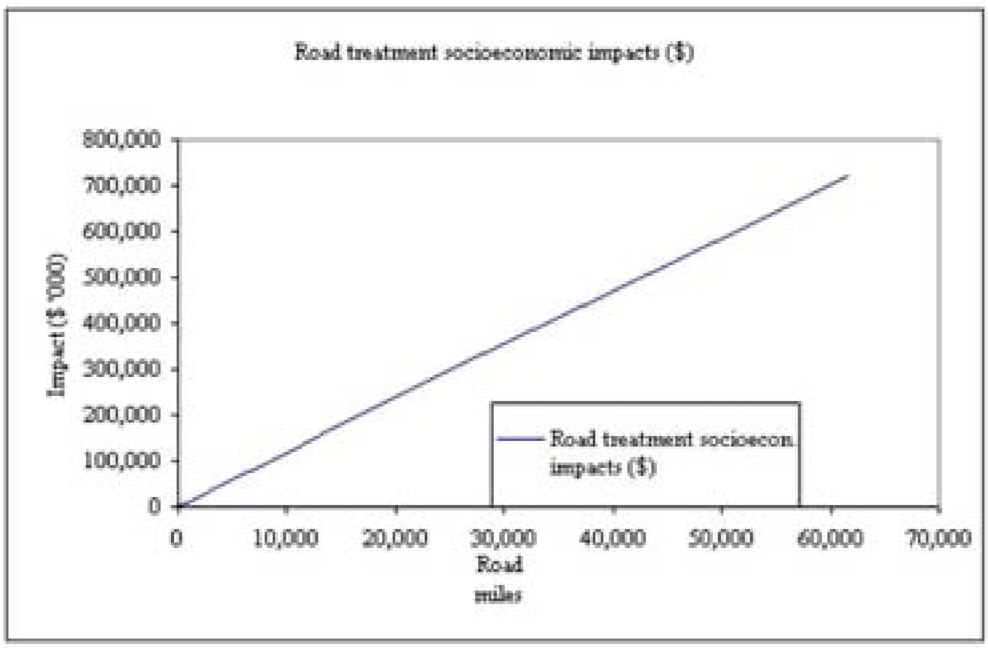
ATTACHMENT 4

TOTAL ESTIMATED COST OF ROAD TREATMENT BY HU

HU	Road Treatment Socioecon. Impacts ($)	Road Miles Where Treatment Needed	Unit Impact ($/Mile)
BAY BRIDGES	-	-	
BIG BASIN	42,067,177	3,455	12,175
BODEGA	3,216,114	266	12,088
CAPE MENDOCINO	31,548,349	2,709	11,647
EEL RIVER	142,783,304	12,267	11,639
EUREKA PLAIN	1,733,398	150	11,534
KLAMATH RIVER	105,072,519	9,109	11,534
MAD RIVER	2,145,712	186	11,534
MARIN COASTAL	13,118,385	1,006	13,046
MENDOCINO COAST	99,659,317	8,452	11,791
REDWOOD CREEK	2,306,891	200	11,534
ROGUE RIVER	3,042,024	264	11,534
RUSSIAN RIVER	78,933,524	6,588	11,982
SAN MATEO	11,868,770	918	12,929
SAN PABLO	-	-	
SANTA CLARA	-	-	
SMITH RIVER	35,522,884	3,080	11,534
SOUTH BAY	-	-	
SUISUN	-	-	
TRINIDAD	9,114,063	790	11,534
TRINITY RIVER	139,867,925	12,126	11,534
WINCHUCK RIVER	1,054,157	91	11,534
Total SONCC	474,191,226	61,658	
Total CCC	248,863,288		
Total excl. SSPP	**723,054,513**	**61,658**	
Scott	63,439	6	11,534
Shasta	-	-	
Total SSPP	**63,439**	**6**	
Total incl. SSPP	**723,117,953**	**61,663**	

ATTACHMENT 4





County	Pasture Operating Costs/Acre	Gross Pasture Returns/Acre	Agriculture Operating Costs/Acre	Gross Agriculture Returns/Acre	Region
Alameda	428	1,030	4,463	5,121	Central coast
Contra Costa	428	1,030	4,463	5,121	Central coast
San Mateo	428	1,030	4,463	5,121	Central coast
Santa Clara	428	1,030	4,463	5,121	Central coast
Santa Cruz	428	1,030	4,463	5,121	Central Coast
Solano	428	1,030	4,463	5,121	Central Coast
Glenn	245	254	221	550	Intermountain
Siskiyou	245	254	222	550	Intermountain
Trinity	245	254	223	550	Intermountain
Del Norte	266	405	1,938	6,300	North Coast
Humboldt	266	405	1,938	6,300	North Coast
Lake	266	405	1,938	6,300	North Coast
Marin	266	405	1,938	6,300	North Coast
Mendocino	266	405	1,938	6,300	North Coast
Napa	266	405	3,561	18,190	North Coast
San Francisco	266	405	3,561	18,190	North Coast
Sonoma	266	405	2,899	12,219	North Coast

Notes on sources:

Farm operating cost data and water use obtained from UC Extension current cost and return studies.

These can be found at http://coststudies.ucdavis.edu/county.htm

The following studies were used here:

1. Pasture in Mendocino county
2. Alfalfa in Siskiyou county
3. Wine grapes in Napa county
4. Wine grapes in Sonoma county
5. Wine grapes in Lake county
6. Broccoli & Cauliflower in Central coast
7. For pasture in the Central Coast used alfalfa data

Notes on sources of other data used to generate this analysis:

County census data for 1997 on irrigated pasture and crop land by county were obtained from http://govinfo.kerr.orst.edu/php/agri/index.php.

County data on irrigated water withdraw levels in 1995 for pasture and crops were obtained from http://water.usgs.gov/watuse/spread95.html.

HABITAT RESTORATION FISCAL COSTS			HABITAT RESTORATION SOCIOECON. IMPACTS		
	Cost ($)	Quantity		Impacts ($)	Quantity
Riparian revegetation (miles)					
Total SONCC	75,418,779	417	Total SONCC	35,446,826	417
Total CCC	2,666,164		Total CCC	1,253,097	
Total	**78,084,943**	**417**	**Total excl. SSPP**	**36,699,923**	**417**
Scott	47,782,069	264	Scott	22,457,572	264
Shasta	39,818,391	220	Shasta	18,714,644	220
Total SSPP	**87,600,460**	**484**	**Total SSPP**	**41,172,216**	**484**
Total incl. SSPP	**165,685,403**	**901**	**Total incl. SSPP**	**77,872,139**	**901**
Streambank restoration (miles)					
Total SONCC	305,042,453	400	Total SONCC	143,369,953	400
Total CCC	326,319,717	80	Total CCC	153,370,267	80
Total	**631,362,170**	**480**	**Total excl. SSPP**	**296,740,220**	**480**
Scott	65,836,089	50	Scott	30,942,962	50
Shasta	171,173,832	130	Shasta	80,451,701	130
Total SSPP	**237,009,922**	**180**	**Total SSPP**	**111,394,663**	**180**
Total incl. SSPP	**868,372,091**	**660**	**Total incl. SSPP**	**408,134,883**	**660**
Fencing (miles)					
Total SONCC	13,397	2,071	Total SONCC	13,397	2,071
Total CCC	226,983		Total CCC	226,983	
Total	**240,380**	**2,071**	**Total excl. SSPP**	**240,380**	**2,071**
Scott	138	50	Scott	138	50
Shasta	358	130	Shasta	358	130
Total SSPP	**495**	**180**	**Total SSPP**	**495**	**180**
Total incl. SSPP	**240,875**	**2,251**	**Total incl. SSPP**	**240,875**	**2,251**
Barriers to passage (number)					
Total SONCC	196,097,109	2702	Total SONCC	116,542,265	2702
Total CCC	456,217,478	2741	Total CCC	273,022,487	2741
Total excl. SSPP	**652,314,587**	5443	**Total excl. SSPP**	**389,564,752**	5443
Scott	2,604,636	23	Scott	1,550,782	23
Shasta	4,455,000	8	Shasta	2,661,000	8
Total SSPP	**7,059,636**	31	**Total SSPP**	**4,211,782**	31
Total incl. SSPP	**659,374,223**	5474	**Total incl. SSPP**	**393,776,534**	5474

Continued...

HABITAT RESTORATION FISCAL COSTS	Cost ($)	Quantity	HABITAT RESTORATION SOCIOECON. IMPACTS	Impacts ($)	Quantity
Road decommissioning (miles)					
Total SONCC	423,985,628	50,039	Total SONCC	282,657,085	52,198
Total CCC	33,242,825	2,159	Total CCC	22,161,884	
Total excl. SSPP	**457,228,453**	**52,198**	**Total excl. SSPP**	**304,818,969**	**52,198**
Scott	-	-	Scott	-	-
Shasta	-	-	Shasta	-	-
Total SSPP	**-**	**-**	**Total SSPP**	**-**	**-**
Total incl. SSPP	**457,228,453**	**52,198**	**Total incl. SSPP**	**304,818,969**	**52,198**
Road treatment (miles)					
Total SONCC	633,583,234	49,425	Total SONCC	474,191,226	61,658
Total CCC	332,514,813	12,232	Total CCC	248,863,288	
Total excl. SSPP	**966,098,047**	**61,658**	**Total excl. SSPP**	**723,054,513**	**61,658**
Scott	84,764	6	Scott	63,439	6
Shasta	-	-	Shasta	-	-
Total SSPP	**84,764**	**6**	**Total SSPP**	**63,439**	**6**
Total incl. SSPP	**966,182,811**	**61,663**	**Total incl. SSPP**	**723,117,953**	**61,663**
Total excl. SSPP	**141,956,388**	**597**			
LWD placement (miles)					
Total SONCC	11,898,330	597	Total SONCC	7,716,225	597
Total CCC	130,058,058	N.a.	Total CCC	84,537,738	N.a.
Total excl. SSPP	**141,956,388**	**597**	**Total excl. SSPP**	**92,253,963**	**597**
Scott	1,500,000	N.a.	Scott	975,000	-
Shasta	758,400	40	Shasta	478,400	40
Total SSPP	**2,258,400**		**Total SSPP**	**1,453,400**	**40**
Total incl. SSPP	**144,214,788**	**N.a.**	**Total incl. SSPP**	**93,707,363**	**N.a.**
In-stream complexity (miles)					
Total SONCC	34,463,477	865	Total SONCC	22,401,260	865
Total CCC	183,892,527	N.a.	Total CCC	119,530,142	N.a.
Total excl. SSPP	**218,356,004**	**865**	**Total excl. SSPP**	**141,931,402**	**865**
Scott	19,000	1	Scott	12,350	1
Shasta	1,520,000	40	Shasta	988,000	40
Total SSPP	**1,539,000**	**41**	**Total SSPP**	**1,000,350**	**41**
Total incl. SSPP	**219,895,004**	**N.a.**	**Total incl. SSPP**	**142,931,752**	**N.a.**

Continued...

HABITAT RESTORATION FISCAL COSTS	Cost ($)	Quantity	HABITAT RESTORATION SOCIOECON. IMPACTS	Impacts ($)	Quantity
Total SONCC	1,680,502,407		Total SONCC	1,082,338,237	
Total CCC	1,465,138,565		Total CCC	902,965,885	
Total excl. SSPP	**3,145,640,972**		**Total excl. SSPP**	**1,985,304,122**	
Scott	117,826,696		Scott	56,002,243	
Shasta	217,725,981		Shasta	103,294,103	
Total SSPP	**335,552,677**		**Total SSPP**	**159,296,346**	
Total incl. SSPP	**3,481,193,649**		**Total incl. SSPP**	**2,144,600,468**	