Appendix 12
Aquatic Biological Resources

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APPENDIX 12A
Fish Species Life Histories

12A.1 Description of Fish Species of Primary Management Concern within the Extended, Secondary, and Primary Study Areas

12A.1.1 Sensitive Species

12A.1.1.1 Chinook salmon (Oncorhynchus tshawytscha)

Chinook salmon are anadromous (they spend much of their lives in the ocean and return to fresh water as adults to spawn). There are four runs of Chinook salmon found in the Primary, Secondary, and Extended study areas: winter-run, spring-run, fall-run, and late-fall-run.

All four runs are found in the Sacramento River watershed. Only fall-run and spring-run are found in the Trinity River watershed. The Feather River downstream of the Fish Barrier Dam supports spring- and fall-run. The American River downstream of Nimbus Dam and the San Joaquin River system support fall-run. Winter-run and spring-run are the two runs protected pursuant to the federal Endangered Species Act (FESA) and the California Endangered Species Act (CESA). Life history characteristics that differentiate the salmon runs include the time of year that adults return to fresh water to spawn, and state of sexual maturity upon arrival to the streams where they were born (natal streams). Table 12A-1 shows the timing of spawning and the early life stages of Sacramento River Chinook salmon upstream of Hamilton City.

The major factors that limit the range and abundance of Chinook salmon are flow, water temperature, barriers to upstream migration, habitat quality, entrainment in water diversions, and ocean conditions. Climate change and its impact on water temperature, hydrology, and ocean conditions will have potentially substantial effects on Chinook salmon populations in the future.

Chinook salmon exhibit two generalized freshwater life history types (Healey, 1991). “Streamtype” Chinook salmon enter fresh water months before spawning and reside in fresh water for one year or more following emergence, whereas “ocean-type” Chinook salmon spawn soon after entering fresh water and migrate to the ocean within their first year. Table 12A-2 summarizes monitoring data for juvenile Chinook salmon and shows the migration timing for the runs of Chinook salmon at points along the river. The majority of juvenile Chinook salmon migrate downstream in the Sacramento River when flow and turbidity are high.

Table 12A-1
Life Stage Occurrence of Chinook Salmon and Steelhead in the Sacramento River

Life Stage	Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Adult Migration	Winter-run Chinook				x								
	Spring-run Chinook												
	Fall-run Chinook										x		
	Late-Fall-run Chinook											x	
	Steelhead										x		
Spawning	Winter-run Chinook						x						
	Spring-run Chinook									x			
	Fall-run Chinook											x	
	Late-Fall-run Chinook		x										
	Steelhead			x									
Egg Incubation	Winter-run Chinook												
	Spring-run Chinook												
	Fall-run Chinook												
	Late-Fall-run Chinook												
	Steelhead												
Juvenile Rearing & Migration	Winter-run Chinook												
	Spring-run Chinook												
	Fall-run Chinook												
	Late-Fall-run Chinook												
	Steelhead												

Note:

Shading indicates the duration/timing of migration, spawning, and egg incubation, while 'x' indicates the peak timing.

Source: Hallock, 1989, Vogel and Marine, 1991

Table 12A-2
Juvenile Chinook Salmon Migration Timing at Monitoring Stations on the Sacramento River

Species	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Winter-run	RBDD								X	XX	XX	X	
	GCID									X	XX	X	
Spring-run	RBDD			XX	XX								XX
	GCID				XX								
	Knights Landing	X		XX	X								X
Fall-run	RBDD	X	XX	X	X								X
	GCID		X	X	XX	XX	XX						
	Knights Landing	XX	XX	X									
Late-Fall-run	RBDD				XX	X			X	X		X	
	Average lengths (mm)												
	GCID										XX	XX	
	Knights Landing				XX		XX						XX
	Average lengths (mm)												

Notes:

XX = High Abundance
X = Moderate Abundance
= Low Abundance

GCID = Glenn-Colusa Irrigation District
Mm = millimeter
RBDD = Red Bluff Diversion Dam

Source: CDFG, 2005; USFWS, 2002; CDFG, 2000

Central Valley Winter-run Chinook Salmon

Status

Winter-run Chinook salmon were listed as endangered pursuant to FESA on January 4, 1994 (Federal Register, 1994a). The possibility of extinction of winter-run Chinook salmon is linked to the lack of access to their historical spawning grounds, and the population remains below the recovery goals for the run (NMFS, 1997).

Critical habitat was designated for winter-run Chinook salmon on June 16, 1993 (Federal Register, 1993a) and includes the Sacramento River from Keswick Dam downstream to the Sacramento-San Joaquin Delta, the adjacent riparian area, and San Pablo and San Francisco bays (Figure 12A-1). Critical habitat includes the river water, river bottom, and the adjacent riparian zone.

Dam construction has greatly diminished the range of winter-run Chinook salmon. Historically, winter-run used winter high flows during their migration to access the headwaters of the Sacramento River, such as the upper Sacramento, McCloud, Pit, and Fall rivers (Figure 12A-1). The upper reaches of Battle Creek also may have supported winter-run before the development of hydroelectric dams. Winter-run Chinook salmon may have also ascended into the upper reaches of the Feather and American rivers (Yoshiyama et al., 2001). Since the construction of Shasta Dam, winter-run Chinook salmon have been confined to the mainstem Sacramento River and Battle Creek (Figure 12A-1).

In contemporary records, there have been fewer winter-run Chinook salmon than either spring-run or fall-run. The number of returning adult winter-run Chinook salmon in the Sacramento River has decreased since 1969 (NMFS, 2009b). Winter-run Chinook salmon adult returns have declined from approximately 120,000 in the mid- to late-1960s to a few hundred in the early 1990s. Since the mid 1990s, abundance had increased and adult returns had been numbering in the thousands (CDFG, 2002); however, in 2008 and 2009, the run declined dramatically to historically low numbers (NMFS, 2009b).

Factors that likely led to past increases in abundance include improved freshwater and marine habitat, changes in hatchery production, restricted commercial harvest, improvements to Shasta Dam operations, decreases in the length of time that the RBDD gates were in, and changes to operations at the CVP and SWP Delta pumping plants (NMFS, 2009b).

General Biology and Life History

Historically, adequate stream flows were necessary to allow adult passage to holding habitat in the upper reaches of spawning streams and rivers, and high flows likely continue to be an important queue for adults holding in the San Francisco bay to begin migration. The preferred temperature range for upstream migration is 38ºF to 56ºF (CDFG, 1998), but water temperatures between 57ºF and 67ºF are suitable (NMFS, 1997).

Adult winter-run Chinook salmon enter San Francisco Bay from November through June (Hallock and Fisher, 1985) and migrate past RBDD from mid-December through early August (NMFS, 1997). The majority of the run passes RBDD from January through May, and peaks in mid-March (Hallock and Fisher, 1985). The timing of migration may vary somewhat because of changes in river flows from dam operation and runoff.

Adults hold in deep cold pools until they are sexually mature and ready to spawn in spring or summer. This trait distinguishes winter-run salmon from the other Central Valley runs. Winter-run hold in the

Sacramento River mostly between Bend Bridge and Keswick Dam (NMFS, 1997) where the river is confined between natural bluffs and volcanic formations, and the pools are between 20 and 60 feet deep.

In holding areas, water temperatures between 55ºF and 56ºF are ideal for gamete (male and female sexual reproductive cells) development and egg viability. Suitability for holding adults begins to decline when water temperatures are higher than 60ºF (NMFS, 1997; DWR, 1988). Temperatures higher than 69.8ºF begin to cause mortality (McCullough, 1999). During the period that adults are holding, late spring and summer water temperatures are dependent on the volume of coldwater storage and releases to the Sacramento River.

Winter-run Chinook salmon mature primarily at age three (67 percent) and two (25 percent). The remaining eight percent are four+ year olds (NMFS, 1997; Fisher, 1994).

Spawning

The onset of spawning begins in late April, peaks in May and June, and usually subsides by mid-August (NMFS, 1997). When compared to the other runs of Chinook salmon, winter-run Chinook salmon may select deeper spawning sites over seemingly equally suitable shallow sites. Winter-run Chinook salmon have been observed spawning at depths in excess of 21 feet in Lake Redding (NMFS, 1997). Most winter-run Chinook salmon spawn in the Redding area of the Sacramento River (CDFG, 2007).

Chinook salmon spawn in gravel bedded areas in rivers and creeks with moderate flow and depths typically greater than 9.5 inches (Allen and Hassler, 1986). Upon finding a suitable site, the female excavates the nest (known as a redd), deposits her eggs, and pushes gravel over them once they have been fertilized by the male. Gravels free of excessive fine sediment (less than 5 percent sand, silt, and clay) that allow movement of water through the egg pockets are important for egg development and survival. Water circulation through the egg pocket delivers oxygen and removes metabolic waste (Platts et al., 1979; Reiser and Bjornn, 1979). It is also important that excess sediment does not block the emergence of fry from the gravel (Allen and Hassler, 1986). After spawning, Chinook salmon die, often within a few days.

Dams reduce the suitability of spawning habitat by capturing sediment and reducing high flow events. The capture of sediment behind dams causes the streambed in spawning areas to coarsen and Chinook salmon are unable to excavate redds in the large cobble that remains. The loss of regular high flows, which scour the streambed, causes fine sediment to clog the spaces between cobbles. The cobbles and fine sediment that comprise the bed eventually become locked together and difficult or impossible to excavate by spawning Chinook salmon.

Eggs develop in the gravel in approximately 40 to 60 days, where they remain for another four to six weeks until the yolk sac is completely absorbed. The rate of development increases with increasing water temperature (NMFS, 1997). Appropriate temperatures for incubation are between 42ºF and 56ºF; 52ºF is ideal (DWR, 1988). At 57.5ºF, significant mortality begins to occur, and total mortality results at 62ºF (DWR, 1988; NMFS, 1997). Following absorption of the yolk sac, fry begin to emerge from the gravel (Allen and Hassler, 1986). Emergence occurs from mid-June through mid-October. Post-emergent fry inhabit calm shallow waters with fine substrates and depend on fallen trees, undercut banks, and overhanging riparian vegetation for refuge (Healey, 1991). During the post-emergent fry (≤ 45mm fork length) and juvenile stages, water temperatures generally between 53ºF and 57ºF are beneficial (NMFS, 1997; DWR, 1988). A water temperature of 60ºF is considered the upper temperature limit for juvenile Chinook growth and rearing (NMFS, 1997).

Rearing Migration Corridors

Juvenile winter-run emigrate down the Sacramento River from mid-July to mid-April and begin to arrive in the Delta as early as September. Movement through the system depends on flows and turbidity during the emigration period (Brandes and McLain, 2001), but peak emigration to the Delta generally occurs between December and April (Brandes and McLain, 2001). Riparian zones on the Sacramento River are considered essential for the conservation of winter-run Chinook salmon because they provide important areas for fry and juvenile rearing. For example, studies of Chinook salmon smolts in the middle reaches of the Sacramento River found higher densities in natural eroding bank habitats with woody debris than other habitat types (USFWS, 2000).

Dams have impacted juvenile Chinook salmon habitat. Dams block the recruitment of woody debris, and management of releases for irrigation and flood management can disrupt the hydraulic and geomorphic processes necessary to establish riparian forest (SRCAF, 2003).

Optimal rearing habitat includes abundant instream cover, such as undercut banks, submerged and emergent vegetation, logs, roots, and dense riparian vegetation. These features provide cover from predators and an abundant supply of invertebrate and larval fish prey. Before becoming independent swimmers, fry also depend on calm shallow areas among these features to avoid getting swept downstream (CDFG, 1998). Ephemeral habitats, such as floodplains and the lower reaches of small streams, are also very important to rearing Chinook salmon (Maslin et al., 1997; Sommer et al., 2001a). These areas can be much more productive than the main channel and provide a safe haven from predatory fish (examples are the Cosumnes River Floodplain [Swenson et al., 2001] and the Yolo Bypass [Sommer et al., 2001a]). It remains unclear whether these differences in feeding and growth translate into improved survival. The use of side channels and low gradient floodplains also subjects juveniles to stranding when high flows subside quickly (NMFS, 1997). In the intertidal zone, mudflats and tule marshes become important habitat for juveniles during high tides. In the Suisun Marsh, Chinook salmon fry tend to remain close to the banks and vegetation, near protective cover, and in dead-end tidal channels (Moyle et al., 1986).

Juvenile winter-run Chinook salmon occur in the Sacramento-San Joaquin Delta from primarily November through early May (Brandes and McLain, 2001). The peak of winter-run juvenile Chinook salmon arrivals generally is from December to April, but may extend into June. Upon arrival in the Delta, Chinook salmon tend to rear in the more upstream freshwater portions of the Delta for approximately the first two months (Kjelson et al., 1981). Based on their size prior to entering the ocean, it is estimated that winter-run juveniles inhabit fresh and estuarine waters for five to nine months (NMFS, 1997).

Estuarine Areas

As juvenile Chinook salmon increase in length, they tend to school in the surface waters of the main and secondary channels and sloughs, following the tide into shallow water habitats to feed (Allen and Hassler, 1986). In the Suisun Marsh, Chinook salmon fry tend to remain close to the banks and vegetation, near protective cover, and in dead-end tidal channels (Moyle et al., 1986).

Winter-run Chinook salmon fry remain in the Bay-Delta Estuary until they reach approximately 118 millimeters (i.e., 5 to 10 months of age) and then begin migrating to the ocean as early as November and continue through May (Fisher, 1994; NMFS, 1998).

There is little information regarding the residence of the juvenile winter-run Chinook salmon in the estuary downstream of the Delta. Juveniles usually spend approximately 40 days migrating through the estuary to marine waters, and demonstrate little or no real estuarine dependence in their growth and development (MacFarlane and Norton, 2002).

Nearshore and Marine

Winter-run Chinook salmon begin entering the ocean from January through June. Before entering the ocean and estuary, juveniles undergo a physiological change known as smoltification that allows them to thrive in the ocean's saltwater environment.

Information on winter-run Chinook ocean distribution is scarce. The data are derived from commercial fisheries, and are biased in favor of locations where fisheries activities occur. Returns from marked winter-run Chinook salmon indicate that most winter-run salmon caught in the ocean are landed between Monterey and Fort Bragg. Mixed results make it difficult to tell if any winter-run Chinook salmon were landed north of Fort Bragg (Hallock and Fisher, 1985). Regardless, it is believed that winter-run Chinook salmon, similar to all Central Valley Chinook salmon, remain localized primarily in California coastal waters. The timing of the onset of ocean upwelling is critical for juvenile salmon that migrate to the ocean in the spring. Juveniles can grow rapidly, and survival is good if upwelling is well-developed when they reach the ocean. If upwelling is not well-developed or is delayed, growth and survival can be poor (NMFS, 2009c).

Spring-run Chinook Salmon

Status

The Central Valley spring-run Chinook salmon Evolutionarily Significant Unit (ESU) is listed as a threatened species pursuant to both CESA and FESA. The State and federal listing decisions were finalized in February 1999 and September 1999, respectively. Critical habitat for Central Valley spring-run Chinook salmon was designated on September 2, 2005 in the Sacramento River Watershed (Federal Register, 2005a). Spring-run Chinook salmon also occur in the Trinity River downstream of Lewiston Dam. Spring-run in the Trinity River are included in the upper Klamath and Trinity ESU and are not listed pursuant to FESA or CESA, but were proposed for listing in 1998.

Critical habitat for Central Valley spring-run includes the mainstem Sacramento River to Keswick Dam and its major tributaries from Clear Creek downstream to the Sacramento-San Joaquin Delta and San Francisco Bay. A map of spring-run critical habitat is shown in Figure 12A-2. Critical habitat includes the river, river bottom, and the adjacent riparian zone.

Spring-run Chinook salmon populations once occupied the headwaters of all major river systems in the Sacramento-San Joaquin Basin up to any natural barrier (Yoshiyama et al., 2001). Spring-run were at least the second most abundant run in the Central Valley prior to the 20th century (CDFG, 1998) and may have been the most abundant (NMFS, 1997). The Central Valley river drainages are estimated to have supported spring Chinook salmon runs as large as 600,000 fish in the early 1880s. In the Sacramento-San Joaquin River Basin, runs were estimated to be between 127,000 and 600,000 during the late 1800s. A gill-net fishery in the Delta, established around 1850, initially targeted spring- and winter-run due to their fresher appearance and better meat quality than fall-run (Fisher, 1994). Commercially, spring-run were the most important run of Chinook salmon up until 1900 (Fisher, 1994). Early gill-net landings reported between 1881 and 1882 were in excess of 300,000 spring-run per year (CDFG, 1998).

By the early part of the 20th century, declines in spring-run abundance became evident and were likely the result of the inland gill-net fishery and habitat degradation and loss from mining and construction of water diversions and dams (CDFG, 1998). Approximately 72 percent (1,066 miles) of available salmon spawning, holding, and rearing habitat have been lost due to the construction of dams, barriers, and the dewatering of streams in the Sacramento-San Joaquin Basin (Figure 12A-2) (Yoshiyama et al., 2001).

The loss and degradation of habitat have diminished the current annual returns of spring-run to between less than 4,000 and over 17,000 adults (CDFG, 2011a). There have been many restoration efforts focused on spring-run recovery, including gravel augmentation and channel restoration on Clear Creek and improvement of fish passage with the construction or reconstruction of fish ladders and the removal of dams on Mill, Deer, Butte, Battle, and Clear creeks. Regulatory agencies have also negotiated agreements with hydroelectric plant operators and water agencies to increase flows during holding and spawning periods.

General Biology and Life History

Spring-run Chinook salmon enter the Sacramento River between mid-February and July. The peak of the migration occurs in May (CDFG, 1998). Adults hold in deep cold pools in proximity to spawning areas until they are sexually mature and ready to spawn in late summer and early fall (CDFG, 1998). Spring-run use high spring flows caused by snowmelt to gain access to the upper reaches of tributaries to the Sacramento River. The largest populations of spring-run in the Central Valley are found in Mill, Deer, and Butte creeks, and the Feather River (CDFG, 2011a), although the Feather River population is primarily of hatchery origin (Sommer et al., 2001b). Clear Creek and Cottonwood Creek also support populations of spring-run (Figure 12A-2). Small numbers of spring-run have been observed intermittently in the recent past in other Sacramento River tributaries (CDFG, 1998). The Trinity River supports spring-run Chinook salmon in the Klamath River watershed.

Spring-run rely on upper reaches of creeks or coldwater releases from dams that sustain cool water temperatures throughout the summer and into early fall. Habitat that would naturally sustain the population in the Feather River, Sacramento River, and the mainstem of the Trinity River has been blocked with the construction of hydroelectric dams in the upper watershed and by Oroville Dam. Conversely, the distribution of the natural populations of spring-run in Mill, Deer, and Butte creeks is much the same as it was historically (CDFG, 1998). Some spring-run may hold and spawn in the Sacramento River between the RBDD and Keswick Dam, but the number of these fish has declined substantially since the late 1980s. Since the early 1990s, spring-run spawning in the mainstem Sacramento River has only numbered in the hundreds and more recently has not exceeded 50 fish (CDFG, 2011a).

Because the present day spring- and fall-run spawning distributions overlap in the mainstem Sacramento, Feather, and Trinity rivers, the later spawning fall-run may be digging up the eggs of spring-run during redd construction (CDFG, 1998). Historically, spring-run would have spawned in areas upstream of Keswick Dam that were inaccessible to fall-run because typically river flows are lower during the fall-run migration (CDFG, 1998; Yoshiyama et al., 2001). Overlap of spring- and fall-run spawning habitat is also a problem in the Feather River and has likely lead to hybridization between the two runs (CDFG, 1998).

Eighty-seven percent of spring-run return to spawn as three-year-olds; four+-year-olds comprise 11 percent, and two-year-olds comprise two percent (Fisher, 1994).

Spawning

Spring-run spawn in the upper reaches of tributaries to the Sacramento River and the mainstem of the Feather River and Trinity River. Few spring-run spawn in the mainstem of the Sacramento River.

In the Sacramento River watershed, spawning begins in mid- to late-August through early October. Timing depends on the stream and elevation. Fish holding in cooler upper elevation reaches tend to begin spawning earlier (CDFG, 1998). The current characterization of the spring-run spawning season extends further into the fall than historically occurred and could reflect hybridization with fall-run Chinook salmon (DWR and Reclamation, 2000).

In the Trinity River, spring-run start spawning approximately the second week of September and spawn through mid October (USFWS and Hoopa Tribe, 1999).

Rearing

In the Sacramento River watershed, the period from spawning until fry begin to emerge from the gravel is from 90 to 120 days. The duration depends on water temperature. In Butte and Big Chico creeks, fry begin to emerge in November after an incubation period of approximately three months. In the colder Mill and Deer creeks, incubation can occur over a period of six months (CDFG, 1998). Trinity River fry and juvenile spring-run Chinook salmon emerge from late December through October (USFWS and Hoopa Tribe, 1999).

Juvenile spring-run Chinook salmon occur in the Sacramento-San Joaquin Delta from October through early May (CDFG, 1998).

Migration Corridors

Emigration timing depends on fall and winter flows. Large numbers of juveniles begin to migrate during high flows; low flows may delay migration timing (CDFG, 1998). Some populations will spend the summer in their natal streams and emigrate as yearlings (CDFG, 1998).

As they migrate, juvenile spring-run Chinook salmon use stream, river, and Delta habitats like those described for winter-run Chinook salmon.

Estuarine Areas

There is little information regarding the residence of the juvenile Chinook salmon in the estuary downstream of the Delta. Juveniles usually spend approximately 40 days migrating through the estuary to marine waters, and demonstrate little or no real estuarine dependence in their growth and development (MacFarlane and Norton, 2002).

Nearshore and Marine

Information on Chinook ocean distribution is scarce. The data are derived from commercial fisheries, and are biased in favor of locations where fisheries activities occur. It is believed that spring-run Chinook salmon, similar to all Central Valley Chinook salmon, remain localized primarily in California coastal waters. The timing of the onset of ocean upwelling is critical for juvenile salmon that migrate to the ocean in the spring. As described for winter-run, upwelling influences juvenile growth and survival.

Fall-run and Late-Fall-run Chinook Salmon

Status

Fall-run Chinook salmon occur in the Sacramento, San Joaquin, and Trinity river watershed portions of the Primary, Secondary, and Extended study areas.

The Central Valley fall-run Chinook salmon ESU is comprised of two runs: fall and late-fall. Trinity River fall-run Chinook salmon are included in the Upper Klamath and Trinity River ESU.

NOAA Fisheries designated the Central Valley fall-run ESU as a Species of Concern on April 15, 2004 (Federal Register, 2004a). Fall and late-fall-run Chinook are both California Special Concern species (Moyle et al., 1995).

Following a status review of the Central Valley fall- and late-fall-run Chinook salmon ESU, NOAA Fisheries determined that listing this ESU as threatened or endangered was not warranted. Long-term population trends appear generally stable or increasing; however, it is unclear if natural populations are self-sustaining. Fall- and late-fall run populations are heavily augmented with hatchery production, and natural fall-run Chinook are not readily distinguishable from hatchery fall-run Chinook (Federal Register, 1999a).

Fall-run Chinook salmon are the most abundant and widely distributed of the four runs of salmon in the Sacramento-San Joaquin Basin (CDFG, 2011a). In the Sacramento-San Joaquin Basin, abundance of adult fall-run Chinook salmon has varied from approximately 50,000 to more than 400,000 adults. Since 2007, the number of adult fall-run returning to the Central Valley and San Joaquin Valley has dropped substantially (CDFG, 2011a). These declines are largely the result of ocean conditions (Lindley et al., 2009). In the Central Valley, the fall-run range has not been substantially diminished like that of spring- and winter-run (Figure 12A-3) (Fisher, 1994). In the Trinity River, abundance of adult fall-run Chinook salmon has ranged from less than 3,000 to more than 100,000 (USFWS and Hoopa Tribe, 1999). Fall-run are also the most common run of Chinook salmon in the Trinity River.

Late-fall-run are less abundant than fall-run and primarily return to the Sacramento River and Battle Creek. Run size estimates for late-fall-run Chinook salmon have ranged from more than 40,000 to less the 1,000 adults (CDFG, 2011a).

General Biology and Life History

Fall- and late-fall-run Chinook salmon are ocean-type Chinook salmon, emigrating predominantly as fry and sub-yearlings and remaining off the California coast during their ocean migration. The primary differences between the two runs are related to timing of migration into fresh water, timing of spawning, timing of juvenile emergence, and length of time juveniles remain in fresh water (Moyle, 2002).

Spawning

In the Central and San Joaquin valleys, fall-run migrate between June and December, with a peak in September and October. Spawning begins in late September and October, peaks in November, and subsides by late December (Vogel and Marine, 1991). Late-fall-run return from the ocean from mid October through mid April. Spawning begins in January, peaks in February and March, and subsides by late April (Vogel and Marine, 1991). Run timing for Trinity River fall-run Chinook salmon is similar to that of Central Valley fall-run Chinook salmon.

Fall-run Chinook salmon typically spawn shortly after they migrate upstream. This is in contrast to both the winter-run and spring-run Chinook salmon that mature in the river over a period of months. Late-fall-run typically mature in fresh water and begin spawning from one to three months after entering the river (Moyle, 2002).

Spawning in the Sacramento River occurs primarily from Keswick Dam to the RBDD, but spawning has been observed as far downriver as Hamilton City (CDFG, 2007). In the San Joaquin Valley, fall-run spawn in the tributaries to the San Joaquin River (Fisher, 1994).

Fall-run generally enter the Trinity River during late summer or early autumn (September to October). They mature quickly and usually begin spawning in the Trinity River and its tributaries in October and continue until mid-December.

Historically, late-fall-run likely spawned farther upstream than fall-run, where water temperatures remained tolerable for the juveniles through the summer. However, rivers are generally higher and more turbid in winter, so late-fall-run adults are hard to observe, and less is known about them and their historical range than about other runs (Williams, 2006).

Rearing and Migration Corridor

Fall-run fry emerge from December to January and typically begin migrating downstream soon after emergence. Late-fall fry emerge from April to June, and the juveniles typically rear in the stream through the summer before beginning their migration in the fall or winter (Fisher, 1994).

Fall-run migrate out to the ocean soon after they emerge from the gravel, and late-fall-run tend to leave fresh water as yearlings (Moyle et. al., 1995; Fisher, 1994). Stream habitat requirements are similar to those described for spring- and winter-run Chinook salmon.

Estuarine Areas

There is little information regarding the residence of the juvenile Chinook salmon in the estuary downstream of the Delta. Juveniles usually spend approximately 40 days migrating through the estuary to marine waters, and demonstrate little or no real estuarine dependence in their growth and development (MacFarlane and Norton, 2002).

Nearshore and Marine

Juvenile fall-run Chinook salmon enter the ocean in spring and stay in nearshore waters in the vicinity of their natal rivers for the first few months of their lives in the ocean. Following this period, they remain between central California and southern Washington over the continental shelf. As described for winter-run, upwelling influences juvenile growth and survival.

12A.1.1.2 Steelhead (Onchorynchus mykiss)

<u>Status</u>

Steelhead occur within the Primary, Secondary, and Extended study areas. Included are the Central Valley Distinct Population Segment (DPS), Klamath Mountain Province ESU, Southern California Coast DPS, South/Central California Coast DPS, and Central California Coast DPS.

Central Valley steelhead are found within the Primary, Secondary, and Extended study areas. The Central Valley DPS was listed as a threatened species pursuant to FESA in March 1998 (Federal Register, 1998).

Critical habitat was designated on September 2, 2005 (Federal Register, 2005a). Critical habitat for the Central Valley ESU includes the mainstem Sacramento River and its major tributaries from Clear Creek downstream to the Sacramento-San Joaquin Delta. Critical habitat was also designated in the San Joaquin River Basin, extending from the Sacramento-San Joaquin Delta upstream to the Merced River and the adjacent mainstem San Joaquin River (Figure 12A-4). Critical habitat includes the river, river bottom, and the adjacent riparian zone. Riparian zones are considered essential for the conservation of steelhead because they provide important areas for fry and juvenile rearing.

Trinity River steelhead populations are found within the Secondary Study Area and are included in the Klamath Mountains Province ESU. This ESU occupies river basins from the Elk River in Oregon to, and including, the Klamath and Trinity rivers in California. This ESU includes both winter and summer steelhead. Steelhead populations from this region are genetically distinct from populations to the north and south (NMFS, 1994).

Southern California Coast, South/Central California Coast, and Central Coast California DPS steelhead occur within the State and federal service areas in the Extended Study Area. Southern California Coast steelhead are listed as endangered pursuant to FESA. South/Central Coast and Central Coast steelhead are listed as threatened pursuant to FESA. Critical habitat has been designated for these species within their range.

Historically, Central Valley steelhead adult populations may have numbered between one and two million (McEwan, 2001). In the 1960s, returning adults were estimated to number approximately 26,000 (CDFG, 1965). Counts at RBDD showed obvious decline in steelhead returns to the upper Sacramento River between 1967 and 1993. More recent escapement data are not available for naturally spawned steelhead, in large part because of gates-out operation at RBDD and the lack of steelhead monitoring programs elsewhere in the Valley (CDFG, 1996). In the Trinity River Basin, returning adults were estimated to number approximately 50,000 in the 1960s. Since then, numbers have been stable or depressed throughout the watershed (NMFS, 1994). The coastal steelhead populations are small, when compared to the Central Valley and Klamath Province populations (Moyle, 2002).

The majority of historical steelhead spawning habitat is now inaccessible because of the construction of large dams; an estimated 80 percent of the spawning grounds in the Central Valley have been blocked because of hydropower, flood control, and water supply dams (Figure 12A-4) (CDFG, 1996, McEwan, 2001). Coastal steelhead have faced similar threats. Steelhead habitat on the Trinity River has been blocked by Lewiston Dam.

General Biology and Life History

Steelhead are the anadromous form of rainbow trout (McEwan, 2001). Central Valley steelhead are found in the Sacramento River downstream of Keswick Dam and the major rivers and creeks in the Sacramento River watershed (Figure 12A-4). The populations in the Feather and American rivers are supported primarily by the Feather and Nimbus hatcheries, respectively. Eel River steelhead were included in the founding stock for the Nimbus Hatchery, and genetic studies have shown that American River steelhead are more closely related to Eel River steelhead than Central Valley stocks. In the San Joaquin River system, naturally producing populations are found in the eastside watersheds. The coastal steelhead populations within the Extended Study Area occupy coastal watersheds from Malibu Creek in Los Angeles County to the Napa River in Napa County (NMFS, 1999).

The other major steelhead populations in the Sacramento River watershed are found in Battle, Mill, Deer, and Butte creeks. Steelhead also occur in Stony and Thomes creeks (McEwan, 2001) and many of the other tributaries to the Sacramento River, including intermittent streams in the Redding area. The tributary creeks support naturally spawning populations, although Battle Creek populations are augmented by Coleman National Fish Hatchery.

In addition to runs of adult steelhead, the Klamath and Trinity rivers also support a run of immature steelhead known as “half-pounders”, which spend two to four months in the ocean before returning to the river in late summer and early fall (Barnhart, 1986). Half-pounders feed extensively in fresh water and are highly prized by sport anglers. Half-pounders overwinter in the river without spawning before returning to the ocean, and then return as mature adults during subsequent migrations. Half-pounders have a very limited geographic distribution and are known to exist only in the Rogue, Klamath-Trinity, Mad, and Eel river systems.

The life history traits of steelhead are similar to that described for Chinook salmon, but the timing and duration of adult and juvenile steelhead movement between freshwater and saltwater habitats vary in California and throughout their range. Central Valley steelhead migrate from the ocean to natal rivers and streams during much of the year, with peak migration occurring in the fall or early winter (Hallock et al., 1961; CDFG, 1996). Migration through the mainstem of the Sacramento River begins in July, peaks in September, and continues through May (CDFG, 1996). The peak of migration up the smaller tributary streams usually occurs in November and again in February (Hallock et al., 1961; Hallock, 1989; CDFG, 1996), with the onset of higher winter flows. Southern, South/Central, and Central coast steelhead also migrate to the upper reaches of coastal watersheds to spawning areas during this time. Coastal steelhead typically rear in their natal streams for one to three years (NMFS, 2009d; CDFG, 1996)

Spawning

Returning steelhead exhibit two strategies: (1) stream-maturing steelhead (summer steelhead), which enter fresh water with immature gonads, and consequently spend several months in the stream before they are ready to spawn; and (2) ocean-maturing steelhead (winter steelhead), which mature in the ocean and spawn relatively soon after entry into fresh water (McEwan, 2001).

Stream-maturing steelhead typically enter fresh water in spring, early summer, and fall. They ascend to headwater tributaries, hold over in deep pools until mature, and spawn in winter. Ocean-maturing steelhead typically begin their spawning migration in fall, winter, and spring, and spawn relatively soon after entering fresh water. Ocean-maturing steelhead generally spawn January through March, but spawning can extend into spring and possibly early summer months. This variability in life history patterns likely confers a survival advantage, especially in unstable variable climatic and hydraulic conditions (CDFG, 1996).

All steelhead in the Central Valley are considered winter steelhead because spawning takes place a few weeks to a few months after entering fresh water. Steelhead enter the Trinity River during several months of the year, and most spawning occurs in early winter. Adult summer-run steelhead are stream-maturing steelhead and hold primarily in the headwaters of mainstem Trinity tributaries during the summer months, and spawn during the following late winter/early spring.

Steelhead spawn in stream habitats with gravel bottoms and a moderate current with depths between six and 24 inches (Bjornn and Reiser, 1991). Steelhead will also spawn on streambeds comprised of cobble and sand (CDFG, 1996). As described for Chinook salmon, substrates with only a small amount of silt and sand (less than or equal to 5 percent) are important for successful spawning (CDFG, 1996). Unlike Pacific salmon, not all steelhead die after spawning. Adults may return to spawn as many as three times, but the percentage that repeat the spawning cycle is generally low (CDFG, 1996).

Eggs usually hatch within four weeks, depending on stream temperature (CDFG, 1996). From observations of more northern populations, preferred water temperatures for spawning and egg incubation are likely between 39°F and 52°F, and egg mortality likely begins at 56°F (CDFG, 1996; McEwan, 2001; Reiser and Bjornn, 1979). The yolk sac fry remain in the gravel after hatching for another four to six weeks (CDFG, 1996).

Rearing

Once the fry emerge, they inhabit shallow areas along the stream margin and seem to prefer areas with cobble substrates (CDFG, 1996). Further into development, juveniles will use a variety of habitats (CDFG, 1996). Habitat use is affected by the presence of predators, and juvenile steelhead survival increases when cover, such as wood debris and large cobble, is available (Mitro and Zale, 2002). Juvenile Central Valley steelhead typically migrate to the ocean after spending from one to three years in fresh water (CDFG, 1996).

Migration

Steelhead do not necessarily migrate at any set age or seemingly at any set season (CDFG, 1996). Some individuals will remain in a stream, mature, and even spawn without ever going to sea; others will migrate to sea at less than one year old, and some will return to fresh water after spending less than one year in the ocean (CDFG, 1996). Attempts to classify steelhead into seasonal runs seem to have led to further confusion rather than clarification (Lindley et al, 2006; McEwan, 2001; CDFG, 1996). Juvenile steelhead migrate downstream during most months of the year, but the peak period of emigration occurs in spring, with a much smaller peak in fall (Hallock et al., 1961). The emigration period for naturally spawned steelhead juveniles migrating past Knights Landing on the lower Sacramento River in 1998 ranged from late December through early May, and peaked in mid-March (McEwan, 2001).

Estuarine Areas

Estuaries can be important rearing areas for juvenile steelhead, especially in small coastal streams (CDFG, 1996). Summer temperatures are moderated by the marine influence of the nearby San Francisco Bay and Pacific Ocean (Lindley et al, 2006). Due to these conditions, residency time in the Delta tends to be longer for the Central Valley steelhead than other salmonids. During their residency in the Delta, pumping operations of the CVP and the SWP can have a detrimental impact on smolt escapement to the ocean (CDFG, 1996).

Nearshore and Marine

Central Valley steelhead tend to use nearshore marine areas as rearing habitat.

12A.1.1.3 Coho Salmon (Oncorhynchus Kisutch)

Status

NOAA Fisheries has identified six ESUs of Coho salmon in California, Oregon, and Washington. Each ESU is treated as a separate species pursuant to the Endangered Species Act (Table 12A-3). The ESUs in

California are the California Central Coast (CCC) Coho ESU and the Southern Oregon-Northern California Coasts (SONCC) Coho ESU (NMFS, 2008).

Table 12A-3
Coho Salmon Evolutionarily Significant Units Identified by NOAA Fisheries

ESU	ESA Listing Status	ESA Critical Habitat
Central California Coast	Endangered 6/28/05 (70FR37160)	Designated 5/5/99 (64FR24049)
Southern Oregon/Northern California coasts	Threatened 6/28/05 (70FR37160)	Designated 5/5/99 (64FR24049)
Lower Columbia River	Threatened 6/28/05 (70FR37160)	Under Development
Oregon Coast	Threatened 2/11/08 (73FR7816)	Designated 2/11/08 (73FR7816)
Puget Sound/Strait of Georgia	Species of Concern 4/15/04 (69FR19975)	NA
Southwest Washington	Undetermined	NA
Olympic Peninsula	Not Warranted	NA

Note:
NA = Not applicable
Source: NMFS, 2008

The CCC Coho ESU and its critical habitat are located within the Extended Study Area. 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 CCC Coho ESU is listed as endangered pursuant to FESA and CESA (Federal Register, 2005b; CDFG, 2011b).

The SONCC Coho ESU includes naturally produced Coho from the Klamath and Trinity rivers (Federal Register, 1997) within the Secondary Study Area. The SONCC Coho ESU begins at Punta Gorda in California and extends north into Oregon to Cape Blanco. The SONCC Coho ESU is listed as threatened pursuant to FESA and CESA.

Critical Habitat for the SONCC Coho Salmon ESU was designated by NMFS on May 5, 1999 (Federal Register, 1999b). Critical habitat for the SONCC Coho Salmon ESU encompasses accessible reaches of all rivers (including estuarine areas and tributaries) between the Mattole River in California and the Elk River in Oregon. Figure 12A-5 shows SONCC Coho salmon distribution and critical habitat in the Klamath River and Trinity River basins.

The population of Coho salmon has decreased significantly since the 1950s. Coho salmon abundance, including hatchery stocks, has declined at least 70 percent since the 1960s, and is currently six to 15 percent of its abundance during the 1940s (CDFG, 2004). It is estimated that in the 1940s, between 200,000 and 500,000 Coho returned to central and northern California streams each fall to spawn. Today, Coho populations in southern Oregon and northern California have fallen to approximately 10,000 naturally produced adults. This decline is reflected in the continued drop in the number of Coho salmon caught commercially. Commercially caught Coho salmon off the California and Oregon coasts ranged between 700,000 and three million in the 1970s. Catches in the 1980s and 1990s dropped, with catches in the 1980s being consistently below one million. Catches averaged less than 400,000 in the 1990s (LAO, 1997).

According to NMFS, a leading factor in the decline of the Coho salmon is the degradation of its habitat caused by various economic activities. These activities include timber harvesting, grazing, mining, water diversions, urbanization, and road and dam construction. Other activities that adversely affect Coho habitat include streambed alteration, unscreened water diversions, and loss of wetlands. Overfishing also contributed to the species' decline (LAO, 1997).

General Biology and Life History

As an anadromous fish, Coho salmon spend most of their lives in the ocean and return to their native freshwater streams to spawn and die. California Coho salmon have a fairly strict three-year lifecycle, with approximately half spent in fresh water and half spent in saltwater (Moyle, 2002). Exceptions to the three-year rule are jack males, which return to fresh water as two-year-olds. The combination of a three-year lifecycle and a strong homing instinct means that each stream has three distinct Coho salmon cohorts (groups of fish that hatched during a given spawning season), which are isolated both temporally and spatially from one another. The jacks (early returning males), however, keep runs from being genetically isolated from one another, as do rare early returning females (Moyle, 2002).

Coho salmon migrate up and spawn mainly in streams that flow directly into the ocean or tributaries of large rivers (Moyle, 2002). Adult Coho salmon enter fresh water to spawn from September through January. On the Klamath and Trinity rivers, Coho salmon begin entering the river in early- to mid-September, and reach a peak in October to November. On coastal streams most Coho salmon return from November to January (Moyle, 2002).

Spawning

The early part of the run is dominated by males, with females returning in greater numbers during the latter part of the run (Moyle, 2002). Spawning itself occurs mainly in November and December (USFWS, 1979). Females usually choose spawning sites near the head of a riffle, just downstream of a pool, where the water changes from a smooth to a turbulent flow and there is a medium to small gravel substrate (Shapovalov and Taft, 1954). Coho salmon typically spawn in small streams or side channels where the velocity is 1.0 to 3.4 feet per second and the stream depth ranges between 3.94 and 13.78 inches, depending on the velocity (Briggs, 1953; Bovee, 1978).

Coho salmon also prefer to construct their redds in areas where water upwells through the gravel bed, eliminating wastes and preventing sediments from filling the spaces between spawning gravel (CDFG, 2004). The flow characteristics of redd locations usually ensure good aeration, and the circulation facilitates fry emergence from the gravel (Moyle, 2002).

Each female builds a succession of redds in the same place, moving upstream as she does so and depositing a few hundred eggs in each (Briggs, 1953). Spawning takes approximately one week to complete, during which time each female lays 1,400 to 3,000 eggs. There is a positive correlation between the size of females and the number of eggs they produce, but California Coho salmon produce fewer eggs than fish from more northern populations (Sandercock, 1991).

The optimum temperature for Coho salmon egg incubation is between 40°F and 55°F (Bjornn and Reiser, 1991). In one study, Coho salmon embryos suffered 50 percent mortality at temperatures above 56.3°F (Beacham and Murray, 1990). In California, eggs incubate in the gravels from November through April. California Coho salmon eggs hatch in approximately 48 days at 48°F, and in 38 days at 51.3°F (Shapovalov and Taft, 1954).

Rearing

After hatching, alevins[1] remain in the interstices of the gravel for two to 10 weeks until their yolk sacs have been absorbed (Shapovalov and Taft, 1954; Laufle et al., 1986; Sandercock, 1991). Coho salmon 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).

Upon emerging, alevins seek shallow water along stream margins. Initially they form shoals (groups of juvenile fish), but as they grow bigger, the shoals break up and juveniles set up individual territories (Moyle, 2002). At this stage, the fish are termed parr. Rearing areas used by juvenile Coho salmon include low-gradient coastal streams, lakes, sloughs, side channels, estuaries, low-gradient tributaries to large rivers, beaver ponds, and large slackwaters. Smaller streams with low-gradient alluvial channels containing abundant pools formed by large woody debris are the most productive juvenile habitats (CDFG, 2004).

Juveniles prefer and presumably grow best at temperatures of 53.6°F to 57.2°F. Temperatures exceeding 77°F to 78.8°F are invariably lethal (Moyle, 2002).

Habitat use by juvenile Coho salmon in some California streams is complex (Nielson, 1992). There are four distinct types of juveniles, termed estuarine, margin, thalweg, and early pulse juveniles. Estuarine juveniles move downstream into estuaries soon after emergence and rear in intertidal areas. Margin juveniles remain in stream margins and backwaters during summer, where growth is typically slow, so that yearling fish move downstream at less than 70 millimeters standard length (SL). Thalweg juveniles are the “standard” juveniles that rear in the deeper parts of the main channel, feeding and growing steadily all season long; they are approximately 100 millimeters SL when they smolt and head out to sea. Early pulse juveniles show two pulses of growth: in spring and in autumn, and transform into smolts at greater than 100 millimeters SL. Their behavior is “trout like” because they rest in deep cover during the day and forage on drifting invertebrates during dawn and dusk (Nielson, 1992).

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, 2004) and can continue until July (Shapovalov and Taft, 1954; Sandercock, 1991). Peak downstream migration in California generally occurs from April to early June (CDFG, 2004). The timing of emigration is influenced by the size of the fish, flow conditions, water temperature, DO levels, day length, and the availability of food (CDFG, 2004).

The outmigrants are primarily one year old and measure 10 to 13 cm fork length, although a few larger two-year-olds may also be present. Parr marks are still prominent in early outmigrants, but later outmigrants are silvery, having transformed into smolts (Moyle, 2002). Most of this movement takes place at night and is interspersed with periods of holding and feeding in low velocity areas (Moyle, 2002).

Migration Corridors

Natural stream flow patterns are important in facilitating the downstream migration of Coho salmon smolts. Increases in stream flow trigger downstream movement of Coho salmon (CDFG, 2004). Short-term increases in stream flow are an important stimulus for smolt emigration (Spence, 1995).

[1] A larval salmonid that has hatched but has not completely absorbed its yolk sac, and generally has not emerged from the spawning gravel.

Artificial obstructions, such as dams and diversions of water, may impede emigration where they create unnatural flow patterns (CDFG, 2004).

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). Water temperature affects timing of emigration, and rapid increases in temperature can trigger downstream migration (Spence, 1995). Coho salmon have been observed emigrating through the Klamath River Estuary in mid- to late-May when water temperature ranged from 53.6°F to 68°F (CDFG, 2004).

Estuarine Areas

Adult Coho salmon 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. The phenomenon of smolts migrating 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 (CDFG, 2004).

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).

Nearshore and Marine

Upon entry into the ocean, immature Coho salmon remain in nearshore 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. 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).

12A.1.1.4 Green Sturgeon (Acipenser medirostris)

Status

NMFS identified two DPSs for North American green sturgeon: the Northern DPS and the Southern DPS. The DPSs are based on the rivers in which the green sturgeon spawn and findings of preliminary genetic studies. In April 2006, NMFS listed the Southern DPS of green sturgeon as threatened (Federal Register, 2006). Green sturgeon are also listed as a State Species of Special Concern by CDFG. The listing of the Northern DPS pursuant to FESA was assessed, but was not warranted (Adams et al. 2002).

The Southern DPS green sturgeon population is located within the Primary, Secondary, and Extended study areas (Figure 12A-6). The Northern DPS green sturgeon population is located within the Secondary Study Area. The Northern DPS includes all green sturgeon populations starting with the Eel River and extending northward. The Southern DPS includes all green sturgeon populations south of the Eel River. The Southern DPS is known to only spawn in the Sacramento River (NMFS, 2005). As of 2012, there is no documentation of green sturgeon spawning in the San Joaquin River. Young green sturgeon have been taken occasionally in the Santa Clara Shoal area in the San Joaquin Delta, but these fish likely originated from elsewhere, most likely the Sacramento River (NMFS, 2005).

NMFS designated critical habitat for Southern DPS green sturgeon on October 9, 2009 (Figure 12A-6). Critical habitat includes riverine, estuarine, and coastal marine habitats in California, Oregon, and

Washington. Designated critical habitat in the Sacramento and San Joaquin river basins includes the Sacramento River downstream of Keswick Dam, the Feather River downstream of Oroville Dam, and the Yuba River downstream of Daguerre Point Dam; portions of the Sutter and Yolo bypasses; the legal Delta, excluding Five Mile Slough, Seven Mile Slough, Snodgrass Slough, Tom Paine Slough, and Trapper Slough; and San Francisco, San Pablo, and Suisun bays. Other designated areas include Humboldt Bay and coastal marine habitats extending from the California/Oregon border to Monterey. The lateral extent of critical freshwater habitat units is defined as the ordinary high-water line, as defined by the U.S. Army Corps of Engineers. In areas where the ordinary high-water line has not been defined, NMFS defined the width of the stream channel by its bankfull elevation (NMFS 2009a).

The population size of Southern DPS green sturgeon is not known, but is considered substantially smaller than the Northern DPS (Adams et al., 2002). In the Sacramento-San Joaquin River Basin, Green sturgeon abundance is much lower than white sturgeon abundance. During tagging studies by CDFG, the majority of sturgeon captured were white sturgeon; an average of only one adult green sturgeon has been captured for every 134 adult white sturgeon. Preliminary green sturgeon genetics information for the Southern DPS confirms that numbers are low in the Sacramento-San Joaquin River system (Israel and May, 2010).

The abundance of North American green sturgeon has declined by 88 percent throughout much of its range (Musick et al., 2000). Although there is no direct evidence that populations of green sturgeon are declining in the Sacramento River, the small size of the population increases the risk that a decline in numbers would be difficult to detect until a collapse in the population occurs. The population is threatened by habitat loss or degradation, lethally high Delta temperatures, entrainment in water diversions, invasive species, and exposure to toxic materials (Moyle et al., 1995; NMFS, 2005).

General Biology and Life History

Less is known about the biology and abundance of green sturgeon than the white sturgeon. Unlike white sturgeon, green sturgeon are not highly regarded as a sport fish. They are taken in relatively small numbers by sport fishermen in San Pablo Bay and by sport and commercial fishermen in Washington and Oregon. On the Klamath River, in California, there is a Native American gillnet fishery (Adams et al., 2002).

Green sturgeon are a slow growing fish specially adapted for feeding on the river bottom. In the Delta, juvenile fish feed on opossum shrimp (*Neomysis mercedis*) and amphipods (*Corophium spp.*). The diet of adult fish includes shrimp, mollusks, amphipods, and small fish (Adams et al., 2002). Green sturgeon can grow to be 386 pounds and 106 inches, but do not often exceed 39.3 inches and 198 pounds in the Delta (Moyle, 2002).

Females become mature between 17 and 40 years old and 71.6 and 75.6 inches fork length (FL). Most females mature by age 27 or 28. Males mature between age 15 and 30 and 54.7 and 66.9 inches FL, with most maturing between age 17 and 18 (Adams et al., 2002).

As an anadromous species, green sturgeon enter freshwater rivers to spawn but also spend more time in the ocean than any other sturgeon. Adults usually begin their upstream spawning migration in the spring and migrate downstream after spawning, or reside within the river over the summer. In the Klamath River, tagged adults exhibited several movement patterns including: upstream spawning migration, spring outmigration to the ocean, summer holding (June to November) in deep pools with eddy currents (for those that do not exhibit post-spawning spring outmigration), and outmigration after summer holding (Benson et al., 2007). In the Rogue and Sacramento rivers, use of summer holding sites has also been observed (Erickson et al., 2002). Green sturgeon congregate in pools greater than 16.4 feet in depth with variable water velocities and flow patterns (UCD and DWR, 2010).

Spawning

During spawning, green sturgeon show fidelity for individual rivers (Bemis and Kynard, 1997), and studies indicate that adults return to spawn every 3 to 5 years (Beamesderfer and Webb, 2002; Adams et al., 2002). Adult green sturgeon begin their upstream spawning migrations into the San Francisco Bay in March, reach Knights Landing during April, and spawn between March and July (Heublein et al. 2008). In the Sacramento River system, spawning has been confirmed to occur only in the Sacramento River.

The Feather River may also be an important spawning river (Moyle et al., 1995). Spawning in the Feather River was confirmed by DWR in 2011. Green sturgeon may have spawned elsewhere in the Sacramento-San Joaquin Basin before the development of major hydroelectric and water projects (Adams et al., 2002).

During flood flows in the Sacramento River system, returning adult green sturgeon are attracted by high flows in the Yolo and Sutter bypasses and move onto the floodplain and eventually concentrate behind Fremont and Tisdale Weirs, where they are blocked from further upstream migration. Agency biologists conduct rescues when fish become stranded behind the weirs (CDFG, 2011c).

Habitat modeling identified potential habitat on the Feather River upstream of Oroville Dam that would have been suitable for sturgeon spawning and rearing prior to construction of the dam (Mora et al., 2009). This modeling also suggests sufficient conditions are present in the San Joaquin River to Friant Dam and in the tributaries, such as Stanislaus, Tuolumne, and Merced rivers upstream to their respective dams, although it is unknown whether green sturgeon ever inhabited the San Joaquin River or its tributaries. Other potential migration barriers include structures, such as the Red Bluff Diversion Dam (prior to its gates-open operation in 2012), Sacramento Deep Water Ship Channel locks, Sutter Bypass, and Delta Cross Channel gates on the Sacramento River, and Shanghai Bench and Sunset Pumps on the Feather River (Federal Register, 2006).

Information on green sturgeon in the Trinity River system is limited. However, the Klamath River Basin is known to contain the largest spawning population of green sturgeon in California (Moyle, 2002). They have a complex anadromous life history, spending more time in the ocean than any other sturgeon. They migrate up the Klamath and Trinity rivers between late February and July to spawn. Gray's Falls (RM 43) is believed to be the upstream limit of sturgeon migration in the Trinity River. Klamath Basin green sturgeon spawn from March through July, peaking mid-April to mid-June (Emmett et al., 1991). Juveniles are found in the Trinity River near Willow Creek from June through September (USFWS, 1998), and appear to outmigrate during their first summer to the lower river or estuary, where they rear for some time before moving to the ocean (USFWS and Hoopa, 1999).

Green sturgeon spawn in the Sacramento River between April and July; spawning occurs approximately 20 river miles upstream and nine river miles downstream of the RBDD (Poytress et al., 2009). The upper and lower extent of the spawning area on the Sacramento River is not definitely known, but the lower extent is thought to be in the vicinity of Hamilton City. Opening of the RBDD gates during the winter-run Chinook migration has likely benefited green sturgeon by re-opening access to spawning areas (Adams et al., 2002), but the upper extent may be limited by coldwater temperatures in the Redding area. Embryos are negatively affected by temperatures at or below 57°F. In the laboratory, embryos thrived at temperatures between 62°F and 64°F, and hatching rates and the length of embryos began to decrease at 57°F (Van Eenennaam et al., 2001).

Green sturgeon choose a spawning site based on fidelity for the site or its habitat characteristics. Eggs have been found (using artificial substrate mats) at depths ranging from 1.9 to 24.9 feet, with an average depth of 14.7 feet. In areas where eggs were found, the dominant substrate was medium-sized gravel (Poytress et al., 2009).

Little is known about sturgeon spawning habitat; they congregate in deep turbulent pools in the mainstem of rivers with gravel and sand substrates, but may also use areas with bedrock bottoms (UCD and DWR, 2010). Large numbers of eggs (6,000 to 140,000) are broadcast over the bottom where they settle and become entrained in the spaces between cobbles (Adams et al., 2002). Green sturgeon eggs are not as adhesive as white sturgeon eggs and likely depend more on pockets in the substrate to prevent getting swept downstream (Adams et al., 2002). Eggs sink rapidly to the bottom into cover; they do not drift (Kynard et al., 2005).

During incubation, water temperatures above 68ºF are lethal (Adams et al., 2002) and temperatures at or below 57ºF negatively affect embryos (Van Eenennaam et al., 2001). Eggs hatch in approximately seven to nine days at 59ºF, and the larvae develop into juvenile fish in approximately 45 days (Van Eenennaam et al., 2001). Green sturgeon juveniles are much less common in rotary screw traps in the Sacramento River in years when there is relatively low flow in the spring. This may be because fewer adults migrate upstream and spawn in low flow years (Poytress et al., 2009).

Rearing

In the laboratory, Klamath River hatchlings preferred cover, were poor swimmers, and could not move farther than a few centimeters to cover. For this reason, green sturgeon females are likely adapted to depositing their eggs in places along the stream bottom that provide cover for egg and hatchling stages. Investigators also found that 12-day-old larvae would migrate at night downstream for a period of 12 days. An exclusive nocturnal migration like this has not been found in other sturgeon species. Later in development, green sturgeon larvae and juveniles (up to day 84) forage day and night, but activity peaks at night. At day 110 to 118, juveniles move downstream at night, and habitat preference suggests that juveniles prefer deep pools with low light and some rock structure (Kynard et. al., 2005). Growth is substantially impaired once temperatures reach 75ºF. Spring and summer water temperature controls for winter-run Chinook have likely improved conditions for larval green sturgeon (Adams et al., 2002). Temperatures between 59ºF and 66ºF are optimal for bioenergetic performance of green sturgeon juveniles (Mayfield and Cech, 2004).

Both larval and juvenile green sturgeon are susceptible to entrainment in pumps and diversions in the Delta and rivers. Screens designed to protect Chinook salmon and steelhead may not protect green sturgeon because of differences in swimming ability and size; however, the behavior of juvenile and larval green sturgeon in the river environment may decrease their encounters with diversions and pumps. For example, larval and juvenile sampling conducted at the RBDD experimental pumping plant (Reclamation, 1999 and 2001) indicates that entrainment of green sturgeon is rare. Screen criteria for green sturgeon have not been developed by NMFS or CDFG.

Migration Corridors

In the Sacramento River, tagged adult green sturgeon were present through November and December before moving downstream with increased winter flows. Winter outmigration from the Klamath and Rogue rivers was initiated when temperatures dropped to below 10°C and discharge increased to greater than 3,531 cfs (Erickson et al., 2002; Benson et al., 2007).

Adults and subadults also occupy the San Francisco Bay, San Pablo Bay, Suisun Bay, and Sacramento-San Joaquin Delta. Adults and subadults primarily inhabit the Delta and bays during summer months, most likely for feeding and growth (Kelly et al., 2006; Moser and Lindley, 2007), but also enter the Delta and bays during their spring migration to the Sacramento River and during their winter outmigration from the Sacramento River to the ocean.

Estuarine Areas

Juveniles appear to spend one to four years in fresh water and estuarine water, and disperse into saltwater at lengths of 1 to 2.5 feet (Moyle et. al., 1995; Beamesderfer and Webb, 2002). Water temperatures of 59ºF are optimal for growth during this rearing stage (Adams et al., 2002). Green sturgeon juveniles feed on the abundant benthic invertebrates including shrimp and amphipods, small fish, and possibly mollusks.

A diversity of depths is important to support different life stages and habitat uses for green sturgeon within estuarine areas. In a study of juvenile green sturgeon in the Delta, relatively large numbers of juveniles were captured primarily in shallow waters from 1 to 3 meters deep, indicating juveniles may require shallower depths for rearing and foraging (Radtke, 1966).

Nearshore and Marine

After leaving San Francisco Bay, they disperse widely in the ocean (Adams et al., 2002). Fish tagged in the Sacramento River have primarily been captured north of the Bay in coastal and estuarine waters (Adams et al., 2002). Green sturgeon are known to range in nearshore waters from Mexico to southeast Alaska (Moyle et al., 1995). Fish are commonly observed in bays and estuaries up and down the Pacific coast (Moyle et al., 1995).

There is evidence that green sturgeon inhabit estuaries on the northern California, Oregon, and Washington coasts during the summer, and inhabit coastal marine waters along the central California coast and between Vancouver Island, British Columbia, and southeast Alaska over the winter (Lindley et al., 2008). Large aggregations of green sturgeon occur in the Columbia River estuary and Washington estuaries and include green sturgeon from all known spawning populations (Moser and Lindley, 2007). Large numbers of green sturgeon also occur off Vancouver Island, BC (Lindley et al., 2008). Seasonal migrations to these oversummering and overwintering habitats are most likely driven by the presence of food resources.

12A.1.1.5 Delta Smelt (Hypomesus transpacificus)

Status

Currently, the delta smelt is listed as a Threatened species pursuant to the ESA by the USFWS (Federal Register, 1993b). In March 2006, a petition seeking to relist delta smelt as an endangered species was submitted to the USFWS. The USFWS issued a twelve-month finding on the petition on April 7, 2010 indicating that reclassifying delta smelt from threatened to an endangered species is warranted, but precluded by other higher priority listing actions (Federal Register, 2010).

Delta smelt are found only in the Sacramento-San Joaquin Delta Estuary and were once one of the most common fish species in the Delta (Moyle, 2002). However, since 2000 the delta smelt, along with other pelagic[2] fish species, have experienced a substantial decline in population abundance (Sommer et al., 2007)**.** The substantial declines in the delta smelt population in recent years, as well as declines in other pelagic fish species, have led to widespread concern regarding the pelagic fish community of the Bay-Delta. Several analyses by agencies and organizations, including the IEP, have focused on identifying the factors potentially influencing the status and abundance of delta smelt and other pelagic fish species within the Bay-Delta. Suspected causes being investigated by the IEP include: stock-recruitment effects, a decline in habitat quality, increased mortality rates, and reduced food availability.

Critical habitat for the delta smelt has been designated by USFWS within the Sacramento–San Joaquin River system (Federal Register, 1994b). Critical habitat for delta smelt is defined by the USFWS as:

> "Areas and all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained within the Delta."

Upstream dams and Delta pumping plants affect delta smelt habitat by affecting flow, turbidity, and salinity within the Delta (BDCP, 2007). The upstream dams and the management of releases for flood control and water supply reduce the frequency and duration of high flows, which reduces turbidity and the transport of nutrients and organic matter. Low winter and spring outflow also increases the distance adult delta smelt must migrate to find suitable salinity levels for spawning. Low spring outflows also do not effectively transport larvae to downstream rearing areas. Water exports at the Delta SWP and CVP pumping plants reduce the abundance of zooplankton and phytoplankton by directly exporting them or reducing residence time in Delta channels. Delta SWP and CVP pumping plants also reduce the amount of rearing habitat available by shrinking the area having suitable salinity levels for delta smelt. Delta smelt juveniles are also susceptible to entrainment in the Delta pumping plants and mortality at fish salvage facilities. Other factors affecting delta smelt abundance include the introduction of non-native animal and plant species (e.g., *Corbula, Limnoitha, Egeria*), toxins, loss of habitat diversity, and Delta power plant cooling pumps (BDCP, 2007).

General Biology and Life History

Delta smelt are a relatively small fish (two to four inches long) and are endemic to the Sacramento-San Joaquin Delta. Delta smelt are moderately euryhaline (can tolerate a wide range of salinities); however, salinity requirements vary by life stage (Moyle, 2002). They are a pelagic species, inhabiting open waters, away from the bottom and shore-associated structural features (Nobriga and Herbold, 2009). They live primarily in or just upstream of the low salinity zone between the freshwater and saltwater interface in the Bay-Delta. Suisun Bay is usually the vicinity of this mixing zone, although changes in stream flow can affect how far downstream low salinity waters occur (Moyle, 2002).

Delta smelt spawn from March through April over sand or gravel substrates in fresh water or slightly brackish water. The fertilized eggs are adhesive and stick to submerged hard surfaces (Moyle, 2002).

[2] Species occurring in the upper portion of open water, rather than close to the bottom or near the shore.

Typically, delta smelt live approximately one year. Some individuals live a second year and can reach lengths of 90 millimeters to 120 millimeters (Moyle, 2002).

Distribution

Delta smelt are found within the Secondary and Extended study areas. Delta smelt spend their entire lifespan within the Bay-Delta. Their abundance and distribution have been observed to fluctuate substantially within and among years. Distribution and movements of all life stages are influenced by water transport associated with flows in the Bay-Delta, which also affect the quality and location of suitable open-water habitat (Feyrer et al., 2007; Nobriga et al., 2008). Smelt are short-burst swimmers that feed on plankton, and therefore, they are typically found in places with low water velocities where the water is cool and well oxygenated (Moyle, 2002). Water turbidity and salinity are also factors affecting their distribution.

Delta smelt occur primarily downstream of Isleton on the Sacramento River side of the Delta and downstream of Mossdale on the San Joaquin River side of the Delta (Moyle, 2002). They are found seasonally throughout Suisun Bay and in small numbers in larger sloughs of the Suisun Marsh. Delta smelt have also been found in the Sacramento River as far upstream as the confluence with the American River (Federal Register, 1994b; Moyle, 2002).

When spawning (mainly March and April), they move into sloughs and channels of the western Delta (e.g., Lindsay Slough). During high-outflow periods, they may be washed into San Pablo Bay, but they do not establish permanent populations there (Moyle, 2002). During periods of drought, the delta smelt are most abundant in the northwestern Delta in the channel of the Sacramento River. During years of average to high outflow, they may concentrate anywhere from the Sacramento River around Decker Island to Suisun Bay prior to spawning movements (Moyle, 2002).

Spawning

Delta smelt spawn in shallow freshwater Delta habitats (Moyle 2002). Most spawning occurs in tidally-influenced backwater sloughs and channel edge-waters (Moyle, 2002; Wang, 2010). The adhesive eggs sink to the bottom and attach to substrates such as cattails, tules, tree roots, submerged branches, sand, and rocks in shallow waters (Moyle, 2002; Wang, 2010). Most spawning likely occurs in the western Delta and in the Sacramento River upstream of Rio Vista. Spawning has also been recorded in Montezuma Slough near Suisun Bay and may occur in Suisun Slough in Suisun Marsh and in the Napa River estuary (Moyle, 2002).

Adult delta smelt begin their spawning migration into the upper Delta beginning in December or January. Adults migrate upstream from the brackish water estuarine areas into shallow fresh or slightly brackish waters in tidally influenced backwater sloughs and channel edge-waters (Wang, 2010). Although the timing and duration varies, spawning generally takes place during March and April (Moyle, 2002). The smelt move to sand or gravel substrates at night to spawn, leaving them before dawn (Moyle, 2002). Most spawning likely occurs between 44.6 °F to 59 °F (Moyle, 2002). Temperatures optimal for embryo and larvae have not yet been determined, but it is likely that survival decreases as temperature increases beyond 64.4°F (Moyle, 2002).

Embryonic development to hatching takes nine to 13 days at 58.64°F to 61.7°F (Moyle, 2002).

Newly hatched delta smelt have a large oil globule that makes them semi-buoyant, allowing them to maintain themselves just off the bottom (Moyle, 2002), where they feed on rotifers (microscopic crustaceans used by fish for food) and other microscopic prey. Once the swim bladder (a gas-filled organ that allows fish to maintain neutral buoyancy) develops, larvae become more buoyant and rise up higher into the water column. At this stage (16 millimeters to 18 millimeters [0.6 to 0.7 inch] total length), most are presumably washed downstream into the low salinity zone or the area immediately upstream of it (Moyle, 2002).

Rearing

Larval and juvenile delta smelt rear within the Bay-Delta for a period of approximately six to nine months (Moyle, 2002). Young smelt tend to feed on immature stages of calanoid copepods, and adult smelt may feed on all life stages, as well as other large planktonic organisms. Growth is rapid, and juvenile fish are 30 millimeters to 40 millimeters (1.2 to 1.6 inches) long after 70 days (Nobriga and Herbold, 2009). The most rapid growth occurs when they reach 30 millimeters fork length and are large enough to prey on a wider variety of food sources.

Larval and juvenile smelt need a shallow food-rich nursery habitat for survival. Adequate flow and suitable water quality is required for transport of juveniles downstream to rearing habitat (Moyle, 2002). Estuarine rearing habitat for delta smelt are typically found in the waters of the lower Delta and Suisun Bay where salinity is between two and seven parts per thousand (ppt) (Moyle, 2002).

12A.1.1.6 Long-fin Smelt (Spirinchus thaleichthys)

Status

Longfin smelt are listed by CDFG as a threatened species pursuant to CESA. Its status remains unresolved at the federal level. In August 2007, USFWS was petitioned to list longfin smelt as endangered. On April 9, 2009, USFWS found that the Delta population did not meet the definition of a Distinct Population Segment (DPS), and as a result, did not warrant listing as a DPS. USFWS is currently conducting a status review of the longfin smelt throughout its range (Federal Register, 2009).

Longfin smelt were once one of the most common fish species in the Delta. However, in recent decades, the longfin smelt, along with other pelagic fish species, have experienced a substantial decline in population abundance**.**

Upstream dams and Delta pumping plants affect longfin smelt habitat generally in the same way delta smelt habitat and prey are affected; i.e., through alteration of flow, turbidity, and salinity within the Delta (BDCP, 2007).

General Biology and Life History

Longfin smelt in California are anadromous. Adults and juveniles can be found in the open waters of estuaries, mostly in the middle or at the bottom of the water column (Moyle, 2002). Most longfin smelt have a relatively short lifespan of two to three years. They reach maturity at two years of age, and can grow from 124 millimeters to 140 millimeters long (Moyle, 2002).

Longfin smelt can tolerate a broad range of salinity concentrations ranging from nearly pure sea water to completely fresh water, although they seem to prefer salinities in the range of 15 to 30 ppt once past the early juvenile stage (Moyle, 2002). They can occupy water as warm as 68°F in summer, but preferred temperatures appear to be approximately 60°F to 64°F. The wide salinity and temperature preferences reflect the ability of smelt to occupy different portions of the estuary according to time of year and life cycle stage (Moyle, 2002).

Distribution

The longfin smelt is found within the Secondary and Extended study areas. The Bay-Delta population of longfin smelt is the southernmost along the United States' Pacific coast (Moyle, 2002). In contrast to delta smelt, longfin smelt juveniles and adults are broadly distributed and inhabit the more saline regions of the Bay-Delta and nearshore coastal waters. In the Delta, longfin smelt are rarely found upstream of Rio Vista or Medford Island (Moyle, 2002).

During non-spawning periods, longfin smelt are most often concentrated in Suisun, San Pablo, and North San Francisco bays (Baxter, 1999a; Moyle, 2002). A substantial portion of the longfin smelt population consistently survives into a second year. During the second year of life, the adult longfin smelt inhabit San Francisco Bay and occasionally have been found in nearshore ocean surveys (Rosenfield and Baxter, 2007).

Spawning

Spawning in the Bay-Delta occurs at water temperatures of 44.6°F to 58.1°F, although spawning has been observed at lower temperatures (Moyle, 2002). The majority of spawning occurs from February to April (Moyle, 2002).

Adult longfin smelt migrate into low salinity or freshwater reaches of coastal rivers and tributary streams to spawn. Spawning takes place in low salinity or fresh water, over sandy or gravel substrates, rocks, and aquatic plants (Moyle, 2002). Longfin smelt eggs have adhesive properties and are likely deposited on rocks or aquatic plants upon fertilization.

In the Delta, spawning appears to occur mainly downstream of Medford Island in the San Joaquin River and downstream of Rio Vista in the Sacramento River. The downstream extent of spawning habitat seems to be in Suisun Bay near Pittsburg and Montezuma Slough in the Suisun Marsh (Moyle, 2002).

Each female lays 5,000 to 24,000 adhesive eggs, but the number can apparently vary considerably. Most longfin smelt die after spawning. A few smelt, mostly females, live another year, although it is not certain whether or not they spawned previously (Moyle, 2002). The embryos hatch in approximately 40 days at 44.6°F (Moyle, 2002). Newly hatched larvae are 5 millimeters to 8 millimeters long and are buoyant.

Rearing

After hatching, larvae are carried downstream to nursery areas by freshwater outflow into more brackish parts of the Estuary (Baxter, 1999a; Moyle, 2002). Larvae are strong enough swimmers that they can move up and down in the water column to maintain position within the mixing zone of the estuary. Larvae metamorphose into juveniles approximately 30 to 60 days after hatching, depending on water temperature.

The distribution of young-of-the year smelt largely coincides with that of the larvae (Baxter, 1999a; Moyle, 2002). There is a strong positive correlation between winter and spring Delta outflow and longfin smelt abundance the following year. There is also a strong correlation between juvenile survival and Delta outflow, as well as the position of X2 (the location in the Delta at which salinity equals 2 ppt) (Moyle, 2002). Strong Delta outflow appears to benefit longfin smelt survival because higher flows transport longfin smelt young to more suitable rearing habitat in Suisun and San Pablo bays (Moyle, 2002).

Migration Corridors

Longfin smelt concentrate in most years in San Pablo Bay from April through June and become more dispersed in late summer. There is a gradual shift in the population in fall and winter as adults move upstream to spawn (Moyle, 2002).

12A.1.1.7 Pacific Lamprey (Lampetra tridendata)

The Pacific lamprey is found within the Primary, Secondary, and Extended study areas. The USFWS received a petition to list the Pacific lamprey pursuant to FESA as either threatened or endangered in January 2003. USFWS found in December 2004 that the Pacific lamprey in the lower 48 states was not a listable species based on information in the record, and did not evaluate its status as either threatened or endangered. It found that the petition and other information indicate there is a decline in Pacific lamprey historical abundance and distribution throughout California (Federal Register, 2004b).

The Pacific lamprey is still common in most watersheds in California and throughout the Pacific Northwest. However, in California, dams on several major rivers have decreased the spawning distribution of Pacific lamprey.

Pacific lampreys are predatory as adults in the ocean and estuary, latching onto large fish and extracting blood and body fluids through a hole it creates with its rasp-like tongue. It is uncertain how long lampreys in California remain in ocean and estuarine waters, but for populations in British Columbia, the oceanic phase lasts from 3 to 4 years (Moyle, 2002).

Adults move into streams to spawn between April and late July. They hold under rocks and logs for several months before spawning. The Pacific lamprey spawns in shallow gravel-bedded riffles by pairing and releasing eggs and milt (fish sperm) over a saucer-shaped depression excavated in the gravel. The adults die after spawning. After a short time in the nest, newly hatched larvae (known as ammocoetes) swim out of the gravel and drift downstream to areas with soft sand or mud bottoms. The ammocoetes burrow down into the substrate tail first, leaving their head exposed to feed on detritus and algae. Ammocoetes will move to new locations within the stream throughout the year (Moyle, 2002). The length of this larval phase likely lasts five to seven years (Moyle, 2002).

12A.1.1.8 River Lamprey (Lampetra ayresi)

The river lamprey is found within the Primary, Secondary, and Extended study areas. USFWS received a petition to list river lamprey pursuant to FESA as either threatened or endangered in January 2003. In December 2004, USFWS found that there was not substantial information that listing of river lamprey was warranted (Federal Register, 2004b). The river lamprey is listed as a species of special concern by CDFG.

The river lamprey is known to range from Alaska to San Francisco Bay. River lamprey populations are not monitored directly in California, but this species has become uncommon in the Sacramento-San Joaquin River Basin (Moyle et al., 1995).

The river lamprey preys on both freshwater and saltwater fish of medium size. Common prey are herring and salmon. River lampreys spend only three to four months in salt water. Little is known about the timing and spawning behavior of river lamprey in California. Studies conducted in British Columbia found that adults returned to fresh water in fall and spawned in streams during winter or spring. Spawning habitat is similar to that of the Pacific lamprey. The larvae seek out sand and mud bottoms to burrow into and feed. Duration of the larval freshwater stage is likely three to five years. Their total life span is likely between six and seven years (Moyle, 2002).

12A.1.1.9 Sacramento Splittail (*Pogonichthys macrolepidotus*)

Sacramento splittail are found within the Primary, Secondary, and Extended study areas. Sacramento splittail are listed as a State and federal species of special concern. Previously, splittail were federally listed as threatened. As a result of litigation over the federal listing, USFWS was required to re-evaluate its final decision. Following its evaluation, USFWS decided to remove splittail from the list of threatened species in 2003 (Federal Register, 2003).

The Sacramento splittail is in the minnow family, and is endemic to the Central Valley with a range that centers on the San Francisco Bay Estuary. Splittail are adapted for living in estuarine waters with fluctuating conditions, as well as in severe conditions that once occurred in alkaline lakes and sloughs on the floor of the Central Valley during droughts (Moyle, 2002). They are tolerant of high salinities, and are regularly found at salinities of 10 to 18 ppt, although lower salinities seem preferred. Salinity tolerance increases with size, and adult splittail can tolerate salinities up to 29 ppt for short periods of time (Moyle, 2002). Temperatures at which splittail are found are typically between 41°F and 75°F. Splittail of all sizes can also survive low DO levels (less than 2 mg of oxygen per liter). These tolerances make them well suited to slow-moving sections of rivers and sloughs (Moyle, 2002).

Sacramento splittail are endemic to the sloughs, lakes, and rivers of the Central Valley. In early surveys, they were found as far up the Sacramento River as Redding (downstream of the Coleman Fish Hatchery in Shasta County), in the Feather River as far north as Oroville, and in the American River to Folsom (Moyle, 2002). As of 2005, they are found most frequently in the Sacramento River downstream of the mouth of the Feather River, and they become increasingly rare in an upstream direction, particularly during summer and fall. A few individuals have been found annually in the Sacramento River at RBDD (RM 242), at Hamilton City (RM 206), at the entrance to the GCID main pump station, and at the mouth of Big Chico Creek (RM 192) (Baxter et al., 1996; Baxter, 1999b, 2000; Feyrer et al., 2005).

Splittail may ascend the San Joaquin River to Salt Slough (RM 129) during high outflow years (Baxter, 1999b, 2000). There were reported catches of splittail from southern San Francisco Bay and at the mouth of Coyote Creek in Santa Clara County in the early 1900s, but they are now rare there. Splittail are found in the Napa River and Petaluma River as well (Feyrer et al., 2005).

Splittail spawn from February through July over flooded vegetation. The fertilized splittail eggs are adhesive and stick to submerged vegetation and debris until hatching. Year class success[3] of splittail is positively correlated with wet years, high Delta outflow, and floodplain inundation (such as the Yolo Bypass), presumably because adults are able to move upstream to suitable spawning areas and to find flooded vegetation for spawning, which also provides cover for larvae and young. Most larvae remain in shallow weedy areas near spawning sites for 10 to 14 days before beginning to move into deeper offshore habitat as swimming ability increases (Moyle, 2002).

In low outflow years, fewer adult splittail appear to migrate, but based on presence of larvae and juveniles, spawning still occurs on the lower Sacramento River margins and may even shift upstream to the Colusa (RM 144), Princeton (RM 183), and Ord Bend (RM 163) regions (Baxter, 1999b).

[3] Survival of the group of young of one type of fish produced during one year.

12A.1.1.10 Hardhead (*Mylopharodon concephalus*)

Hardhead are found within the Primary, Secondary, and Extended study areas. Hardhead are a California Species of Special Concern. They are a member of the minnow family, Ciprinidae, and are similar in appearance to the Sacramento pikeminnow (Moyle, 2002).

Hardhead exist throughout the Sacramento-San Joaquin River Basin and are fairly common in the Sacramento River and in the lower reaches of the American and Feather rivers, but in other parts of their range, populations have declined or have become increasingly isolated (Moyle, 2002). Hardhead can also inhabit reservoirs and are abundant in a few impoundments where water level fluctuations prevent bass from reproducing in large numbers (Moyle, 2002). Hardhead tend to be absent from areas that have been highly altered (Moyle et al., 1995) or that are dominated by introduced fish species, especially centrarchids (species of the sunfish family) (Moyle et al., 1995).

Hardhead are omnivorous; their diet consists mostly of benthic invertebrates and aquatic plants, but also includes drifting insects. In reservoirs, hardhead also prey upon zooplankton (Moyle et al., 1995).

Hardhead spawn mainly in April and May, but some may spawn as late as August in the foothill regions of the upper San Joaquin River (Wang, 2010). They migrate upstream and into tributary streams as far as 45 miles to spawning sites. Spawning behavior has not been documented, but it is assumed to be similar to that of the pikeminnow, which deposit their eggs over gravel-bottomed riffles, runs, and at the head of pools (Moyle et al., 1995). Spawning substrates may also include sand and decomposed granite (Wang, 2010).

Optimal temperatures for hardhead appear to be between 75°F and 82°F (Moyle et al., 1995), although hardhead inhabit portions of the Sacramento River upstream of RBDD (USFWS, 2002) where temperatures are maintained at approximately 56°F.

12A.1.1.11 Sacramento Perch (*Archoplites interruptus*)

Sacramento perch are found within the Extended Study Area. The Sacramento perch is a California Species of Special Concern. Sacramento perch is the only member of the sunfish family that occurs naturally west of the Rocky Mountains. Historically, Sacramento perch were found throughout the Central Valley, in the Pajaro and Salinas rivers, and in Clear Lake. As of 2002, the only populations that represent continuous habitation within their native range are those in Clear Lake and Alameda Creek. Within their native range, Sacramento perch exist primarily in farm ponds, reservoirs, and lakes into which they have been introduced (Moyle, 2002). Sacramento perch are often associated with beds of rooted, submerged, and emergent vegetation and other submerged objects. Sacramento perch are able to tolerate a wide range of water conditions. This tolerance is likely an adaptation to fluctuating environmental conditions resulting from floods and droughts. They do well in highly alkaline water (Moyle, 2002). Most populations today are established in warm turbid moderately alkaline reservoirs or farm ponds. Spawning occurs during spring and early summer and usually begins by the end of March, continuing through the first week of August (Moyle, 2002). Introductions of non-native species, not necessarily habitat alterations, are foremost in the cause of Sacramento perch declines (Moyle, 2002).

12A.1.1.12 California Roach (*Lavinia symmetricus*)

California roach are found within the Primary, Secondary, and Extended study areas. The California roach is a California Species of Special Concern found in the Sacramento-San Joaquin River Basin (except the Pit River), as well as tributaries to the San Francisco Bay. California roach are generally found in small warm intermittent streams, and are most abundant in mid-elevation streams in the Sierra foothills and in the lower reaches of some coastal streams (Moyle 2002; Moyle et al., 1982). Assuming that the California roach is indeed a single taxon (which is unlikely), it is abundant in a large number of streams, but is absent from several streams and stream reaches where it once occurred (Moyle 2002). Roach are tolerant of relatively high temperatures (86°F to 95°F) and low oxygen levels (1 to 2 ppm) (Moyle et al., 1982). However, they are habitat generalists, also being found in cold well-aerated clear streams, in human-modified habitats, and in the main channels of rivers (Moyle 2002; Moyle et al., 1982).

12A.1.2 Sport Fish

12A.1.2.1 Rainbow Trout (Oncorhynchus mykiss)

Rainbow trout are found within the Primary, Secondary, and Extended study areas. The Sacramento River supports a large population of rainbow trout and provides some of the best rainbow trout fishing in California. Rainbow trout have been able to flourish in the Sacramento River because water temperatures are kept cool downstream of Keswick Dam year-round for the management of Chinook salmon. Resident rainbow trout migrate seasonally within the Sacramento River. Migration past the RBDD occurs mainly in August and September. These fish are seeking upstream or tributary locations for spawning and foraging. Pulses of juvenile migration have been detected at RBDD from January to April and again from mid August to October, with peaks in February and September (USFWS, 2002). Stream habitat requirements for spawning and rearing rainbow trout are similar to those described for steelhead (the anadromous form of rainbow trout).

12A.1.2.2 White sturgeon (Acipenser transmontanus)

White sturgeon are found within the Primary, Secondary, and Extended study areas. White sturgeon, similar to the green sturgeon, are anadromous fish that spend most of their lives within an estuary, usually returning to fresh water only to spawn (Beamesderfer and Webb, 2002). White sturgeon have been found in some cases to travel hundreds of miles to other estuaries and river systems. They have a long life span that may have exceeded 100 years historically (Moyle, 2002). In the Central Valley, white sturgeon spawn in the Sacramento River between Knights Landing and Colusa and possibly farther upstream. In some years, white sturgeon may also spawn in the Feather and San Joaquin rivers (Moyle, 2002).

When sturgeon larvae hatch in a stream, they begin swimming around in a vertical position as they are suspended by a yolk sac, making them more susceptible to be carried down to the estuary in the current (Wang, 2010). After the sac is consumed, the larvae begin swimming freely and feeding through their mouth (Moyle, 2002).

White sturgeon reside in estuaries of large rivers for much of their lives. They are found in brackish portions of the estuary and they may move around a bay or estuary to find optimal brackish water areas (Kohlhorst et al., 1991).

The diet of young sturgeon consists primarily of different types of crustaceans, although they begin to increase the diversity of food items with age. Most food is taken from the bottom of the estuary where the sturgeon may pick up clams, crabs, and shrimp. Larger sturgeon begin to feed on other fish, such as anchovies, starry flounder, smelt, and striped bass (Moyle, 2002). They grow quickly in their first year, up to 30 cm FL in the Bay-Delta, and the growth rate generally decreases with age (Moyle, 2002).

Male sturgeon reach sexual maturity before the females, although time of onset of maturity for both varies with photoperiod[4] and temperature. Males are sexually mature as early as three to four years. Females mature as early as five years (Wang, 2010). White sturgeon do not necessarily breed annually, and only a small percentage of the adult population spawns in a given season. Males may spawn every one to two years, and females may spawn every two to four years. The sturgeon begin migrating in streams during winter, with large peak flows triggering spawning between February and early June. The suitable water temperature for spawning falls in the range of 53.6°F to 59°F (Wang, 2010). Fish biologists believe the white sturgeon pick deep swift water areas to spawn, such as riffles or pools with rock and gravel substrate. Female sturgeon produce many eggs, with white sturgeon in the Sacramento River producing an average of 5,648 eggs per kilogram of body weight (Moyle, 2002). Male sturgeon fertilize the eggs, giving them a tacky property that allows the eggs to stick to the substrate until the larvae emerge four to 12 days later (Wang, 2010).

12A.1.2.3 American Shad (*Alosa sapidissima*)

American shad are found within the Primary, Secondary, and Extended study areas. American shad occur in the Sacramento River, its major tributaries, the San Joaquin River, and the Delta. Because of its importance as a sport fish, American shad have been the subject of investigations by CDFG. American shad are native to the Atlantic coast, and were planted in the Sacramento River in 1871 and 1881 (Moyle, 2002).

Adult American shad typically enter Central Valley streams from the ocean from late March through early July, with the spawning migration peaking from mid May through June (Moyle, 2002). Water temperature is an important factor influencing the timing of spawning. American shad are reported to spawn at water temperatures ranging from approximately 46ºF to 78.8ºF (Wang, 2010), although optimal spawning temperatures are reported to range from approximately 60ºF to 70ºF. Spawning takes place mostly in the main channels of rivers although larval American shad have been found in off-channel floodplain habitats. Approximately 70 percent of the spawning run is comprised of first time spawners (Moyle, 2002).

In contrast to salmonids, distribution of spawning American shad are determined by river flow rather than homing[5] behavior (Moyle, 2002). Shad have the ability to navigate and to detect minor changes in their environment (Moyle, 2002).

When suitable spawning conditions are found, American shad school and broadcast their eggs throughout the water column. At 62ºF, eggs hatch in six to eight days.

12A.1.2.4 Striped Bass (*Morone saxatilis*)

Striped bass are found within the Primary, Secondary, and Extended study areas. Striped bass occur in the Sacramento River, its major tributaries, and the Delta. Substantial striped bass spawning and rearing occurs in the Sacramento River and Delta, although their range extends up into tributary rivers and creeks. Striped bass are native to the Atlantic coast. They were first introduced to the Pacific coast in 1879, when they were planted in the San Francisco Bay Estuary (Moyle, 2002).

[4] The duration of an organism's daily exposure to light.

[5] Ability of some species to return to a specific area or location, such as a natal stream.

Adult striped bass inhabit Central Valley streams throughout the year, with peak abundance occurring in the spring months coincident with the spawning period. Spawning begins in April, and peaks in May and early June. Striped bass spawn in warmer temperatures ranging from 59ºF to 68ºF. In the Sacramento River, most spawning is believed to occur between Colusa and the mouth of the Feather River (Moyle, 2002).

12A.1.2.5 Brown Trout, Green Sunfish, Largemouth and Smallmouth Bass

Green sunfish and largemouth and smallmouth bass mostly spawn in the spring and summer. They are more successful in disturbed environments than native species. In general, they are adapted to warm, slow-moving, and nutrient rich waters (Moyle, 2002). Largemouth and smallmouth bass are important sportfish in lakes, reservoirs, and rivers. These species spawn in the nearshore, shallow littoral zone in reservoirs and are susceptible to reduced spawning success from reservoir fluctuations. The brown trout spawns in the fall and has habitat requirements similar to rainbow trout. Each of these non-native species is found within the Primary, Secondary, and Extended study areas.

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Figures

FIGURE 12A-1
Current and Historical Distribution of Winter-run Chinook Salmon in the Central Valley Drainages including Critical Habitat Designation
North-of-the Delta Offstream Storage Project

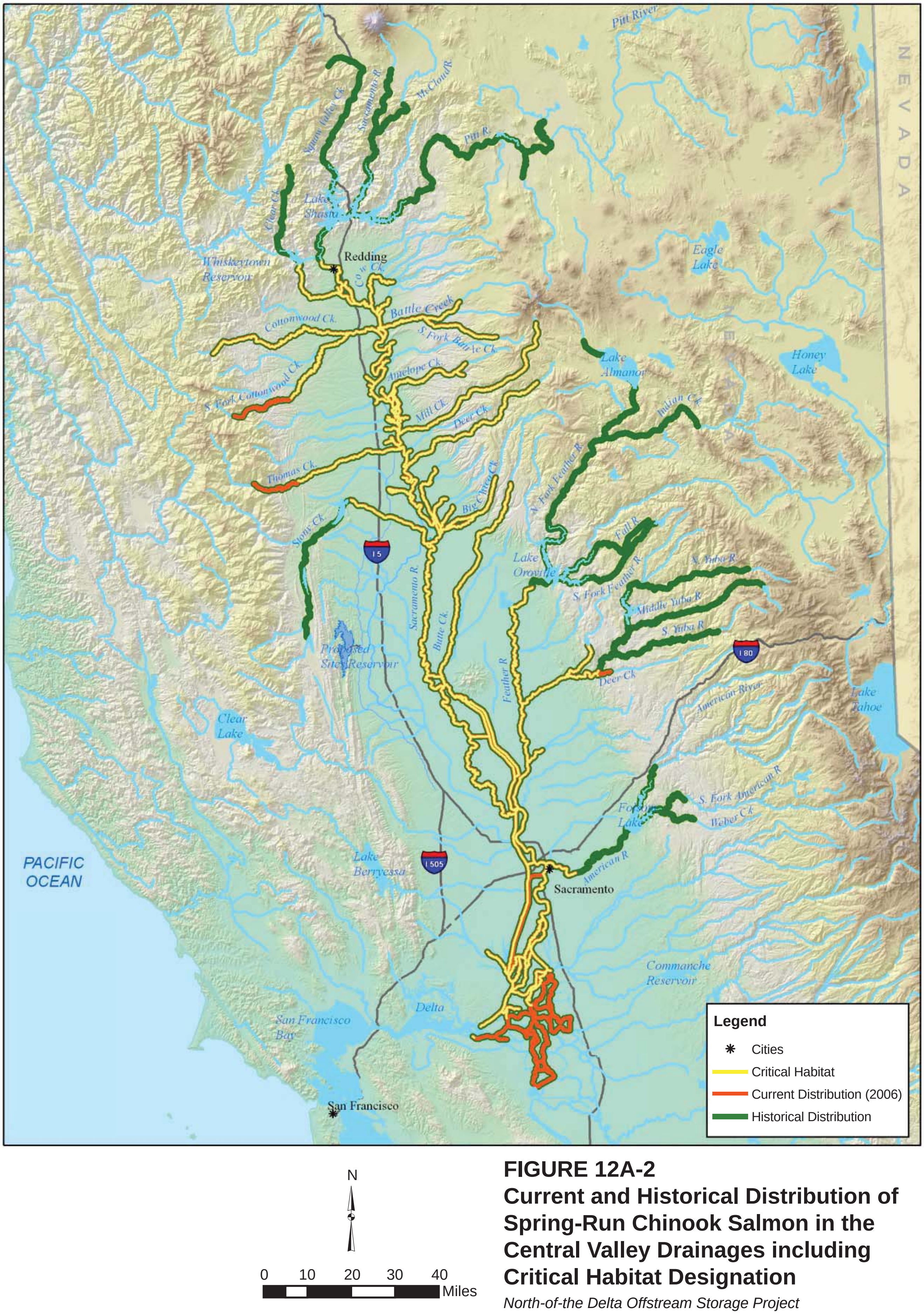
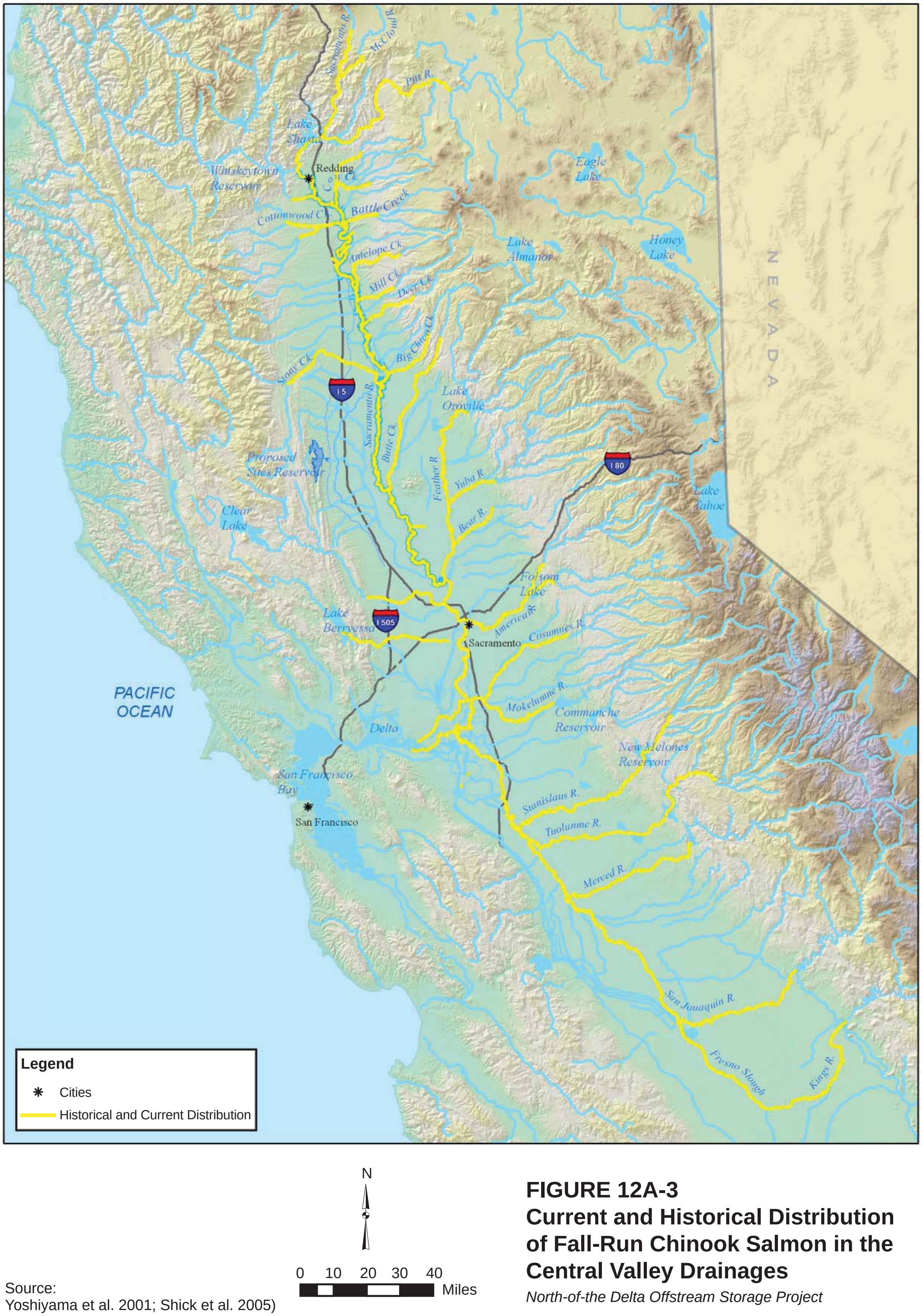


FIGURE 12A-2
Current and Historical Distribution of Spring-Run Chinook Salmon in the Central Valley Drainages including Critical Habitat Designation
North-of-the Delta Offstream Storage Project



Source:
Yoshiyama et al. 2001; Shick et al. 2005)

FIGURE 12A-3
Current and Historical Distribution of Fall-Run Chinook Salmon in the Central Valley Drainages
North-of-the Delta Offstream Storage Project

WBG020812033556SAC

FIGURE 12A-4
Current and Historical Distribution of Steelhead in the Central Valley Drainages including Critical Habitat Designation

North-of-the Delta Offstream Storage Project

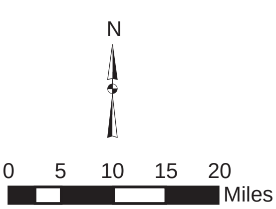


FIGURE 12A-5
Coho Salmon Current Distribution and Critical Habitat Designation
North-of-the Delta Offstream Storage Project

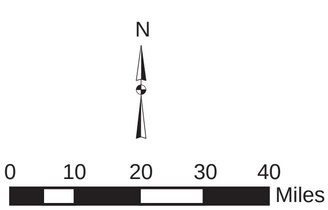


FIGURE 12A-6
Current and Historical Distribution of Green Sturgeon in the Central Valley Drainages including Critical Habitat Designation
North-of-the Delta Offstream Storage Project

Appendix 12B
Fisheries Impact Assessment Methodology

APPENDIX 12B
Fisheries Impact Assessment Methodology

This appendix describes the impact assessment methodology, impact indicators, and significance criteria used to evaluate the potential impacts of the proposed North-of-the-Delta Offstream Storage (NODOS) Project action alternatives (alternatives) on aquatic biological resources, as compared to Existing Conditions and the No Project/No Action Alternative for regulatory compliance purposes.

Several fish species are sensitive to changes in both river flows and water temperatures throughout the year. Because the NODOS Project is anticipated to result in changes in water temperatures and river flows, the fisheries impact assessment focused on these and other habitat-based elements. Taking into account species- and life stage-specific habitat requirements, the construction, maintenance, and operational components of the NODOS Project alternatives were assessed to evaluate potential impacts on identified fish species and associated aquatic habitat.

For each component of the NODOS Project’s Extended, Secondary, and Primary study areas, the impact assessment identified fish species of primary management concern. Species of primary management concern consist of special-status fish species (federal- and State- listed threatened and endangered, federal candidate species and species of concern, and State species of special concern), as well as other recreationally important species (e.g., striped bass and American shad). Species of primary management concern were identified for specific geographic components of the NODOS Project study areas, as described below.

Both quantitative and qualitative assessments were conducted to evaluate potential impacts to fisheries and aquatic resources that could occur as a result of implementation of the NODOS Project alternatives. Mass balance hydrologic and water temperature modeling was performed to provide a quantitative basis from which to assess potential operations-related impacts of the NODOS Project alternatives on fish species of primary management concern and aquatic habitats within the Extended (e.g., San Luis Reservoir), Secondary (e.g., Trinity, Sacramento, Feather and American rivers, Clear Creek, and the Delta), and Primary (e.g., Sites and Funks reservoirs) study areas, relative to the bases of comparison. Specifically, the hydrological modeling analyses were utilized to simulate data representing Central Valley Project/State Water Project (SWP/CVP) operational conditions that would occur from implementation of the NODOS Project alternatives, and compared to modeled data representing operational conditions under the bases of comparison (i.e., Existing Conditions and the No Project/No Action Alternative). The methodologies used to simulate comparative operational scenarios under the alternatives, relative to the bases of comparison, are described in Appendix 6A and Appendix 6B.

For the DEIR/EIS, the impact assessment of aquatic biological resources consisted of three primary elements, including: (1) temporary and localized impacts associated with construction of the proposed Project facilities; (2) ongoing impacts associated with the operation and maintenance of the proposed Project facilities; and (3) ongoing hydrologic changes associated with the proposed Project operations. The analytical framework used to assess the potential impacts of each component of the NODOS Project alternatives evaluated in the D EIR/EIS is described below.

12B.1 Extended Study Area

As described in Chapter 1: Introduction, the Extended Study Area consists of: (1) the SWP/CVP water service areas; (2) the Level 4 wildlife refuges and wildlife areas that could receive an alternate water supply from the proposed Project; and (3)export service area reservoirs, including San Luis Reservoir.

For fisheries impact evaluation purposes, the focus of the analyses was placed on the Level 4 wildlife refuges and San Luis Reservoir.

12B.1.1 Level 4 National Wildlife Refuges and Wildlife Areas

As described in the Affected Environment Section of Chapter 12 Aquatic Biological Resources, fish species occur in waterways and floodplains within the wildlife refuges that receive Level 4 water deliveries from the CVP[1].

An alternate source of Level 4 wildlife refuge water supply could potentially affect fisheries resources in the wildlife refuges or in the water distribution systems within the refuges. However, potential changes in water deliveries to individual refuges is not currently known and not provided as part of the CALSIM II model output. Therefore, the alternate supply of Level 4 wildlife refuge water to these refuges was evaluated qualitatively under the NODOS Project alternatives, relative to the bases of comparison.

Within the Sutter NWR, native anadromous fish include steelhead and four distinct runs of Chinook salmon (USFWS, 2009). According to USFWS (2009), federal and State listed fish species are not reported to occur in the other three refuges (i.e., Sacramento, Delevan and Colusa). Encompassing an area of about 2,600 acres, the Sutter NWR is located about 50 miles north of Sacramento, 10 miles southwest of Yuba City, and five miles south of Sutter, California. Approximately 80 percent of the Sutter NWR is located within the Sutter Bypass, which is located west of Yuba City, California (USFWS, 2009). The east and west Sutter Bypass canals are part of lower Butte Creek, and are tributary to the larger Sacramento River system.

Adult salmon and steelhead migrate up the Sutter Bypass canals at various times of the year depending upon the run (USFWS, 2009). Floodplain productivity is important to immature salmonids and other native fishes that escape from large predatory fish in shallow waters. When inundated, the relatively warmer waters of the floodplain become very productive and produce an abundance of prey. Juvenile salmonids also return through the Sutter Bypass and may use the canal and Refuge wetlands, depending upon flood conditions (USFWS, 2009).

During periods of high flows in the Sutter Bypass, large numbers of Chinook salmon and steelhead can use the Sutter NWR (USFWS, 2009). Adult Chinook salmon and steelhead that spawn in Butte Creek pass through the Sutter Bypass to their spawning area in upper Butte Creek, and migrating juveniles pass through the Sutter Bypass to the Pacific Ocean (USFWS, 2009).

During periods of flooding, the Sutter NWR provides high value rearing habitat for migrating juvenile Chinook salmon. Chinook salmon and steelhead typically pass through the Sutter Bypass within the east and west borrow channels, which are adjacent to the Sutter NWR. Adequate flows are maintained through

[1] The Level 4 water deliveries that could be affected by Project operation are contracted to the Sacramento and Delevan NWRs, West Bear Creek unit of the San Luis National Wildlife Refuge (NWR) Complex and the Merced unit of the Merced NWR, as well as the Los Banos, Volta, and Mendota WAs, the China Island and Salt Slough units of the North Grasslands Wildlife Area, and private wetlands of the Grassland Resource Conservation District within the San Joaquin River Basin; and to the Kern and Pixley NWRs within the Tulare Lake Basin.

the wetland units within the Sutter Bypass during the juvenile Chinook salmon and steelhead migration period (USFWS, 2009).

Water enters Sutter Bypass in at least three ways. First, Butte Creek, a non-SWP/CVP tributary of the Sacramento River, spills into Sutter Bypass via Butte Slough (Feyer et al., 2006). A second mechanism for floodplain inundation is that relatively small flow events in the Sacramento River create water surface elevations that inundate the lower portion of Sutter Bypass. Finally, water also enters Sutter Bypass at weirs along the Sacramento River during high flow events; water enters Sutter Bypass at Tisdale Weir when Sacramento River flow exceeds 595 m^3/s [21,012 cfs], at Moulton Weir when flow exceeds 1,274 m^3/s [44,990 cfs], and at Colusa Weir when flow exceeds 1,841 m^3/s [65,014 cfs] (Feyer et al., 2006).

The flow regime in the Sutter bypass generally reflects natural conditions in that it exhibits dynamic seasonal flooding that has been lost from much of the watershed (Feyer et al., 2006). However, with the exception of Chinook salmon and splittail, fish communities appeared to be largely a function of the underlying physical habitat rather than the flow regime. One important consideration, though, is that the system exhibits relatively little, if any, flow at times during the summer and fall dry seasons (Feyer et al., 2006).

Fish communities in the Sutter Bypass appear to be structured primarily by the habitat characteristics of the floodplain and secondarily by the flood pulse dynamics (Feyer et al., 2006). Although dynamic flooding appears unable to override the underlying physical habitat differences in structuring the overall fish communities, it is an important factor controlling the abundances of two prominent native species: Chinook salmon and splittail. Juvenile Chinook salmon were abundant in Sutter Bypass in all months but June because of the direct connection with Butte Creek, which supports a substantial population of anadromous salmonids (Moyle, 2002).

When Sacramento River flows exceed between 90,000 and 100,000 cfs at Ord Ferry, water flows naturally over the banks into the Butte Basin. In addition to the Sacramento River overbank flows at Ord Ferry, the basin receives inflow over the Colusa and Moulton Weirs and from tributary streams draining from the northeast, principally Cherokee Canal and Butte Creek.

Studies conducted on the Sutter Bypass show that the highest proportion of flows are diverted from December through March with a peak occurring in February, corresponding to the range and peak outmigration patterns for juvenile winter-run Chinook salmon (NMFS, 1997). Juveniles diverted into the bypasses may experience migration delays, potential stranding as flood flows recede and increased rates of predation. However, both the Sutter and Yolo bypasses provide high quality rearing habitat for juveniles, potentially resulting in greater survival relative to fish that stay in the mainstem (Sommer et al., 2001).

NODOS model output (i.e., flow) nodes available from USRDOM included:

- Ord Ferry Spills into Sutter Bypass
- Moulton Weir Spills into Sutter Bypass
- Colusa Weir Spills into Sutter Bypass
- Tisdale Weir Spills into Sutter Bypass

Any water acquired under the NODOS Project alternatives for refuge-related purposes would be used to help meet Reclamation’s obligations under the CVPIA to provide Incremental Level 4 wildlife refuge water supply. Thus, water supplies to wildlife refuges along the Sacramento River corridor would not be adversely affected by an alternate source of water supply from the SWP/CVP system implemented under the proposed Project.

However, to assess the potential impacts of the NODOS Project alternatives on fisheries resources in the Sutter Bypass, the cumulative probability distributions were evaluated for each of the four modeled locations where the Sacramento River can spill into the Sutter Bypass.

12B.1.2 San Luis Reservoir and Export Service Area Reservoirs

San Luis Reservoir provides habitat for both coldwater and warmwater fish species, which include largemouth bass, striped bass, crappie, bluegill, bullhead catfish, shad, yellow perch, and occasional white sturgeon (State Parks, 2007) (Table 12B-1).

Table 12B-1
Fish Species of Primary Management Concern Evaluated for San Luis Reservoir

Common Name	Status
• Coldwater Fisheries (e.g., trout)	Recreational importance
• Warmwater Fisheries (e.g., largemouth bass, striped bass, crappie, bluegill, bullhead, catfish)	Recreational importance

Fish production in San Luis Reservoir is generally limited by changes in water elevations during critical spawning periods, overall reservoir levels, and the availability of shallow near-shore rearing habitat. Stocking by CDFG keeps the reservoir well supplied with trout. Bass fishing derbies are often held here, and crappie and bluegill are also caught.

To assess potential impacts of the NODOS Project alternatives on coldwater fisheries resources in San Luis Reservoir, the following outputs for end-of-month storage during the April through November period were evaluated: (1) long-term averages; (2) averages by water year type; and (3) the cumulative probability distributions.

To assess potential reservoir water surface elevation change-related impacts on the warmwater fisheries resources in San Luis Reservoir, the following approach was used.

- The magnitude of change (feet msl) in reservoir water surface elevation occurring each month of the primary spawning period for nest-building fish (March through June) under the NODOS Project alternatives were determined and compared to that modeled for the bases of comparison.
- The number of times that reservoir reductions of six feet or more per month could occur under the NODOS Project alternatives was compared to the number of occurrences that were modeled under the bases of comparison.
- The potential impacts to coldwater and warmwater fisheries resources in other export service area reservoirs were evaluated qualitatively.

12B.2 Secondary Study Area

The Secondary Study Area consists of the SWP and CVP water bodies and the waterways within the Sacramento River Watershed, the Feather River Watershed, the Trinity River Watershed, and the American River Watershed. Specifically, the Secondary Study Area includes Shasta Lake, Sacramento River downstream of Keswick Dam, Trinity Lake, Trinity River, Klamath River downstream of the Trinity River, Clear Creek, Lake Oroville, Feather River, Sutter Bypass, Yolo Bypass, Folsom Lake, lower American River, the Sacramento-San Joaquin Delta, and Suisun, San Pablo, and San Francisco bays.

12B.2.1 Assessment Approach for Construction-Related Impacts

Construction in the Secondary Study Area would consist of the installation of additional pump into an existing bay at the Red Bluff Pumping Plant during the annual maintenance period for the T-C Canal. Although the canal would be dry during construction, construction activities would occur near the Sacramento River and therefore could potentially impact fish species of primary management concern that would be in the vicinity of the pumping plant during the construction period. The potential construction-related impact mechanisms evaluated included: (1) increases in sedimentation and turbidity; and (2) hazardous materials and chemical spills.

12B.2.2 General Assessment Approach for Operations-Related Impacts

Several fish species of primary management concern are sensitive to changes in both river flows and water temperatures throughout the year. Because the NODOS Project may result in changes in water temperatures, river flows, and Delta habitat parameters (e.g., salinity) in the Secondary Study Area, the impact assessment focused on these and other habitat-based elements. Specifically, the analysis of potential impacts was conducted using an ecologically scaled hierarchy. Changes to aquatic ecosystem-level functions (e.g., flow, hydrodynamics, water temperature, and salinity) that are relevant to multiple fish species were evaluated first. The results of these analyses were then used to conduct individual fish species evaluations using species-specific habitat requirements and species-specific evaluation tools to identify potential impacts on fish species of primary management concern.

The analytical framework used to assess the potential impacts of the proposed Project is described below.

12B.2.2.1 Analytical Tools

The aquatic biological resources impact assessment relied on hydrologic modeling to provide a quantitative basis from which to assess the potential impacts of the NODOS Project alternatives on fish species of primary management concern and aquatic habitats within the SWP/CVP system, relative to the bases of comparison. Specifically, the hydrological modeling and post-processing applications were utilized to simulate operations expected to occur in SWP/CVP reservoirs and rivers, and the Delta, as a result of implementation of the NODOS Project alternatives, relative to the bases of comparison.

Hydrologic simulation results of monthly river flows and end-of-month reservoir storages provided a quantitative basis to assess the potential impacts of operations on fish species, relative to the bases of comparison, for the period of simulation extending from water year 1922 through 2003 (82-year simulation period). These simulated results were used as inputs to Reclamation's Water Temperature Models (Appendix 7E), which simulate monthly water temperature of the main river systems (Trinity, Sacramento, Feather, and American rivers) for the same simulation period. The water temperature results were used as inputs to Reclamation's Early Lifestage Chinook Salmon Mortality Model (Reclamation Salmon Mortality Model) to estimate annual mortality rates for the embryonic lifestage of Chinook salmon. Flows and water temperatures were also utilized as inputs to other analytical tools including IOS, SALMOD, and the SacEFT to estimate potential population-level impacts on various life stages and habitat for some Sacramento River fishes.

Specific nodes from hydrologic and water temperature model output for fisheries impact assessment purposes, as well as the types of model outputs for flows and water temperatures (e.g., cumulative probability exceedance distributions) are identified below. The following sections present a summary of the evaluation tools used to support the aquatic biological resources impact assessment. Detailed information about specific modeling tools, the modeling assumptions used to characterize NODOS Project operations, and the appropriate use of model output results is presented in Appendix 6A and Appendix 6B. Detailed discussion regarding each fish species and water body evaluated is presented in each of the river-specific assessment approach sections, below. Detailed information and results of modeling tools are presented in the following appendices:

- Simulated riverine, reservoir, and Delta hydrology, and X2 location:
  - Appendix 6B – CALSIM II Modeling (includes overview of modeling framework)
  - Appendix 6C – River Flow Modeling (USRDOM)
  - Appendix 7D – Delta Modeling (DSM2)
- Simulated water temperatures:
  - Appendix 7E – River Temperature Modeling
  - Appendix 7F – Sites Reservoir Discharge Temperature Modeling
- Summarized simulated hydrology and water temperature data (Appendix 12E and Appendix 12F)
- Simulated fisheries habitat and population parameters:
  - Appendix 12G – Sacramento Splittail Usable Flooded Area Analyses
  - Appendix 12I – Delta Pumping Salvage and Entrainment Analysis
  - Appendix 12J – Reclamation Salmon Mortality Modeling
  - Appendix 12K – Salmonid Population Modeling (SALMOD)
  - Appendix 12L – Winter Run Chinook Life Cycle Modeling (IOS)
  - Appendix 12M – Delta Passage Modeling (DPM)
  - Appendix 12N – Weighted Useable Area Analysis

Model Uncertainty

The physical habitat models used in the analyses, although mathematically precise, should be viewed as having inherent uncertainty because of limitations in the theoretical basis of the model and the scope of the formulation and function for which the model is designed. Additionally, the accuracy of the models is unknown and unquantifiable because of the speculative nature under which the assumptions of the projected conditions were established. Nonetheless, physical habitat models developed for planning and impact assessment purposes represent the best available information with which to conduct evaluations of proposed changes in SWP and CVP operations. Therefore, physical habitat models were utilized as analytical tools to identify potential changes in aquatic habitat variables (i.e., flows and water temperatures), as well as inputs to species-specific analytical tools (e.g., SALMOD, IOS, SacEFT), described below. Detailed discussion of specific modeling tools, the modeling assumptions used, and the uncertainty associated with the models is presented in Appendix 6B.

12B.2.2.2 Application of Model Output

Computer simulation models and post-processing tools were used to assess potential changes in reservoir storage and water surface elevation, river flows and water temperatures, and other parameters (e.g., salinity) that could occur under the NODOS Project alternatives, relative to the bases of comparison. Model assumptions and results were used for comparative purposes, rather than for absolute predictions, and the focus of the analysis was on differences in the results among comparative scenarios (e.g., a comparison of simulated conditions under NODOS Project Alternative A, relative to Existing Conditions). All of the assumptions were the same for both the with-Project and without-Project model runs, except assumptions associated with the action itself, and the focus of the analysis was the differences in the results. Results from a single simulation may not necessarily correspond to actual system operations for a specific month or year, but are representative of general water supply conditions. Model results are best interpreted using various statistical measures such as long-term and year-type average, and probability of exceedance. Detailed discussion of specific modeling tools, the modeling assumptions used, and the appropriate use of model output results is presented in Appendix 6B.

12B.2.2.3 Analytical Approach for Evaluating Fisheries and Aquatic Resources (Flow)

Output from the various modeling tools discussed above was used to evaluate potential impacts on hydrologic parameters for the SWP/CVP system. These hydrologic parameters were evaluated because they are associated with broad ecological concepts that apply to fisheries and aquatic resources.

Streamflow quantity and timing are critical components of water supply, water quality, and the ecological integrity of river systems (Poff et al., 1997). Streamflow, which is strongly correlated with many critical physicochemical characteristics of rivers, can be considered a master variable that limits the distribution and abundance of riverine species (Power et al., 1995 and Resh, et al., 1988) and regulates the ecological integrity of flowing water systems.

Components of the flow regime can be used to characterize the entire range of flows and specific hydrologic phenomena (e.g., floods and low flows) that are vital to the integrity of river ecosystems. The five components of the flow regime include: (1) magnitude; (2) frequency; (3) duration; (4) timing; and (5) rate of change of hydrologic conditions (Poff et al., 1997). Furthermore, Poff et al. (1997) report that by defining flow regimes in these terms, the ecological consequences of particular human activities that modify one or more components of the flow regime can be considered explicitly. The following discussion regarding these components is taken directly from Poff et al. (1997).

- **Magnitude**: The magnitude and frequency of high and low flows regulate numerous ecological processes. Frequent, moderately high flows effectively transport sediment through the channel (Leopold et al., 1964). This sediment movement, combined with the force of moving water, exports organic resources, such as detritus and attached algae, rejuvenating the biological community and allowing many species with fast life cycles and good colonizing ability to reestablish (Fisher, 1983). Consequently, the composition and relative abundance of species that are present in a stream or river often reflect the frequency and intensity of high flows (Meffe and Minckley, 1987; Schlosser, 1985).

Flows of low magnitude also provide ecological benefits. Periods of low flow may present recruitment opportunities for riparian plant species in regions where floodplains are frequently inundated (Wharton et al., 1981). Streams that dry temporarily, generally in arid regions, have aquatic (Williams and Hynes, 1977) and riparian (Nilsen et al., 1984) species with special behavioral or physiological adaptations that suit them to these harsh conditions.

- **Frequency**: The frequency of occurrence refers to how often a flow above a given magnitude recurs over some specified time interval. Frequency of occurrence is inversely related to flow magnitude. For example, a 100-year flood is equaled or exceeded on average once every 100 years – and the median flow over a specified time period has a 50 percent probability of occurrence.

- **Duration**: Duration is the period of time associated with a specific flow condition. Duration can be defined relative to a particular flow event (e.g., a floodplain may be inundated for a specific number of days by a ten-year flood), or it can be a defined as a composite expressed over a specified time period (e.g., the number of days in a year when flow exceeds some value).

The duration of a specific flow condition often determines its ecological significance, and changes in the duration of flow conditions have significant biological consequences (Poff et al., 1997). For aquatic species, prolonged flows of particular levels can be damaging. For example, differences in tolerance to prolonged flooding in riparian plants (Chapman et al., 1982) and to prolonged low flow in aquatic invertebrates (Williams and Hynes, 1977) and fishes (Closs and Lake, 1996) allow these species to persist in locations from which they might otherwise be displaced by dominant, but less tolerant, species. Changes in duration of inundation, independent of changes in annual volume of flow, can alter the abundance of plant cover types (Auble et al., 1994).

- **Timing:** The timing, or predictability, of flows of defined magnitude refers to the regularity with which they occur. This regularity can be defined formally or informally, and with reference to different time scales (Poff, 1996). For example, annual peak flows may occur with low seasonal predictability or with high seasonal predictability. The timing, or predictability, of flow events is critical ecologically because the life cycles of many aquatic and riparian species are timed to either avoid or exploit flows of variable magnitudes. For example, the natural timing of high or low stream flows provides environmental cues for initiating life cycle transitions in fish, such as spawning (Montgomery et al., 1983; Nesler et al., 1988), egg hatching (Naesje et al., 1995), rearing (Seegrist and Gard, 1978), movement onto the floodplain for feeding or reproduction (Junk et al., 1989; Sparks, 1992; Welcomme, 1992), or migration upstream or downstream (Trepanier, et al., 1996).
- **Rate of Change**: The rate of change, or “flashiness”, refers to how quickly flow changes from one magnitude to another. At the extremes, “flashy” streams have rapid rates of change, whereas “stable” streams have slow rates of change. The rate of change, or “flashiness”, in flow conditions can influence species persistence and coexistence.

Naturally variable flows create and maintain the dynamics of in-channel and floodplain conditions, and habitats that are essential to aquatic and riparian species (Poff et al., 1997). Fish and other aquatic organisms require habitat features that cannot be maintained by minimum flows alone. A range of flows is necessary to scour and revitalize gravel beds, to import wood and organic matter from the floodplain, and to provide access to productive riparian wetlands. Inter-annual variation in these flow peaks is also critical for maintaining channel and riparian dynamics (Poff et al., 1997).

The natural flow regime of virtually all rivers is inherently variable, and that this variability is critical to ecosystem function and native biodiversity. Recognizing the natural variability of river flow and explicitly incorporating the five components of the natural flow regime (i.e., magnitude, frequency, duration, timing, and rate of change) into a broader framework for ecosystem management would constitute a major advance over most present management, which focuses on minimum flows and on just a few species (Poff et al., 1997). Components of a natural flow-regime can be characterized using various time series and probability analyses of, for example, extremely high or low flows, or of the entire range of flows expressed as average daily discharge (Poff et al., 1997).

For the NODOS Project, the river-specific fisheries impact assessment included quantitative evaluation of the types of flow-related changes described above, as well as qualitative consideration of other concepts related to the natural flow regime that are described in Poff et al., 1997.

Long-Term Average Flow and Average Flow by Water Year Type

Post-processing tools utilized CALSIM output (i.e., monthly flow data) to calculate the long-term average flows, by month, occurring over the 1922 through 2003 simulation period under the bases of comparison and NODOS Project alternatives. Monthly average simulated flows by water year type were used to compare differences between the bases of comparison and the alternatives. Presented in tabular format, the data tables for the long-term average flows by month, and the monthly average flows by water year type demonstrate the changes that could be expected to occur as a result of the implementation of the NODOS Project alternatives, relative to the bases of comparison.

Flow Exceedance Curves

Flow exceedance curves were developed for the 1922 through 2003 simulation period and illustrate the distribution of simulated flows under the NODOS Project alternatives and the bases of comparison. In general, flow exceedance curves represent the probability, as a percent of time that modeled flow values would be met or exceeded at a specific location, during a certain time period. Therefore, exceedance curves demonstrate the cumulative probabilistic distribution of flows for each month at a given river location under a given simulation.

Exceedance curves are particularly useful for examining flow changes occurring at lower flow levels. Results from past instream flow studies indicate that Chinook salmon spawning and rearing habitat is most sensitive to changes during lower flow conditions (CDFG, 1994; USFWS, 1985). Changes in rearing habitat also are examined using flow exceedance curves. Rearing habitat area tends to reach maximum abundance at low flows that inundate most of the channel area in a river (Jones & Stokes, 2003). Rearing habitat area declines as flows increase, primarily in response to increased average velocity. Because juvenile Chinook salmon and steelhead fry generally prefer low velocity areas, increasing flows often lead to reductions in habitat area. However, this flow-habitat relationship may be misleading because it may not adequately reflect local habitat conditions (i.e., availability of low velocity) or the importance of flow-related habitat attributes (e.g., water temperature conditions or cover and prey availability). Given the uncertainty of flow-habitat relationships associated with anadromous salmonid rearing in large riverine environs, the impact assessment specifically evaluated changes in low flow conditions (e.g., flows for critical and dry year types). In accordance with the selected flow criteria described below, a change in flow in the lowest quartile distribution (i.e., 25th percentile) of 10 percent or greater under an alternative, relative to the bases of comparison, was used as an impact indicator (see Section 12B.4 Impact Indicators, below, for species-specific application). This approach is consistent with the methodology included in previous environmental documentation, including the Freeport Regional Water Project EIS/EIR (Jones & Stokes, 2003) and the Yuba Accord EIR/EIS (YCWA et al., 2007).

The analysis considered monthly changes in flow of 10 percent or greater over the 82-year period under the alternatives, relative to the bases of comparison. However, it also was recognized that water temperature changes often exhibit a greater influence on fisheries resources and aquatic habitat utilization. Thus, the flow analyses were supplemented by separate species-specific water temperature analyses.

Flow-Dependent Habitat Availability

Flow-dependent habitat availability refers to the quantity and quality of habitat available to individual species and life stages for a particular instream flow. Typically, the relationship between instream flow and the quantity and quality of instream habitat is expressed in terms of weighted usable area (WUA) produced by a particular flow level (SWRI, 2002).

For the Chinook salmon adult spawning life stage, flow dependent habitat availability refers to the amount of appropriate spawning habitat, including the suitable water depths, velocities, and substrate for successful spawning that is, in part, contingent on stream flow. Salmonids typically deposit eggs within a range of depths and velocities that ensure adequate exchange of water between surface and substrate interstices to maintain high oxygen levels and remove metabolic wastes from the redd. Stream flow directly affects the availability of appropriate spawning habitat (SWRI, 2002). In general, the amount of habitat suitable for spawning increases with increasing stream flow; however, stream flows above a certain level do not provide additional habitat, and excessive stream flows can cause scouring of the substrate, resulting in mortality to developing eggs and embryos (Spence et al., 1996).

The physical habitat simulation (PHABSIM) system is a commonly used method to express indices of the quantity and quality of habitat associated with specific flows. PHABSIM is the combination of hydraulic and habitat models, the output of which is expressed as weighted usable area (WUA), and is used to predict the relationship between instream flow and the quantity and quality of habitat for various life stages of one or more species of fish. WUA-discharge relationships were available only for some rivers for which simulated flow were available. Therefore, flow dependent habitat availability was evaluated quantitatively only for the Sacramento, Feather, and American rivers and was not reported for other rivers and creeks evaluated in this DEIR/EIS. Detailed descriptions of the spawning habitat-discharge relationships and calculations of spawning WUA for the Sacramento, Feather, and lower American rivers are provided in Appendix 12N.

Evaluation Criteria

A decrease in monthly flow of 10 percent or greater has been previously identified by various environmental documents as an appropriate criterion to evaluate flow changes. For example, in the Trinity River Mainstem Fishery Restoration DEIS/EIR (USFWS et al., 1999), the USFWS identified reductions in flow of 10 percent or greater as changes that could be sufficient to reduce habitat quantity or quality to an extent that could significantly affect fish. The Trinity River DEIS/EIR further states, "*…[t]his assumption [is] very conservative…[i]t is likely that reductions in streamflows much greater than 10 percent would be necessary to significantly (and quantifiably) reduce habitat quality and quantity to an extent detrimental to fishery resources.*" Conversely, the Trinity River DEIS/EIR considers increases in streamflow of 10 percent or greater, relative to the basis of comparison, to be "beneficial" to fish species.

In addition to the USFWS et al. (1999) criteria, the San Joaquin River Agreement EIS/EIR (Reclamation and SJRGA, 1999) used USGS, 1977 criteria thresholds, which were derived based on the ability to accurately measure stream flow discharges to ±10 percent. The criterion used to determine impacts associated with implementation of the San Joaquin Agreement was based on average percentage changes to stream flow relative to the basis of comparison. The San Joaquin River Agreement EIS/EIR considered flow changes of less than ±10 percent to be insignificant (Reclamation and SJRGA, 1999).

The Freeport Regional Water Project DEIS/EIR (Jones & Stokes, 2003) used a similar rationale as the USGS documentation for selecting criteria to evaluate changes in flow. The Freeport EIS/EIR states: "*Relative to the base case, a meaningful change in habitat is assumed to occur when the change in flow equals or exceeds approximately 10 percent. The 10 percent criterion is based on the assumption that changes in flow less than 10 percent are generally not within the accuracy of flow measurements, and will not result in measurable changes to fish habitat area.*"

Although the environmental documents listed above have been legally certified, biological justifications specific to using a 10 percent change as a criterion for a meaningful change in habitat affecting fisheries resources in a particular river have not been provided. Nevertheless, these documents apparently have resulted in consensus in the use of 10 percent when evaluating the potential effects of flow changes on fish and aquatic habitat.

According to Reclamation and DWR (2005), natural variability is difficult to describe with a single value, but it is assumed that 10 percent of a specified numerical criterion (for variables with numerical criteria) or 10 percent of the mean value (for variables without numerical criteria) would be a reasonable representation of natural variability that would be expected to occur without causing a significant impact (Reclamation and DWR, 2005).

Accordingly, the fisheries impact assessment relied on previously established information and, therefore, evaluated changes of 10 percent or greater in monthly mean flows under the NODOS Project alternatives and the bases of comparison (see Section 12B.4 Impact Indicators, below, for species-specific application). Specifically, a change of 10 percent or greater in flow exceedance probabilities is considered an evaluation criterion that indicates a potentially substantial impact on fisheries resources, while a change of 10 percent or more in long-term average flow or average flows in a specific water year type is less meaningful because the arithmetic average of a population is a measure of central tendency and is used to describe the properties of a population (i.e., flows) and purposefully reduces the effect of large deviations in individual flow values (i.e., individual years within a monthly distribution) on the effect of the overall population. Therefore, this impact assessment utilized changes of one percent or greater in long-term average flows or average flows by water year type and exceedance probability distribution changes of 10 percent or greater as evaluation criteria.

12B.2.2.4 Analytical Approach for Evaluating Aquatic Biological Resources (Water Temperature)

<u>Long-Term Average Water Temperature and Average Temperature by Water Year Type</u>

Post-processing tools utilizing Reclamation's Temperature Model output were used to calculate the long-term average water temperatures, by month, that would occur over the 82-year simulation period under the bases of comparison and the alternatives. Monthly average simulated water temperatures by water year type also were used to compare differences between the bases of comparison and the alternatives. Long-term average water temperatures for each month and monthly average water temperatures by water year type are presented in tabular format, and demonstrate the changes that could be expected to occur as a result of implementation of the NODOS Project alternatives, relative to the bases of comparison.

<u>Water Temperature Exceedance Curves</u>

Water temperature exceedance curves were developed for the 82-year simulation period and illustrate the distribution of simulated water temperatures under the NODOS Project alternatives, and the bases of comparison. In general, water temperature exceedance curves represent the probability, as a percent of time, that modeled water temperature values would be met or exceeded at a specific location, during a certain time period. Therefore, exceedance curves demonstrate the cumulative probabilistic distribution of water temperatures for each month at a given river location under a given simulation.

Exceedance curves are particularly useful for examining water temperature changes occurring at warmer water temperature levels. Anadromous salmonid spawning and rearing habitat could be most affected by changes when water temperatures are relatively warm (i.e., when flows are in approximately the lowest 25 percent of the cumulative flow distribution). The impact assessment specifically evaluated changes during warm water temperature conditions (i.e., water temperatures in the 75th percentile – the warmest quartile) between the NODOS Project alternatives and the bases of comparison.

12B.2.2.5 Reclamation Salmon Mortality Model

The Reclamation Salmon Mortality Model was used to assess potential water temperature-related impacts on the early life stage survival of Chinook salmon in the Trinity, Sacramento, Feather, and American rivers. Water temperature output from Reclamation’s water temperature models was used in the Reclamation Salmon Mortality Model (Reclamation, 1991) to characterize water temperature-related losses of early life stages of Chinook salmon under the NODOS Project alternatives, relative to the bases of comparison. According to Reclamation (2008), the model uses CDFG and USFWS data on Chinook salmon spawning distribution and timing in the individual rivers (Reclamation, 1991, Loudermilk, 1994, and Reclamation, 1994). Temperature-exposure mortality criteria for three life stages (pre-spawned eggs, fertilized eggs, and pre-emergent fry) are used along with the spawning distribution data and output from the river temperature models to compute the percentage of potential emergent fry lost as a result of temperature-induced mortality (Reclamation, 2008). Model output represents the percentage of potential emergent fry produced, based on all eggs brought to the river by spawning adults, that would survive under the water temperature regime that would occur under each model simulation.

As discussed in the Trinity River EIS/EIR (USFWS et al., 1999), the Reclamation Salmon Mortality Model uses weekly average water temperatures obtained from the water temperature models and tracks water temperature impacts on Chinook salmon egg and larval (sac-fry) development. Algorithms are used to compute the cumulative survival of eggs spawned in a particular week through fry emergence from the spawning gravel. Temperature mortality schedules (relationships) for Chinook salmon eggs and larvae were developed that establish temperature-related instantaneous daily mortality rates for modeling salmon losses.

The assessment of early life stage survival resulting from implementation of the NODOS Project alternatives, relative to the bases of comparison, involved the examination of the annual average relative difference in mortality over the long-term and by water year type. Additionally, total annual mortality exceedance probabilities were evaluated to identify differences in the probability of occurrence of mortality for all life stages evaluated by the model. Examination of the relative difference was necessary to avoid the masking of more severe impacts on evaluated fish species, and to evaluate the biological significance of changes in water temperature conditions on early lifestage survival. Relative difference comparisons appropriately assessed the magnitude of change in conditions between the NODOS Project alternatives and the bases of comparison.

As part of the Oroville Project FERC relicensing efforts, the Reclamation Salmon Mortality Model was revised to include new spawning distribution and water temperature data, and more detailed Feather River reach segments. Simulated Chinook salmon early life stage survival estimates specific to the Feather River incorporated new data associated with: (1) temporal spawning and pre-spawning distributions; and (2) mean daily water temperature data in the Feather River. This modeling approach estimated the percentages of Chinook salmon egg and alevin losses due to water temperature-induced mortality, based upon updated pre-spawning and spawning temporal distributions derived from shifted smoothed carcass distributions, and from calculated mean daily water temperature data throughout the pre-spawning, spawning and incubation periods of Chinook salmon in the Feather River during the 2002/2003 spawning and incubation season. Pre-spawning, spawning, and reach distributions were created to reflect more recent carcass survey data.

A version of the Reclamation Salmon Mortality Model was developed for the Sacramento River that is based on a daily time-step (SacSalMort). SacSalMort provides early life stage (adult pre-spawning in vivo egg, incubating embryos and incubating alevins) water temperature-related mortality estimates. Using SacSalMort output for each run of Chinook salmon in the Sacramento River, the following parameters were evaluated:

- Average annual survival (%) both long-term and by water year type. The average annual survival estimates include all three components (adult pre-spawning in vivo egg, incubating embryos, and incubating alevins).
- Average annual mortality exceedance probability distributions for each of the three components (adult pre-spawning in vivo egg, incubating embryos, and incubating alevins).

Life stage-specific mortality estimates also were expressed in terms of percent survival because a positive difference is considered to be a beneficial outcome. Detailed information and model results are included in Appendix 12J.

Although the Reclamation Salmon Mortality Model is commonly used to conduct impact assessments in environmental planning documents, with respect to the application of the Reclamation Salmon Mortality Model in NMFS October 2004 Biological Opinion on the Long-Term Central Valley Project and State Water Project OCAP (NMFS, 2004), three concerns were reported by the California Bay-Delta Authority (CBDA) (2005). First, CBDA (2005) questioned the use of water temperature predictions that were developed by linear interpolation between monthly means without accounting for variation. Second, water temperature at the time of spawning was taken as an index of pre-spawning temperature exposure, which reportedly may be an unsatisfactory approach for spring-run Chinook salmon, which may hold in the river throughout the summer. Lastly, and reportedly the expert panel's most serious concern, "…*the data used to develop the relationships between temperature and mortality on eggs, alevins, and especially gametes was not the best available*."

To address these three concerns, the CBDA (2005) recommended that NMFS: (1) perform a thorough analysis of the data, relationships, and calculations of the Reclamation Salmon Mortality Model; (2) investigate how variation around monthly mean water temperatures would affect Reclamation Salmon Mortality Model results; and (3) suggest or make improvements to the model.

Given the aforementioned limitations associated with the Reclamation Salmon Mortality Model, several other modeling tools have been developed, and are presently being used for fisheries impact assessment purposes. Many of these modeling tools are specific to a geographic region in the Secondary Study Area, or to a species or run of fish. The subsequent discussions below provide a brief synopsis of the available modeling tools used as part of the NODOS Project aquatic biological resources impact analysis.

12B.2.2.6 Upper Sacramento River Water Quality Model

The Upper Sacramento River Water Quality Model (USRWQM), which simulates mean daily water temperatures (using six-hour meteorology) over an 82-year period (water years 1922 through 2003), was developed from the U.S. Army Corps of Engineers' (USACE) HEC-5Q water quality model, and calibrated for the upper Sacramento River system (RMA, 2003). The USRWQM was modified and expanded to include facilities associated with the proposed Project from Keswick Dam to Knights Landing, inclusive of the Sacramento River, Red Bluff Diversion Dam, Black Butte Dam and downstream Stony Creek, T-C Canal, GCID Canal, Colusa Basin Drain, the proposed Delevan Pipeline, the proposed Holthouse Reservoir, and the proposed Sites Reservoir.

Output from the USRWQM was used as an input to a number of biological models used to evaluate upstream life stages of salmonids and sturgeon. Species-specific impact assessment methodologies, including species-specific water temperature impact indicators evaluated using the USRWQM, are provided below.

Detailed discussion of the USRWQM's use of disaggregated mean monthly river flows and reservoir releases simulated by CALSIM II and the USRDOM (described below) into mean daily values and subsequent water temperature simulation is provided in Appendix 6C and Appendix 7E.

12B.2.2.7 Upper Sacramento River Daily Operations Model

A common criticism of CALSIM II is its monthly time-step, which cannot capture finer hydrologic variability necessary for a variety of water delivery and ecological studies. Recently, an extension was developed for CALSIM II called the Upper Sacramento River Daily Operations Model (USRDOM). The USRDOM was developed to simulate hydrologic, regulatory, and operational conditions of the upper Sacramento River on a daily timestep for the purpose of supporting hydrologic alternatives evaluations. The model is capable of simulating both low-flow (regulatory, CVP project system, water supply, water quality, and ecosystem restoration) and high-flow (reservoir refill and flood) operations of the upper Sacramento River. In addition, the model simulates the operations of the Colusa Basin and can be used to analyze existing and proposed facilities related to the NODOS Project alternatives, and provides the information needed by other models to assess and quantify temperature, salmon production and flow regime-related impacts and benefits. The USRDOM simulates daily reservoir operations and daily river flows for the facilities and tributaries within the reach of the upper Sacramento River from Keswick Dam to Knights Landing, including conveyance and storage facilities of the proposed Project. Detailed information and model results are included in Appendix 6C.

For fisheries impact assessment purposes the USRDOM was used to provide inputs into the USRWQM and Interactive Object-Oriented Salmon Simulation Model (IOS), described below.

12B.2.2.8 SALMOD

SALMOD is a computer model that estimates juvenile production for each run of Chinook salmon in the Sacramento River. The model's primary assumption is that egg and fish mortality are directly proportional to spatially and temporally variable microhabitat and macrohabitat limitations, which are functions of the timing and quantity of flow and other meteorological variables, such as air temperature (Reclamation, 2008). SALMOD characterizes fish habitat quality and carrying capacity using the hydraulic and thermal characteristics of individual mesohabitats (e.g., pools, riffles, or runs), categorized primarily by channel structure and hydraulic geometry, but modified by the distribution of features such as fish cover (Reclamation, 2008). Habitat area (quantified as weighted usable area or WUA) is computed from flow versus microhabitat area functions developed empirically or by using the Physical Habitat Simulation Model (PHABSIM) or similar physical habitat models (Reclamation, 2008).

SALMOD tracks a population of spatially distinct cohorts that originate as eggs and grow from one life stage to the next until immature smolt, accounting for spawning (egg deposition), egg and alevin development and growth, mortality, and movement due to habitat limitation, freshets and seasonal stimuli as a function of local water temperature, typically concluding with fish that are physiologically "ready" (e.g., pre-smolts), and are swimming downstream toward the ocean (Reclamation, 2008). SALMOD accounts for mortality caused by (1) water temperature, (2) changes in flow and habitat (e.g., mortality associated with superimposition, mortality related to movement resulting from habitat limitation, and from sudden increases in streamflow), (3) seasonal movements, and (4) all other causes not directly modeled (i.e., base or background mortality). Detailed information and model results are included in Appendix 12K.

The inputs to SALMOD include flows simulated by USRDOM, water temperatures simulated by the USRWQM, spawning distribution based on aerial surveys, spawning timing depending on the salmon run, and the number of spawners provided by the model user (e.g., recent average escapement).

For impact assessment purposes, juvenile Chinook salmon production estimates at Red Bluff Diversion Dam derived from SALMOD under each of the NODOS Project alternatives were compared to estimates under the bases of comparison. Specifically, annual production estimates were averaged over the entire 82-year simulation period and by water year type. Average annual production estimates were then evaluated under each NODOS Project alternative, relative to the bases of comparison. Additionally, annual production estimates were ranked and sorted to create exceedance probability distributions to evaluate the probability, as a percent of time, that simulated annual average potential production or mortality would be met or exceeded over the long term.

12B.2.2.9 Interactive Object-Oriented Salmon Simulation Model Winter-Run Life Cycle Model (IOS)

The IOS model is a winter-run Chinook salmon life-cycle model that serves as a quantitative framework for estimating the long-term response of Sacramento River winter-run Chinook salmon populations to changing environmental conditions (e.g. river discharge, temperature, habitat quality at a reach scale) (Reclamation, 2008). Life cycle models integrate survival changes at various life stages, across multiple habitats, and through many years (Reclamation, 2008).

The IOS model tracks daily abundance of winter-run Chinook salmon for seven different life stage categories (eggs, alevins, fry, parr, smolts, subadults, and adults) in 22 reaches of the Sacramento River, in the Delta, and in the Pacific Ocean (Reclamation, 2008). IOS also tracks average fry and parr size in each reach using water temperature and density dependent growth functions (Reclamation, 2008).

Variables that influence simulated life cycle processes include flows, diversions, water temperatures, the status of migration barriers, spawning habitat capacity, in-river sport harvest, sex ratio of spawning adults, pre-spawn mortality, fecundity, egg deposition timing, redd dewatering, egg incubation time, base and thermal mortality for eggs and alevins, fry/parr growth and maturation rate, juvenile emigration rate, juvenile mortality in the Sacramento River, the Delta, and the Pacific Ocean, adult ocean harvest, and non-harvest-related adult mortality in the Pacific Ocean (see Appendix 12L).

IOS model outputs were provided for winter-run Chinook salmon only and include: (1) egg–to-fry survival; (2) juvenile migration survival through the Sacramento River upstream of the Delta (e.g., fry-to-smolt survival); (3) juvenile migration survival through the Delta; and (4) adult female spawner escapement. Detailed information and model results are included in Appendix 12L.

For impact assessment purposes, each of the IOS model outputs for each of the NODOS Project alternatives were compared to estimates under each of the bases of comparison. Additionally, exceedance probability distributions for each of the IOS model outputs also were evaluated under each NODOS Project alternative, relative to the bases of comparison.

12B.2.2.10 Sacramento River Ecological Flows Tool (SacEFT)

The Sacramento River Ecological Flows Tool (SacEFT) system is a database-centered software system used for linking flow management actions to changes in physical habitats for several focal species of concern (Appendix 8B). The SacEFT includes the mainstem Sacramento River from RM 301 (Keswick) downstream to RM 143 (Colusa) (Appendix 8B). The SacEFT is intended to illustrate the *relative* benefits of management alternatives, clarify ecological tradeoffs, identify critical uncertainties, and explore potential adaptive flow management experiments (Appendix 8B).

SacEFT uses daily flows provided by USRDOM and correlated water temperatures from USRWQM as inputs. Relevant performance measures (outputs) integrated into the SacEFT for steelhead include area of suitable spawning habitat, area of suitable rearing habitat, egg-to-fry survival rate, index of juvenile stranding, redd scour, and redd dewatering. The only performance measure integrated into the SacEFT for green sturgeon includes egg-to-larvae survival rate.

Because the SacEFT provides the only source for estimating steelhead and green sturgeon egg survival, for impact assessment purposes, each of the relevant performance measure estimates (model outputs) derived from the SacEFT for steelhead and green sturgeon under the NODOS Project alternatives were compared to output performance measure estimates under the bases of comparison.

SacEFT outputs for Chinook salmon were not utilized for impact assessment purposes for several reasons. First, the SacEFT is a new model, not previously used by DWR and Reclamation to conduct impact assessments for environmental documents, and is still under development. Additionally, although the SacEFT provides outputs (e.g., index of juvenile stranding, redd scour, etc.) that are not provided by other Chinook salmon impact assessment models (IOS, SALMOD, Reclamation Salmon Mortality Model) it does provide the same types of information provided by these models (e.g., egg-to-fry survival rate). However, because SacEFT is not yet widely used in environmental documents and has not been thoroughly reviewed by NMFS, USFWS, and CDFG, the degree to which it is appropriate to use SacEFT and potentially compare results to other existing models is unknown. Therefore, for impact assessment purposes Chinook salmon early life stage mortality was evaluated using other accepted models (SALMOD and Reclamation Salmon Mortality Model). However, for disclosure purposes, SacEFT outputs for Chinook salmon are provided in Appendix 8B.

12B.2.2.11 DRERIP Conceptual Models

The CALFED Ecosystem Restoration Program implementing agencies (CDFG, USFWS, and NMFS) initiated the development of a series of conceptual models as part of the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP). These conceptual models are being developed to aid in planning and decision making of potential ecosystem restoration actions in the Delta. The suite of conceptual models that were developed, or are under development, are intended to collectively articulate the current scientific understanding of important aspects of the Sacramento-San Joaquin River Delta ecosystem.

The DRERIP Conceptual Models include both Delta ecosystem element models (including models related to Delta processes, habitats, and stressors), and species life history models. The models describe the current understanding of how the ecosystem works, and are designed and intended to be used by experts to identify and evaluate potential restoration actions in the Delta region. The models are not quantitative, numeric computer models that can be "run" to determine the effects of actions. Instead, they are designed to facilitate informed discussions regarding expected outcomes resulting from restoration actions, and the scientific basis for those expectations.

The DRERIP conceptual models served as a basis for understanding which of the Delta processes and stressors potentially influenced by the NODOS Project alternatives (e.g., freshwater input into the Delta) could impact the fish species of primary management concern. Additionally, each of the DRERIP processes and stressors identified as having the potential to impact fish species of primary management concern and that could be influenced by the NODOS Project alternatives were evaluated using quantitative model output (e.g., X2 location, Delta inflow, entrainment) where appropriate and available, or were evaluated qualitatively when quantitative model output was not available (e.g., predation risk) (CDFG, 2013).

12B.2.2.12 Delta Smelt Habitat/Fall X2 Model

Feyrer et al. (2010) developed an index of delta smelt habitat suitability, using both habitat quantity (surface area), and habitat quality (water temperature, salinity, and turbidity) (see Feyrer et al., 2007) in areas where delta smelt are known to occur. A relationship was then developed between the delta smelt habitat suitability index and average Fall X2 (i.e., the average location of X2 during September to December). September to December reportedly is an important time period in the delta smelt life cycle because it is when delta smelt recruit to the adult population (Feyrer et al., 2010). This relationship was used to assess potential impacts on delta smelt associated with changes in X2 location during September through December because of the association between freshwater flow and the areal extent of suitable abiotic habitat for delta smelt rearing and maturation (Feyrer et al., 2010).

Feyrer et al. (2010) concluded that, as X2 location increases, predicted delta smelt habitat declines, but the association is nonlinear. Specifically, changes in X2 mainly affect habitat suitability between approximately River Kilometer (Rkm) 65 and 80 Rkm (Feyrer et al., 2010 *in* BDCP, 2010).

For impact assessment purposes, X2 location output simulated by CALSIM II for the months of September through December was evaluated under the NODOS Project alternatives, relative to the bases of comparison. Specifically, an increase in fall X2 location under an alternative, relative to the basis of comparison, was considered a negative impact while a decrease in fall X2 location was considered a benefit. However, because the relationship between X2 location and habitat reported by Feyrer et al. (2010) is non-linear, the evaluation focused on potential changes between RKm 65 and RKm 80.

Although Feyrer et al. (2007) identified a relationship between an observed long-term trend in the average location of X2 in the fall and a corresponding reduction in the amount and location of suitable abiotic habitat utilized by delta smelt, and Feyrer et al. (2010) reported that as X2 location increases delta smelt habitat declines, uncertainty regarding the relationship remains because the significance of the relationship is reportedly driven by a single data point (see letter from San Luis and Delta-Mendota Water Authority and State Water Contractors to Mr. Rodney McInnis and Ren Lohoefener, dated October 28, 2008). Additionally, a committee of experts appointed by the National Research Council (NRC) considered the management of the location of X2 in the fall (NRC, 2010) as part of a review of the USFWS Biological Opinion on long-term operations of the SWP and CVP (USFWS, 2008). The committee noted that there is evidence of the link between the location of X2 and the distribution of delta smelt, but the statistical relationship between the location of X2 and the size of the smelt population is weak. Because of the controversy surrounding the use of a habitat suitability index for delta smelt, the NODOS Project impact analysis utilized the principle that X2 location is an indicator of delta smelt distribution and evaluated changes in X2 location as an indicator of potential impact on delta smelt, but did not directly evaluate changes in the index of habitat suitability developed by Feyrer et al. (2010).

12B.2.2.13 Delta Passage Model

The Delta Passage Model (DPM) simulates migration and mortality of juvenile Chinook salmon entering the Delta from the Sacramento River, the Mokelumne River, and the San Joaquin River through a simplified Delta channel network, and provides quantitative estimates of relative juvenile Chinook salmon survival (or a survival index) through the Delta to Chipps Island (Appendix 12M). The DPM is based on a detailed accounting of migratory pathways and reach-specific mortality as smolts travel through a network of Delta channels. The biological functionality of the DPM is based upon the foundation provided by Perry et al. (2010), as well as other acoustic tag-based studies and earlier coded wire tag (CWT) analyses provided by Newman (2003) and Kimmerer (2008), among others. Depending on the reach, reach-specific survival is either predicted as a function of reach-specific flow or Delta exports, or obtained from recent Delta acoustic tagging studies, which primarily used large (>150 mm) hatchery late fall-run Chinook salmon. The DPM has been applied to other Chinook salmon runs by adjusting emigration timing and by assuming that all migrating Chinook salmon will respond similarly to Delta conditions. Smolt movement in the DPM occurs daily and is a function of reach-specific length and migration speed informed by acoustic tagging studies. The methods used to predict smolt migration speed depend on the geographic region, but include using simulated channel flows, or observed migration speeds from acoustic tagging studies (Appendix 12M). Mortality for smolts migrating from Georgiana Slough and the Mokelumne River into the interior Delta associated with South Delta exports is modeled as based on a modified relationship between smolt survival and exports described by Newman and Brandes (2009). Detailed information and model results, including the data utilized to develop flow-survival, export-survival, flow-migration route, and flow-migration speed relationships, as well as other assumptions made in the model are included in Appendix 12M.

For impact assessment purposes, the DPM was applied to all runs of Chinook salmon (the IOS module utilized to simulate through-Delta survival for winter-run Chinook salmon is identical to the DPM utilized for other Chinook salmon runs) under each of the NODOS Project alternatives and bases of comparison. Survival estimates derived from the model were then evaluated to identify potential impacts associated with implementation of the NODOS Project alternatives.

12B.2.2.14 DSM2

DSM2 is a one-dimensional hydrodynamic and water quality simulation model used to simulate hydrodynamics (DSM2-HYDRO) and water quality (DSM2-QUAL) in the Sacramento-San Joaquin Delta. Detailed information and model results are included in Appendix 7D.

12B.2.3 Topics Eliminated From Further Analytical Consideration

Several SWP/CVP re-regulating reservoirs are located within the Secondary Study Area including Lewiston Reservoir downstream of Trinity Dam, Keswick Reservoir downstream of Shasta Dam, Thermalito Forebay and Thermalito Afterbay downstream of Oroville Dam, and Lake Natoma downstream of Folsom Dam. No storage- or elevation-related impacts on fishery resources in these reservoirs are expected to occur with implementation of the NODOS Project alternatives, relative to the bases of comparison. As regulating afterbays, the re-regulating reservoirs are operated to receive highly variable flows and, as a result, monthly storage and elevation fluctuate significantly on a daily and hourly basis. Therefore, changes in releases from upstream reservoirs under the NODOS Project alternatives would not affect monthly mean storage or elevation, relative to the baseline conditions. Consequently, no assessment of potential storage- or elevation-related impacts on fishery resources in re-regulating reservoirs was warranted.

12B.2.4 River-Specific Assessment Approach

Changes in SWP/CVP operations resulting from implementation of the NODOS Project alternatives could potentially alter seasonal flows and water temperatures in the Trinity River, Clear Creek, the Sacramento River, the Feather River, the American River, and the Delta.

For this Draft EIR/EIS, the river-specific fisheries impact assessment focused on the hydrologic changes, including reservoir water surface elevation, storage, and instream flows and water temperatures associated with implementation of the NODOS Project alternatives. Taking into account species-specific habitat requirements, operational components of the NODOS Project alternatives were assessed to evaluate potential impacts on identified fish species of primary management concern and associated aquatic habitat.

Because the fish species that inhabit, traverse, or utilize these areas could differ among regions, the fisheries impact assessment approach varied among geographic areas. The river-specific impact assessment included identification of fish species of primary management concern, model output and node locations, and species- and life stage-specific evaluation methodologies for the NODOS Project alternatives.

Where specific flow requirements have not been developed for species evaluated in a specific river, potential flow-related impacts determinations were based on an evaluation of the frequency and magnitude of change in modeled monthly mean flow under the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative). Water temperature-related impact determinations were based on species- and life stage-specific water temperature impact indicator values (presented in Section 12B.4 Impact Indicators, below)

12B.2.5 Trinity River

12B.2.5.1 Trinity Lake

Trinity Lake supports several coldwater sport fish species including rainbow trout, Kokanee salmon, and landlocked Chinook salmon, in addition to warmwater fish species such as smallmouth and largemouth bass (USFWS et al., 2000). The maximum surface area of the reservoir is 16,500 acres, with an irregular shoreline of about 145 miles. As is typical with most reservoirs, Trinity Lake is characterized by steep sides, with the upper one-fifth of the reservoir consisting of gentle slopes. Thermal stratification occurs between May and November, while the remainder of the year the reservoir is relatively isothermal (i.e., water temperature is the same at all depths). The banks of Trinity Lake have high erosion potential, and under windy conditions contribute to high turbidity near the shoreline.

Temperature within Trinity Lake is dependent on season and reservoir storage conditions (e.g., water surface area and water surface elevation). Generally, water temperatures in Trinity Lake are adequate to sustain reservoir fisheries.

Implementation of the NODOS Project alternatives could potentially result in alterations to storage levels and water surface elevations in Trinity Lake, which could potentially affect reservoir fish species. Parameters used to determine potential impacts included:

- End-of-month (average annual monthly) reservoir storage volume under the NODOS Project alternatives compared to the bases of comparison.
- End-of-month (average annual monthly) water surface elevations under the NODOS Project alternatives compared to the bases of comparison.

The following fish species guilds (Table 12B-2) were evaluated for Trinity Lake.

Table 12B-2
Fish Species of Primary Management Concern Evaluated for Trinity Lake

Common Name	Status
• Coldwater Fisheries (e.g., Kokanee salmon, trout sp.)	Recreational importance
• Warmwater Fisheries (e.g., largemouth bass, spotted bass, striped bass, crappie, bluegill, bullhead, catfish)	Recreational importance

Coldwater Fish Species

Trinity Lake coldwater reservoir fish species include Kokanee salmon (*Oncorhynchus nerka*), rainbow trout (*O. mykiss*), brown trout (*Salmo trutta*), and brook trout (*Salvelinus fontinalus*), as well as several native non-salmonid species including speckled dace, coast range sculpin, Klamath smallscale sucker, and river lamprey (USFWS et al., 2004). Kokanee salmon are a non-anadromous (i.e., land-locked) form of sockeye salmon. USFWS et al. (2004) indicates that Kokanee salmon were introduced and have become well established in both Trinity and Lewiston lakes. The species makes its spawning migration into streams between early August and February. Rainbow trout are the most abundant salmonid found in Trinity Lake. Rainbow trout spawn in streams tributary to the reservoir during spring months, but year-to-year rainbow trout spawning periodicity is dependent on Trinity Lake elevations and water temperatures. Juvenile rainbow trout migrate out of the spawning streams entering the reservoir to forage and mature where the cold, deep water provides suitable habitat. Hatchery trout are stocked in Trinity Lake by CDFG each year to support the sport fishery. The timing and number of planted fish are dependent upon several factors, including water temperature, availability of hatchery fish, and reservoir surface acreage.

During the period when Trinity Lake is thermally stratified (generally April through November), coldwater fish within the reservoir reside primarily within the reservoir's metalimnion and hypolimnion where water temperatures remain suitable. Reduced reservoir storage during this period could reduce the reservoir's coldwater pool volume, thereby reducing the quantity of habitat available to coldwater fish species during these months. Reservoir coldwater pool size generally decreases as reservoir storage decreases, although not always in direct proportion because of the influence of reservoir basin morphometry. Therefore, to assess potential storage-related impacts on coldwater fish habitat availability in Trinity Lake, end-of-month storage modeled for each year of the 82-year simulation period under the NODOS Project alternatives were compared to end-of-month storage under the bases of comparison for each month of the April through November period.

To assess the potential impacts of implementation of the NODOS Project alternatives on coldwater fisheries resources in Trinity Lake, the following outputs for end-of-month storage during the April through November period were evaluated: (1) long-term averages; (2) averages by water year type; and (3) the cumulative probability distributions.

Warmwater Fish Species

Trinity Lake warmwater fish species include warmwater species: largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieu*), green sunfish (*Lepomis cyanellus*), white catfish (*Ameiurus catus*), and black bullhead (*Ameiurus melus*) (USFWS et al., 2004).

Water surface elevation and fluctuating water levels are frequently identified as the primary factors adversely affecting reservoir fish production. Warmwater fish species in Trinity Lake (including smallmouth bass and largemouth bass) use the warm upper layer of the reservoir and nearshore littoral habitats throughout most of the year, seasonal changes in reservoir storage, as it affects reservoir water surface elevation (feet msl), and the rates at which water surface elevation change during specific periods of the year, can directly affect the reservoir’s warmwater fish.

Because warmwater fish species in Trinity Lake use the warm upper layer of the reservoir and nearshore littoral habitats throughout most of the year, seasonal changes in reservoir storage, as it affects reservoir water surface elevation (feet msl), and the rates at which water surface elevation change during specific periods of the year, can directly affect the reservoir’s warmwater fish. Reduced water surface elevations can potentially reduce the availability of nearshore littoral habitats used by warmwater fish for rearing, thereby potentially reducing rearing success and subsequent year-class strength. In addition, decreases in reservoir water surface elevation during the primary spawning period for warmwater fish nest building may result in reduced initial year-class strength through warmwater fish nest “dewatering.” Given the differences in geography and altitude among the reservoirs within the area of analysis, warmwater fish spawning and rearing periods vary somewhat among reservoirs analyzed. Although black bass spawning may begin as early as February, or as late as May, in southern and northern California reservoirs, respectively, and may possibly extend to July in some waters, the majority of black bass and other centrarchid spawning in California occurs from March through May (Lee, 1999; Moyle, 2002). However, given the geographical and altitudinal variation among the SWP/CVP and non-Project reservoirs, in order to examine the potential of nest dewatering events to occur, the warmwater fish-spawning period was assumed to extend from March through June. This period encompasses the majority, if not the entire, primary warmwater fish spawning and rearing period for Trinity Lake, as well as the other reservoirs included in this impact analysis.

To assess potential reservoir water surface elevation change-related impacts on the warmwater fish of reservoirs, the following two-phased approach was used. First, the magnitude of change (feet msl) in reservoir water surface elevation occurring each month of the primary spawning period for nest-building fish (March through June) under the proposed Project were determined and compared to that modeled for the bases of comparison. Review of the available literature suggests that, on average, self-sustaining black bass populations in North America experience a nest success (i.e., the nest produces swim-up fry) rate of 60 percent (Friesen, 1998; Goff, 1986; Hunt and Annett, 2002; Hurley, 1975; Knotek and Orth, 1998; Kramer and Smith, 1962; Latta, 1956; Lukas and Orth, 1995; Neves, 1975; Philipp et al., 1997; Raffetto et al., 1990; Ridgway and Shuter, 1994; Steinhart, 2004; Turner and MacCrimmon, 1970).

A study by CDFG, which examined the relationship between reservoir water surface elevation fluctuation rates and nesting success for black bass, suggests that a reduction rate of approximately six feet per month or greater would result in 60 percent nest success for largemouth bass and smallmouth bass (Lee, 1999).

Therefore, a decrease in reservoir water surface elevation of six feet or more per month was selected as the threshold beyond which spawning success of nest-building, warmwater fish could potentially result. To evaluate impacts on largemouth bass, smallmouth bass, and ultimately warmwater fish in general, the net number of times that reservoir reductions of six feet or more per month could occur under the NODOS Project alternatives was compared to the number of occurrences that were simulated under the bases of comparison.

Criteria for reservoir water surface elevation increases (nest flooding events) have not been developed by CDFG. Because of overall reservoir fishery benefits (e.g., an increase in the availability of littoral habitat for warmwater fish rearing), greater reservoir elevations that would be associated with rising water levels would offset negative impacts due to nest flooding (Lee, 1999). Therefore, the likelihood of spawning-related impacts from nest flooding is not addressed for reservoir fisheries.

Water temperatures in Trinity Lake and other reservoirs potentially impacted by the NODOS Project alternatives could change as a result of altered operations. However, the small changes in lake temperatures that could occur would not be expected to adversely affect the lakes' warmwater fisheries. Any changes in water temperatures in the reservoirs are not anticipated to affect spawning warmwater game fish nesting success due to the wide water temperature ranges in which they spawn. For example, black basses reportedly spawn between approximately 55ºF and 75ºF (Graham and Orth, 1986; Moyle, 2002). Due to their wide range in water temperature tolerance, it is anticipated that during the nesting season (March through June) there would be an adequate amount of habitat with suitable water temperatures in which warmwater game fish could successfully spawn and no evaluation of water temperatures in Trinity Lake or other SWP and CVP reservoirs was conducted for warmwater game fishes.

Because reservoir warmwater fish species use the warm upper layer of the reservoir and nearshore littoral habitats, seasonal changes in reservoir storage, as it affects reservoir water surface elevation, and the rates at which water surface elevation change during specific periods of the year, can directly affect warmwater fish nesting and spawning success. The period of analysis was March through June (spawning). A decrease in reservoir water surface elevation of six feet or more per month was selected as the threshold beyond which spawning success of nest-building, warmwater fish could potentially result in long-term population declines.

To assess potential reservoir water surface elevation change-related impacts on the warmwater fish, the following approach was used.

- The magnitude of change (feet msl) in reservoir water surface elevation occurring each month of the primary spawning period for nest-building fish (March through June) under the alternatives were determined and compared to that modeled for the bases of comparison.
- To evaluate impacts on warmwater fish, the number of times that reservoir reductions of six feet or more per month could occur under the alternatives was compared to the number of occurrences that were modeled under the bases of comparison.

12B.2.5.2 Trinity River and Klamath River downstream of the Trinity River

Trinity River diversions historically represented 17 percent of the average flows in the Sacramento River (Reclamation, 2008). However, since implementing the Trinity River Mainstem Fishery Restoration Record of Decision (ROD) (DOI, 2000) flows in 2000, the Trinity River diversions have provided a smaller proportion (than 17 percent) of the average flows to the Sacramento River. Operations under the proposed Project are not expected to substantially alter instream flows, water temperatures, or habitat conditions for fish inhabiting the Trinity River. However, as part of the NODOS Project impact assessment, modeling results were reviewed and an analysis conducted on seasonal flows, water temperatures, and habitat availability in the Trinity River.

Fish Species of Primary Management Concern

The mainstem Trinity River, downstream of Lewiston Reservoir, supports several anadromous and non-anadromous fish species including native spring- and fall-run Chinook salmon (*Oncorhynchus tshawytscha*), Southern Oregon/Northern California Coast Coho salmon (*O. kisutch*), and winter and summer steelhead (*O. mykiss sp.*). In addition, coastal cutthroat trout (*O. clarki clarki*) are found in the Lower Klamath River Basin/Coastal Area. Native non-salmonid anadromous species found in the Trinity River Basin include green sturgeon, white sturgeon, and Pacific lamprey (USFWS et al., 2004).

Non-anadromous, native fish species in the Trinity River Basin include gamefish such as resident rainbow trout, and non-game fish such as speckled dace, Klamath smallscale sucker, and coast range sculpin. These non-anadromous, native fish species existed in the pre-dam Trinity River and are presumably adapted to pre-dam conditions, although the factors affecting their populations are not well understood (USFWS et al., 2004).

Non-native fish species found in the Trinity River Basin include striped bass, American shad, three-spined stickleback, brown trout, and brook trout. Striped bass have only recently been reported to occur in the Trinity River basins. However, reports of striped bass are rare. American shad are known to occur in the lowermost portions of the Trinity River Basin, but are primarily found in the Lower Klamath River Basin. Anadromous brown trout are currently limited to the upper portions of the river, although CDFG, on occasion, captures brown trout in the estuary during the spring. Brook trout provide a significant sport fishery in the tributary streams and high elevation reservoirs of the Trinity River Basin. Its life cycle and habitat requirements are similar to that of brown trout. The abundance of all of these species in the Trinity and Lower Klamath river basins is unknown. Factors that affect their abundance in the Trinity and Lower Klamath river basins are generally unknown, but may be similar to those factors affecting native anadromous species (USFWS et al., 2004). For purposes of this impact assessment, the following species (Table 12B-3) were evaluated for the Trinity River.

American shad and striped bass were not considered for detailed evaluation in the Trinity River impact assessment for several reasons. Striped bass are rarely reported in the system and, therefore do not represent a recreationally or commercially important fishery. Because the species is not native and does not represent a substantial fishery, no further evaluation under NEPA and CEQA is required. American shad also are not native and are reported to be prevalent only from the lower reaches of the Klamath River. Therefore, within the Trinity River, American shad do not represent a recreationally or commercially important fishery. Additionally, it is anticipated that the expected minor changes in Trinity Reservoir operations, that would result in minor changes in Trinity River flows would result in little and few, if any, changes in flows in the Lower Klamath River. For these reasons, American shad were not evaluated in detail for the Trinity River.

Table 12B-3
Fish Species of Primary Management Concern Evaluated for the Trinity River and Klamath River downstream of the Trinity River

Common Name	Status
• Southern Oregon/Northern California Coast Coho salmon	Federally and State threatened
• Upper Klamath-Trinity River spring-run Chinook salmon	Not Warranted for Listing State species of special concern Trinity River is EFH
• Upper Klamath-Trinity River fall-run Chinook salmon	Not Warranted for Listing Recreational and/or commercial importance
• Klamath Mts. Province ESU Steelhead (winter- and summer-run)	Not Warranted for Listing State species of special concern (summer-run)
• Northern DPS of North American green sturgeon	Federal species of concern State species of special concern
• White sturgeon	Recreational and/or commercial importance
• Pacific lamprey	Federal species of concern

Notes:
ESU = evolutionarily significant unit
DPS = distinct population segment
EFH = essential fish habitat

Changes in SWP/CVP operations associated with the NODOS Project alternatives could potentially alter instream flow and seasonal water temperatures in the Trinity River below Lewiston Lake and adversely affect Trinity River fish species. CALSIM II was used to evaluate potential impacts associated with changes in flow. Reclamation's Water Temperature Model was used to assess water temperatures in the Trinity River. The Reclamation Salmon Mortality Model was used to evaluate water temperature-related mortality on fall-run Chinook salmon in the Trinity River.

Species-Specific Analytical Approach

To evaluate the potential environmental consequences of the NODOS Project alternatives on anadromous salmonid habitat in the Trinity River Basin, Trinity River flow and water temperature operational influences were addressed. Trinity River flow and water temperature magnitude, frequency, and duration are controlled by operations of Trinity Lake and Lewiston Dam. The modeling results from CALSIM II were used in this analysis to compare the NODOS Project alternatives to the bases of comparison to determine the incremental effects of implementing each alternative. Comparisons were made relative to Existing Conditions and the No Project/No Action Alternative.

Following the preparation of the *Trinity River Fishery Restoration Final Environmental Impact Statement/Environmental Impact Report (FEIS/EIR)*, NMFS released a Biological Opinion (BO) in October 2000 to evaluate the Preferred Alternative described in the 1999 FEIS/EIR, and the potential effects of implementing the project on Southern Oregon/Northern California Coast Coho salmon, Sacramento River winter-run Chinook salmon, and Central Valley spring-run Chinook salmon (NMFS, 2000). The BO (NMFS, 2000) concluded that the proposed action and cumulative effects of the proposed action were *"not likely to jeopardize the continued existence of Southern Oregon/Northern California Coast Coho salmon, Sacramento River Winter-Run Chinook salmon, Central Valley Spring-run Chinook salmon, or Central Valley Steelhead"*, and is *"not likely to destroy or adversely modify critical habitat for these species"*.

The Record of Decision (ROD) was released in December 2000 (DOI, 2000) which prescribed Trinity River flows for five water-year types: The main elements of the ROD (DOI, 2000) include annual instream flow recommendations below Lewiston Dam to provide physical fish habitat (e.g., species-specific water depths, velocities, and temperature regimes for anadromous salmonids), and to restore the riverine processes that create and maintain the structural integrity and spatial habitat complexity. The ROD (DOI, 2000) requires Reclamation to maintain a total volume ranging from approximately 369,000 acre-feet to 815,000 acre-feet to be released into the Trinity River below Lewiston Dam, depending on water-year type (815,200 acre-feet during extremely wet years, 701,000 acre-feet during wet years, 646,900 acre-feet during normal, 452,600 acre-feet during dry, and 368,600 acre-feet during critically dry). After the 2000 ROD was issued, several legal challenges were made in federal court; ultimately the ROD (DOI, 2000) was upheld by the United States Court of Appeals for the Ninth Circuit.

The Preferred Alternative, as described in the FEIS/EIR and summarized in the 2000 ROD, adopts the recommendations contained in the detailed Trinity River Flow Evaluation Study (TRFES) that was completed by the USFWS, in conjunction with the Hoopa Valley Tribe. The TRFES recommends a year-round baseflow of 300 cfs to provide spawning and rearing habitat for salmon and steelhead, a release of 450 cfs from July 1 to October 14 to meet the summer/fall temperature objectives, spring/summer seasonal releases to provide improved conditions for smolt outmigration, and releases ranging between 2,000 to 8,500 cfs to meet physical river processes that create and maintain river habitats (USFWS and Hoopa Valley Tribe, 1999).

Generally, flows in the Trinity River are governed by releases from Trinity Lake via Lewiston Reservoir. CALSIM II simulated flows in the Trinity River, including the flow requirements prescribed in the Trinity River Mainstem Fishery Restoration ROD (DOI, 2000) are described in Appendix 6A and Appendix 6B.

Water temperatures in the Trinity River could be influenced by changes in coldwater pool availability within Trinity Lake.

The potential for changes in flows and water temperatures resulting from implementation of the NODOS Project alternatives to impact fish resources of the Trinity River are dependent on the species-specific habitat and physiological requirements. Therefore, species-specific flow and water temperature assessment methodologies for the Trinity River fisheries assessment are discussed below.

Coho Salmon

Trinity River naturally-produced Southern Oregon/Northern California Coast (SONCC) Coho salmon are listed as threatened under the federal and State ESA. Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (September through January)
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork
- Adult spawning, embryo incubation, and initial rearing (October through May)
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork Trinity River

- Juvenile rearing and emigration (year-round)
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork Trinity River
- Smolt emigration (February through June)
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork Trinity River

Potential flow-related impacts determinations for fish species in the Trinity River were based on an evaluation of the frequency and magnitude of change in modeled monthly mean flow for all NODOS Project alternatives, relative to the bases of comparison. A decrease in monthly modeled flow of 10 percent or greater was identified as an appropriate criterion to evaluate flow changes in the *Trinity River Mainstem Fishery Restoration Draft EIS/EIR* (USFWS et al., 1999) and other various environmental documents.

To assess the potential flow- and water temperature-related impacts of implementation of the NODOS Project alternatives on SONCC Coho salmon, relative to the bases of comparison, the above specified locations, life stages, and periodicities were evaluated using: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Upper Klamath-Trinity Rivers Chinook Salmon ESU

The Upper Klamath-Trinity Rivers Chinook salmon ESU includes two temporally distinct populations, fall- and spring-run. NMFS (1998) (63 FR 11482) determined that neither of these runs are warranted for ESA listing. However, the spring-run Upper Klamath-Trinity rivers Chinook salmon population is listed 12, 2001 NMFS announced a 90-day status review for a petition to list Chinook salmon in the Upper Klamath and Trinity river basins as threatened or endangered and designate critical habitat under the ESA (NMFS, 2011). Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison, were conducted separately for Trinity River fall- and spring-run Chinook salmon life stages.

Trinity River Fall-Run Chinook Salmon

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and No Project/No Action Alternative), were conducted to identify potential impacts on fall-run Chinook salmon in the Trinity River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (August through October)
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork Trinity River
- Adult spawning and embryo incubation (October through June)
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork Trinity River
- Juvenile rearing and emigration (January through October)
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork Trinity River

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on fall-run Chinook salmon in the Trinity River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Trinity River Spring-Run Chinook Salmon

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on spring-run Chinook salmon in the Trinity River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (April through September);
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork Trinity River
- Adult spawning and egg incubation (August through November)
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork Trinity River
- Juvenile rearing and emigration (year-round)
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork Trinity River
- Smolt emigration (February through July)
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork Trinity River

The assessment of potential flow- and water temperature-related impacts of implementation of the NODOS Project alternatives on spring-run Chinook salmon in the Trinity River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Steelhead (Winter and Summer)

The Trinity River is reported to support two runs of steelhead with alternate adult immigration periodicity, but overlapping spawning, rearing, and emigration timing. Because adult summer-run steelhead enter the Trinity River and hold in deep pools primarily during the summer months prior to spawning during the following late winter/early spring, two periods of adult immigration and holding were assessed for steelhead.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on steelhead (winter- and spring-run) in the Trinity River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding for winter-run steelhead (August through April)
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork Trinity River
- Adult immigration and holding for summer-run steelhead (June through August)
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork Trinity River
- Adult spawning and egg incubation (December through June)
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork Trinity River

- Juvenile rearing (year-round)
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork Trinity River
- Smolt emigration (February through July)
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork Trinity River

The assessment of potential flow- and water temperature-related impacts of implementation of the NODOS Project alternatives on steelhead (winter- and spring-run) in the Trinity River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Green Sturgeon

The Trinity River has been identified by NMFS as a spawning river for the Pacific-northern Distinct Population Segment of green sturgeon (*Acipenser medirostris),* which are identified by NMFS as a Species of Concern (74 FR 52084). While the exact numbers of green and white sturgeon produced in the Trinity and Klamath river basins is generally unknown, USFWS et al. (2004) reports that these basins contain the largest spawning population of adult green sturgeon in California and a small run of adult white sturgeon. Spawning green sturgeon are known to occur in the mainstem upstream to at least as far as Gray's Falls (RM 43) near Burnt Ranch, while juvenile green sturgeon have been captured during annual surveys in the mainstem Trinity River as far upstream as Big Bar (USFWS et al., 2004).

Little is known regarding instream flow requirements and suitable habitat requirements for sturgeon in the Trinity River. However, life history information and habitat requirements have been established in other river systems.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on green sturgeon in the Trinity River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (February through November)
  - Flows below Lewiston Dam
  - Water temperatures at North Fork Trinity River
- Adult spawning (May through August)
  - Flows below Lewiston Dam
  - Water temperatures below at North Fork Trinity River
- Juvenile rearing and emigration (year-round)
  - Flows below Lewiston Dam
  - Water temperatures at North Fork Trinity River

The assessment of potential flow- and water temperature-related impacts of implementation of the NODOS Project alternatives on green sturgeon in the Trinity River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions. For the purposes of this analysis, it was additionally assumed that any benefits or adverse impacts on naturally produced native anadromous salmonid species in the Trinity River would be the same as those for native anadromous sturgeon.

White Sturgeon

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on white sturgeon in the Trinity River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (November through May)
  - Flows below Lewiston Dam
  - Water temperatures at North Fork Trinity River
- Adult spawning (February through May)
  - Flows below Lewiston Dam
  - Water temperatures at North Fork Trinity River
- Juvenile rearing and emigration (year-round)
  - Flows below Lewiston Dam
  - Water temperatures at North Fork Trinity River

The assessment of potential flow- and water temperature-related impacts of implementation of the NODOS Project alternatives on white sturgeon in the Trinity River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Pacific Lamprey

Pacific lamprey (*Entosphenus tridentatus*) are an anadromous species native to the Trinity River. Lampreys in general have a somewhat unique life history because unlike any other fish species they have an “ammocoete” larval lifestage. However, little is known regarding Pacific lamprey upstream distribution, instream flow requirements, and suitable habitat requirements in the Trinity River.

The USFWS and Hoopa Valley Tribe (1999) report that Pacific lamprey immigrate sporadically through the summer, gaining momentum into the winter months prior to spawning during the snowmelt runoff period in spring/early-summer. Eggs are deposited in pits excavated in gravel and cobble substrates, which are typically associated with run and riffle habitats similar to salmon spawning areas (USFWS and Hoopa Valley Tribe, 1999). Ammocoetes drift downstream into slow-water habitats, where they burrow into sand or silt for as long as five years before emergence and emigration (USFWS et al., 2004; USFWS and Hoopa Valley Tribe, 1999). Given the lack of lifestage-specific temporal information, the adult immigration, spawning, and embryonic development life stages were separately analyzed from other lamprey life stages.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on Pacific lamprey in the Trinity River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration (January through June)
  - Flows below Lewiston Dam
- Adult spawning and embryo incubation (January through August)
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork Trinity River
- Ammocoete rearing and juvenile outmigration (year-round)
  - Flows below Lewiston Dam
  - Water temperatures below Lewiston Dam, at Douglas City, and at North Fork Trinity River

The assessment of potential flow- and water temperature-related impacts of implementation of the NODOS Project alternatives on Pacific lamprey in the Trinity River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions. For the purposes of this analysis, it was additionally assumed that any benefits or adverse impacts on naturally produced native anadromous salmonid species in the Trinity River would be the same as those for native anadromous Pacific lamprey.

12B.2.5.3 Clear Creek

Water operations in the Clear Creek, including diversions to Clear Creek from the Trinity River, are components of the integrated operations of the Trinity River Division CVP system. From Whiskeytown Lake, water is released through the Spring Creek Power Conduit to the Spring Creek Powerplant and into Keswick Reservoir (up to 2,000 cfs). All of the water diverted from the Trinity River, plus a portion of Clear Creek flows, is diverted through the Spring Creek Power Conduit into Keswick Reservoir to assist in meeting water temperature objectives in the Sacramento River (Reclamation, 2008; Western Shasta RCD, 1996).

Additionally, a Memorandum of Agreement (MOA) between Reclamation and CDFG, implemented in 1960, established minimum flows to be released to Clear Creek at Whiskeytown Dam. In 1963 a release schedule for Whiskeytown Dam was developed by USFWS and implemented, but never finalized. However, Whiskeytown Dam has operated according to the proposed schedule since May 1963. Reclamation's operations follow the CVPIA AFRP guidelines (USFWS, 2001) which, for Clear Creek, are: "*200 cfs October 1 to June 1 from Whiskeytown dam for spring-run, fall-run, and late fall-run salmon spawning, egg incubation, emigration, gravel restoration, spring flushing and channel maintenance; and release 150 cfs or less, from July through September to maintain < 60°F temperatures in stream sections utilized by spring-run Chinook salmon.*" Flows exceeding 500 cfs in Clear Creek are the result of uncontrolled runoff or pulse flows prescribed through collaboration with fishery agencies for the benefit of fish and habitat (Reclamation, 2008). USFWS separates fall-run Chinook salmon adults from spring-run Chinook salmon adults holding in the upper reaches of Clear Creek with the use of a picket weir located at RM 8.0 from August 1 to November 1 to prevent the hybridization of spring- and fall-run Chinook salmon. After November 1, fall-run Chinook salmon have access to the entire river for spawning.

Consistent with Central Valley Project Improvement Act (CVPIA) (b)(2), Reclamation can augment flows on Clear Creek with CVP water to provide actual in-stream flows to ESA-listed fish below Whiskeytown Dam greater than the flows that would have occurred under the 1963 proposed release schedule (pre-CVPIA). As stated in Reclamation (2008), augmentation of Clear Creek flows is usually in consideration of providing adequate flows and water temperatures for passage and spawning during the summer months in most years for steelhead and in late summer months for spring-run Chinook salmon.

Clear Creek generally receives the same temperature water as the water released to the Sacramento River, which has generally provided suitable conditions for Clear Creek fish species (Reclamation, 2008). Since 1999, mean daily water temperatures have been maintained at 60°F or less down to the USGS gage at Igo (RM 10.9) consistent with the 2004 NMFS Opinion for steelhead over summering requirements (NMFS, 2009a). Although water temperatures may exceed 60°F downstream of the Igo Gage, mean daily temperatures near the confluence with the Sacramento River (RM 1.7) rarely exceed 70°F (USFWS, 2007a). Since 2002, Reclamation has managed releases to meet a daily average water temperature of 56°F at the Igo Gauge (four miles downstream of Whiskeytown Dam) from September 15 through October 30, to provide for spring-run Chinook salmon spawning. In 2004, an additional daily average temperature of 60°F was implemented from June 1 to September 15 to protect over-summering juvenile steelhead and holding adult spring-run Chinook salmon.

Fish Species of Primary Management Concern

Fish species found in Clear Creek include three runs of Chinook salmon from the Sacramento River watershed, including spring-run, fall-run, and late fall-run Chinook salmon, and steelhead and rainbow trout (*O. mykiss*) (anadromous and resident forms). Although winter-run Chinook salmon have been reported to inhabit Clear Creek, a naturally self-sustaining population of winter-run Chinook salmon does not exist in Clear Creek (USFWS, 2003). USFWS (2003) reports non-anadromous native species reported found in Clear Creek include hardhead, lamprey, cottid (sp) fry, riffle sculpin, and Sacramento pike minnow. For purposes of this impact assessment, the following species (Table 12B-4) were evaluated for the Trinity River.

Table 12B-4
Fish Species of Primary Management Concern Evaluated for Clear Creek

Common Name	Status
• Central Valley spring-run Chinook salmon	Federally and State threatened
• Central Valley fall-/late fall-run Chinook salmon	Federal species of concern State species of special concern Recreational and/or commercial importance
• Central Valley steelhead	Federally threatened Recreational and/or commercial importance
• Pacific lamprey	Federal species of concern
• River lamprey	State species of special concern
• Hardhead	State species of special concern
• California roach	State species of special concern

Changes in SWP/CVP operations associated with the NODOS Project alternatives could potentially alter instream flow and seasonal water temperatures in Clear Creek below Whiskeytown Dam and adversely affect Clear Creek fish species. CALSIM II was used to evaluate potential impacts associated with changes in flow. Reclamation's Water Temperature Model was used to assess water temperatures.

Species-Specific Analytical Approach

Trinity River Division operations divert water through Whiskeytown Lake, which become a part of the Clear Creek releases. Due to the diversions of Trinity River water, flows are greater during parts of the year and temperatures are cooler than what was present in Clear Creek prior to the construction of Whiskeytown Dam. There is no temperature control device (TCD) on Whiskeytown Dam, although a temperature control curtain reduces mixing of cold water near the dam. Therefore, water temperature can only be controlled by changing releases.

The potential for changes in flows and water temperatures resulting from implementation of the NODOS Project alternatives to impact fish resources of Clear Creek are dependent on the species-specific habitat and physiological requirements. Therefore, species-specific flow and water temperature assessment methodologies for the Clear Creek fisheries assessment are discussed below.

Spring-run Chinook Salmon

The Central Valley spring-run Chinook salmon ESU is federally and State listed as threatened. NMFS (2005) designated critical habitat for the ESU.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on spring-run Chinook salmon in Clear Creek for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (April through October)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek
- Adult spawning and embryo incubation (August through March)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek
- Juvenile rearing (August through April)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek
- Juvenile emigration (May through January)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek

The assessment of potential impacts of implementation of the NODOS Project alternatives on Central Valley spring-run Chinook salmon in Clear Creek, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Fall and Late Fall-run Chinook Salmon

Fall-run and late fall-run Chinook salmon are both present in lower Clear Creek and use the creek during the fall, winter and spring when water temperatures are relatively cool. Fall-run Chinook salmon adults migrate into Clear Creek from September to December and peak in October. The peak outmigration of juveniles as measured at USFWS rotary screw traps occurs between mid-January and May.

Late fall-run Chinook salmon adults migrate from December to April and peak during January. Spawning occurs from January through April. The peak outmigration of juveniles as measured at the USFWS rotary screw trap occurs from mid-April through May. Some late fall-run Chinook juveniles may remain in stream through June, depending on flow and water temperature conditions that occur during the season.

The impact assessment for fall-/late fall-run Chinook salmon generally followed the methodologies previously described for Central Valley spring-run Chinook salmon. Modifications to the methodology were made in consideration of fall-/late fall-run Chinook salmon life stages and periodicities.

Although fall- and late fall-run Chinook salmon are considered part of the same ESU, their life stages were evaluated separately because distinct differences in timing exist.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on fall- and late fall-run Chinook salmon in Clear Creek for each of the following life stages, life history periodicities, and modeled locations:

Fall-run Chinook Salmon

- Adult immigration (September through December)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek
- Adult spawning and embryo incubation (September through March)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek
- Juvenile rearing (October through May)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek
- Juvenile emigration (January through June)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek

Late Fall-run Chinook Salmon

- Adult immigration (December through April)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek
- Adult spawning and embryo incubation (January through April)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek
- Juvenile rearing (February through May)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek

- Juvenile emigration (April through June)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek

The assessment of potential impacts of implementation of the NODOS Project alternatives on Central Valley fall- and late fall-run Chinook salmon in Clear Creek, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Central Valley Steelhead

BLM (2008) reports that both anadromous (steelhead) and non-anadromous (rainbow trout) forms of *O. mykiss* spawn in Clear Creek. Rainbow trout may reside solely in Clear Creek or may migrate into Clear Creek from the Sacramento River.

Most steelhead adults are expected to migrate upstream in Clear Creek during December through March to spawn. Spawning occurs in Clear Creek from late December through May with a peak in January. Timing of juvenile emergence in lower Clear Creek ranges from February through July with a peak in April and May. Most fry will likely remain in upstream areas near where they were spawned, at least through the early rearing period until early summer. Generally, steelhead exhibit a stream type life history with at least some juvenile rearing occurring year-round and yearling outmigration occurring concurrent with young-of-year downstream movement.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on steelhead in Clear Creek for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration (August through March)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek
- Adult spawning and embryo incubation (December through May)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek
- Juvenile rearing and emigration (year-round)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek

The assessment of potential impacts of implementation of the NODOS Project alternatives on Central Valley steelhead in Clear Creek, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Pacific Lamprey

Earley et al., (2008) reported capturing unidentified lamprey fry during winter and early spring 2002 and 2003 in Clear Creek. Further, Earley et al. (2008) reported that a portion of these unidentified lamprey fry likely were Pacific lamprey. However, little is known about Pacific lamprey use of Clear Creek. Therefore, generalized life history periodicity was used in this analysis.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on Pacific lamprey in Clear Creek for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration (January through June)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
- Adult spawning and embryo incubation (January through August)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek
- Ammocoete rearing and emigration (year-round)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek

The assessment of potential impacts of implementation of the NODOS Project alternatives on Pacific lamprey in Clear Creek, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

River Lamprey

Earley et al. (2008) reported capturing unidentified lamprey fry during winter and early spring 2002 and 2003 in Clear Creek. Further, Earley et al. (2008) reported that a portion of these unidentified lamprey fry likely were river lamprey. However, little is known about river lamprey use of Clear Creek. Therefore, generalized life history periodicity was used in this analysis.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on river lamprey in Clear Creek for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration (September through June)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
- Adult spawning and embryo incubation (February through July)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek
- Ammocoete rearing and emigration (year-round)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek

The assessment of potential impacts of the NODOS Project alternatives on river lamprey in Clear Creek, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Hardhead

Hardhead generally occur in large, undisturbed low- to mid-elevation rivers and streams throughout the Sacramento River system (Moyle, 2002). Earley et al. (2008) reported that, during juvenile salmonid monitoring studies conducted during 2002 and 2003, the most captured non-salmonid taxon was hardhead. However, little is known about specific habitat use and life history characteristics, including life stage periodicity, in Clear Creek. Therefore, generalized life history periodicity was used in this analysis.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on hardhead in Clear Creek for each of the following life stages, life history periodicities, and modeled locations:

- Adults and other life stages (year-round)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek
- Adult spawning (April through June)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek

The assessment of potential impacts of implementation of the NODOS Project alternatives on hardhead in Clear Creek, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

California Roach

The California roach is generally found in small, warm intermittent streams throughout the Sacramento River drainage, and is most abundant in mid-elevation streams in the Sierra foothills (Moyle, 2002). However, roach are habitat generalists, also being found in cold, well-aerated clear streams, in human-modified habitats and in the main channels of rivers (Moyle, 2002; Moyle et al., 1982). Little is known about specific California roach habitat use and life history characteristics, including life stage periodicity, in Clear Creek. Therefore, generalized life history periodicity was used in this analysis.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on California roach in Clear Creek for each of the following life stages, life history periodicities, and modeled locations:

- Adults and other life stages (year-round)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek
- Adult spawning (March through June)
  - Flows below Whiskeytown Dam (releases to Clear Creek)
  - Water temperatures below Whiskeytown Dam, at Igo, and at the mouth of Clear Creek

The assessment of potential impacts of implementation of the NODOS Project alternatives on California roach in Clear Creek, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

12B.2.6 Sacramento River

As described in the Affected Environment section of Chapter 12 Aquatic Biological Resources, the Sacramento River Watershed in the Secondary Study Area includes Shasta Lake and the Sacramento River.

12B.2.6.1 Shasta Lake

Shasta Lake was formed when Shasta Dam was constructed in 1935 through 1945, and its filling in 1948 impounded the Pit, McCloud, and Sacramento rivers. Shasta Lake has a storage capacity of 4.5 million acre-feet (MAF), a capacity equal to Folsom and Oroville reservoirs combined. It has 365 miles of shoreline and a surface area of 30,000 acres. When full, the surface water elevation is 1,067 feet above mean sea level (msl) and its maximum depth is 517 feet.

Shasta Lake provides an outstanding fishery, with both coldwater and warmwater species commonly pursued by recreational anglers. Thermal stratification, which occurs in Shasta Lake annually between April and November, establishes a warm surface water layer (epilimnion), a middle water layer characterized by decreasing temperature with increasing depth (metalimnion or thermocline), and a bottom, coldwater layer (hypolimnion) within the reservoir. In terms of aquatic habitat, the warm epilimnion of Shasta Lake provides habitat for warmwater fishes, whereas the reservoir's lower metalimnion and hypolimnion form a "coldwater pool" that provides habitat for coldwater fish species throughout the summer and fall portions of the year. Hence, Shasta Lake supports a "two-story" fishery during the stratified portion of the year (April through November), with warm-water species using the upper, warm-water layer and coldwater species using the deeper, colder portion of the reservoir.

Coldwater species include rainbow trout (*O. mykiss*), brown trout (*Salmo trutta*), landlocked white sturgeon (*Acipenser transmontanus*), and landlocked Coho salmon (*O. kisutch*); warmwater species include smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), spotted bass (*Micropterus punctulatus*), black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), channel catfish (*Ictaluris punctatus*), white catfish (*Ameiurus catus*), and brown bullhead (*Ameiurus nebulosus*). Other, nongame species in Shasta Lake include hardhead, golden shiner (*Notemigonus crysoleucus*), threadfin shad (*Dorosoma pentenense*), common carp (*Cyprinus carpio carpio*), Sacramento sucker (*Catostomus occidentalus occidentalus*), and Sacramento pikeminnow (*Ptychocheilus grandis*).

Implementation of the NODOS Project alternatives could result in alterations to storage levels and water surface elevations in Shasta Lake. Differences in storage and water surface elevations (and fluctuations) potentially could affect reservoir fish species. Parameters used to determine potential impacts included:

- End-of-month reservoir storage levels under the alternatives compared to bases of comparison
- End-of-month water surface elevations under the alternatives compared to bases of comparison

The following guilds of species (Table 12B-5) were evaluated for Shasta Lake:

Table 12B-5
Fish Species of Primary Management Concern Evaluated for Shasta Lake

Common Name	Status
• Coldwater Fisheries (e.g., trout)	Recreational importance
• Warmwater Fisheries (e.g., largemouth bass, striped bass, crappie, bluegill, bullhead, catfish, shad, yellow perch)	Recreational importance

Coldwater Fish Species

Reduced reservoir storage could reduce the reservoir's coldwater pool volume, thereby reducing the quantity of habitat available to coldwater fish species.

Substantial reductions in reservoir storage are considered to result in substantial reductions in coldwater pool volume and, therefore, in habitat availability for coldwater fish. Impacts on coldwater fish species in Shasta Lake were identified by evaluating changes in reservoir storage as an indicator of cold water pool availability from April through November as described for Trinity Lake, above. Specifically, to assess the potential impacts of implementation of the NODOS Project alternatives on coldwater fisheries resources in Shasta Lake, the following outputs for end-of-month storage from April through November were evaluated: (1) long-term averages; (2) averages by water year type; and (3) the cumulative probability distributions.

Warmwater Fish Species

Because reservoir warmwater fish species (including largemouth bass, smallmouth bass, spotted bass, green sunfish, bluegill, crappie, and catfish) use the warm upper layer of the reservoir and nearshore littoral habitats, seasonal changes in reservoir storage, as it affects reservoir water surface elevation, and the rates at which water surface elevation change during specific periods of the year, can directly affect warmwater fish nesting and spawning success. Reduced water surface elevations can potentially reduce the availability of nearshore littoral habitats used by warmwater fish for rearing, thereby potentially reducing rearing success, and subsequent year-class strength. In addition, decreases in reservoir water surface elevation during the primary spawning period for warmwater fish nest building may result in reduced initial year-class strength through warmwater fish nest "dewatering."

To assess the potential impacts of implementation of the NODOS Project alternatives on warmwater fisheries resources in Shasta Lake, the approach described for Trinity Lake, above was used.

12B.2.6.2 Sacramento River

Flows in the upper Sacramento River are primarily regulated by Shasta Dam and are re-regulated 15 miles downstream at Keswick Dam. The watershed above Shasta Dam drains approximately 6,650 square miles with an average annual runoff of 5.7 MAF. Shasta Lake has the largest capacity of any reservoir in the state. Annual releases range from 9 MAF in wet years to 3 MAF in dry years. From 1964-1996, Keswick releases averaged 7.3 MAF annually. More recently (1986-1996), Keswick annual releases averaged 5.9 MAF.

Shasta Lake releases, and therefore, Sacramento River flow, often are governed by water temperature requirements below Keswick Dam for April through October and an end-of-September minimum carryover storage for Shasta Lake of 1.9 MAF to protect Sacramento River winter-run Chinook salmon. To meet the temperature objectives, a dynamic evaluation of ambient air temperature, weather forecasts, water temperature at the release point, and release rate occurs. Determination of the appropriate release rate is often made based on the temperature of the water released rather than the rate needed to support CVP operations. Generally, it takes higher releases to meet water temperature targets with warmer water and lower releases with colder water. The coldwater pool in the reservoir is essentially a function of the volume of water in the reservoir. More cold water is available when the reservoir is full; less is available as the reservoir is drawn down. In years when CVP facilities cannot be operated to meet required temperature and storage objectives, Reclamation re-initiates consultation with NMFS.

Fish Species of Primary Management Concern

The Sacramento River below Keswick Dam is utilized by a number of fish species of primary management concern, either as habitat during one or more of their life stages, or as a migration corridor to available habitat in the upper Sacramento River and its tributaries. Changes in SWP/CVP operations under the NODOS Project alternatives could potentially alter seasonal flows and water temperatures in the Sacramento River, which in turn could affect the relative habitat availability for fish species that are present in the Sacramento River. For these reasons, species-specific impact assessments were conducted for the following species (Table 12B-6) for the Sacramento River:

Table 12B-6
Fish Species of Primary Management Concern Evaluated for the Sacramento River

Common Name	Status
• Sacramento River winter-run Chinook salmon	Federally and State endangered
• Central Valley spring-run Chinook salmon	Federally and State threatened
• Central Valley fall-/late fall-run Chinook salmon	Federal species of concern State species of special concern Recreational and/or commercial importance
• Central Valley steelhead	Federally threatened Recreational and/or commercial importance
• Southern DPS of North American green sturgeon	Federally threatened State species of special concern
• White sturgeon	Recreational and/or commercial importance
• Hardhead	State species of special concern
• Pacific lamprey	Federal species of concern
• River lamprey	State species of special concern
• Sacramento splittail	State species of special concern
• California roach	State species of special concern
• Warmwater game fish*	Recreational and/or commercial importance
• American shad	Recreational and/or commercial importance
• Striped bass	Recreational and/or commercial importance

*Largemouth bass were evaluated as an indicator species in this DEIR/EIS analysis to reflect potential Project-related impacts on warmwater game fishes

Note:
DPS = distinct population segment

Species-Specific Analytical Approach

The potential for changes in flows and water temperatures resulting from implementation of the NODOS Project alternatives to impact fish resources of the Sacramento River are dependent on the species-specific habitat and physiological requirements. Therefore, species-specific flow and water temperature assessment methodologies for the Sacramento River fisheries assessment are discussed below.

Winter-run Chinook Salmon

The upper Sacramento River is the only spawning area used by winter-run Chinook salmon, although occasional strays have been reported in Battle and Clear creeks. Since fish passage was improved in 2001 at the ACID Dam, winter-run Chinook salmon spawning has shifted upstream. The majority of winter-run Chinook salmon in recent years (i.e., >50% since 2007) spawn in the area from Keswick Dam downstream to the ACID Dam (approximately 5 miles) (Reclamation, 2008).

The Biological Opinion for winter-run Chinook salmon and the NMFS Biological Opinion on the Long-term Operations of the CVP and SWP provide flow criteria for the Sacramento River below Keswick Dam (NMFS, 2009a). No specific flow requirements have been identified for other fish species in the upper Sacramento River, or for fish in the lower Sacramento River. Therefore, potential flow-related impacts determinations for fish species in the upper Sacramento River, or for the lower Sacramento River, are based on an evaluation of the frequency and magnitude of change in modeled monthly mean flow, relative to the bases of comparison. A change in monthly flow of 10 percent or greater has been previously identified by various environmental documents as an appropriate criterion to evaluate flow changes.

Potential water temperature-related impacts on winter-run Chinook salmon were evaluated through distinct assessments, all of which focused on distinct life stages and the respective life history periodicities, described below.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on winter-run Chinook salmon in the Sacramento River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (December through July)
  - Flows below Keswick Dam, below Red Bluff Diversion Dam, at Freeport and at Rio Vista
  - Water temperatures below Keswick Dam, below Red Bluff Diversion Dam, below the Feather River confluence, and at Freeport
- Adult spawning, embryo incubation, and initial rearing (April through August)
  - Flows below Keswick Dam and at Bend Bridge
  - Water temperatures below Keswick Dam, at Ball's Ferry, at Jelly's Ferry, and at Bend Bridge
- Juvenile rearing and emigration (July through April)
  - Flows below Keswick Dam, below Red Bluff Diversion Dam, at Verona, at Freeport, and at Rio Vista
  - Water temperatures below Keswick Dam, below Red Bluff Diversion Dam, below the Feather River confluence and at Freeport

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on Sacramento River winter-run Chinook salmon, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

In addition to evaluating flows and water temperatures to assess potential impacts on winter-run Chinook salmon habitat, the following evaluations also were conducted:

- Potential flow-related impacts on winter-run Chinook salmon spawning habitat availability (WUA) was evaluated by comparing the monthly percentage of maximum WUA occurring under the NODOS Project alternatives, relative to the bases of comparison
- Total early life stage mortality was evaluated using the Reclamation Salmon Mortality Model
- Population mortality and production potential were evaluated using SALMOD
- Population survival and female spawner abundance were evaluated using IOS

Spring-run Chinook Salmon

NMFS designated critical habitat for the Central Valley spring-run Chinook salmon ESU on September 2, 2005. Most spring-run Chinook salmon are believed to rear in the upper Sacramento River and tributaries during the winter and spring, and emigrate as juveniles or smolts. It has been reported that some spring-run Chinook salmon emigrate from natal streams soon after emergence during the winter and early-spring (NMFS, 2004), whereas some may spend as long as 18 months in freshwater and move downstream as smolts during the first high flows of the winter from November through January (CDFG, 1998; USFWS, 1995). In the Sacramento River drainage, spring-run Chinook salmon smolt emigration reportedly occurs from October through March (CDFG, 1998). In the Feather River, some spring-run Chinook salmon smolts reportedly emigrate from the Feather River system from October through June (Cavallo, pers. comm., 2004). Because spring-run Chinook salmon smolts reportedly emigrate from the Feather River system from October through June, and are presumably migrating through the lower Sacramento River to more saline environs in the Bay/Delta, the evaluation period for spring-run Chinook salmon juvenile and smolt emigration in the lower Sacramento River was from October through June.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on spring-run Chinook salmon in the Sacramento River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (February through September)
  - Flows below Keswick Dam, below Red Bluff Diversion Dam, at Verona, at Freeport and at Rio Vista
  - Water temperatures below Keswick Dam, below Red Bluff Diversion Dam, below the Feather River confluence, and at Freeport
- Adult spawning embryo incubation, and initial rearing (September through January)
  - Flows below Keswick Dam, at Bend Bridge, and below Red Bluff Diversion Dam
  - Water temperatures below Keswick Dam, at Ball’s Ferry, at Jelly’s Ferry, and at Bend Bridge
- Juvenile rearing and emigration (year-round)
  - Flows below Keswick Dam and below Red Bluff Diversion Dam
  - Water temperatures below Keswick Dam and below Red Bluff Diversion Dam
- Smolt emigration (October through June)
  - Flows below Red Bluff Diversion Dam, at Verona, at Freeport, and at Rio Vista
  - Water temperatures below Red Bluff Diversion Dam, below the Feather River confluence, and at Freeport

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on Central Valley spring-run Chinook salmon in the Sacramento River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

In addition to evaluating flows and water temperatures to assess potential impacts on spring-run Chinook salmon habitat, the following evaluations also were conducted:

- Total early life stage mortality was evaluated using the Reclamation Salmon Mortality Model
- Population mortality and production potential were evaluated using SALMOD

Fall and Late Fall-run Chinook Salmon

The impact assessment for fall-/late fall-run Chinook salmon generally followed the methodologies previously described for Central Valley spring-run Chinook salmon. Modifications to the methodology were made in consideration of fall-/late fall-run Chinook salmon life stages and periodicities.

Although fall- and late fall-run Chinook salmon are considered part of the same ESU, their life stages were evaluated separately because distinct differences in timing exist.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on fall- and late fall-run Chinook salmon in the Sacramento River for each of the following life stages, life history periodicities, and modeled locations:

Fall-run Chinook Salmon

- Adult immigration and holding (July through December)
  - Flows below Keswick Dam, below Red Bluff Diversion Dam, at Verona, at Freeport and at Rio Vista
  - Water temperatures below Keswick Dam, below Red Bluff Diversion Dam, below the Feather River confluence, and at Freeport
- Adult spawning, embryo incubation, and initial rearing (October through January)
  - Flows below Keswick Dam and at Bend Bridge
  - Water temperatures below Keswick Dam, at Ball’s Ferry, at Jelly’s Ferry, and at Bend Bridge
- Juvenile rearing and emigration (December through June)
  - Flows below Red Bluff Diversion Dam, at Verona, at Freeport and at Rio Vista
  - Water temperatures below Red Bluff Diversion Dam, below the Feather River confluence, and at Freeport

Late Fall-run Chinook Salmon

- Adult immigration and holding (October through April)
  - Flows below Keswick Dam, below Red Bluff Diversion Dam, at Verona, at Freeport and at Rio Vista
  - Water temperatures below Keswick Dam, below Red Bluff Diversion Dam, below the Feather River confluence, and at Freeport

- Adult spawning and egg incubation (January through May)
  - Flows below Keswick Dam and at Bend Bridge
  - Water temperatures below Keswick Dam, at Ball's Ferry, at Jelly's Ferry, and at Bend Bridge
- Juvenile rearing and emigration (April through December)
  - Flows below Red Bluff Diversion Dam, at Verona, at Freeport and at Rio Vista
  - Water temperatures below Red Bluff Diversion Dam, below the Feather River confluence, and at Freeport

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on Central Valley fall- and late fall-run Chinook salmon in the Sacramento River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

In addition to evaluating flows and water temperatures to assess potential impacts on winter-run Chinook salmon habitat, the following evaluations also were conducted:

- Total early life stage mortality was evaluated using the Reclamation Salmon Mortality Model
- Population mortality and production potential were evaluated using SALMOD

Steelhead

The impact assessment for steelhead generally followed the methodologies previously described for Sacramento River spring-run Chinook salmon flow, survival, and water temperature-related impacts. Modifications to the methodology were made in consideration of spring-run Chinook salmon life stages and periodicities.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on Central Valley steelhead in the Sacramento River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (August through March)
  - Flows below Keswick Dam, below Red Bluff Diversion Dam, at Verona, at Freeport and at Rio Vista
  - Water temperatures below Keswick Dam, below Red Bluff Diversion Dam, below the Feather River confluence, and at Freeport
- Adult spawning and egg incubation (December through April)
  - Flows below Keswick Dam
  - Water temperatures below Keswick Dam
- Juvenile rearing and emigration (year-round)
  - Flows below Keswick Dam, at Bend Bridge, and below Red Bluff Diversion Dam
  - Water temperatures below Keswick Dam, at Ball's Ferry, at Jelly's Ferry, and below Red Bluff Diversion Dam
- Smolt emigration (October through May)
  - Flows below Keswick Dam, below Red Bluff Diversion Dam, at Verona, at Freeport and at Rio Vista
  - Water temperatures below Red Bluff Diversion Dam, below the Feather River confluence, and at Freeport

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on Central Valley steelhead in the Sacramento River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

In addition to evaluating flows and water temperatures to assess potential impacts on winter-run Chinook salmon habitat, the following evaluations also were conducted:

- Total early life stage mortality was evaluated using the Reclamation Salmon Mortality Model
- Population mortality and production potential were evaluated using SALMOD
- Spawning habitat availability, egg-to-fry survival, redd dewatering, redd scour, juvenile stranding, and juvenile rearing habitat were evaluated using SacEFT

Green Sturgeon

Adult green sturgeon begin their upstream spawning migrations into freshwater during late February with spawning occurring between March and July (NMFS, 2009a). After spawning, adult green sturgeon reportedly may hold over in the upper Sacramento River between RBDD and GCID until December, waiting for an increase in flows prior to moving downstream (NMFS, 2009a). Suitable water temperatures for green sturgeon adult immigration range from 52°F to 59°F, while water temperatures ranging from 61°F to 66°F are reportedly tolerable (NMFS, 2009a). Green sturgeon spawning reportedly occurs in the Sacramento River from April through July, while egg incubation reportedly occurs during April through August (NMFS, 2009a). The upper limit of optimal water temperatures for green sturgeon embryos reportedly ranges from 17°C to 18°C (~63-64°F), while water temperatures greater than 23°C (~73°F) reportedly led to complete mortality of embryos prior to hatching (Van Eenennaam et al., 2005). Suitable water temperatures for green sturgeon spawning and egg incubation reportedly range from 46°F to 57°F, while water temperatures ranging from 57°F to 65°F are tolerable (Mayfield and Cech, 2004; NMFS, 2009a). Green sturgeon larvae may be present in the Sacramento River from April through October (Israel and Klimley, 2008). Green sturgeon larval rearing habitats occur downstream of the China Rapids and Iron Canyon spawning areas (Israel and Klimley, 2008). Optimum water temperatures for green sturgeon larvae reportedly are less than 17°C (~63°F) (Israel and Klimley, 2008). Reproductive success and young-of-year recruitment may be negatively impacted when larvae are exposed to water temperatures greater than 20°C (68 °F) (Israel and Klimley, 2008). Young of the year juvenile green sturgeon may occur within the middle and lower Sacramento River from approximately August through March (Israel and Klimley, 2008). Optimal juvenile green sturgeon water temperatures reportedly range from 59°F to 66°F (15-19°C), while water temperatures of 27°C (81°F) are considered lethal (Israel and Klimley, 2008).

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on the Southern DPS of North American green sturgeon in the Sacramento River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (February through December)
  - Flows below Keswick Dam, at the proposed Delevan Pipeline Intake Facilities, and at Rio Vista
  - Water temperatures below Keswick Dam, at the proposed Delevan Pipeline Intake Facilities, and at Rio Vista

- Adult spawning and embryo incubation (March through August)
  - Flows below Keswick Dam, below Red Bluff Diversion Dam, and at Wilkins Slough
  - Water temperatures below Keswick Dam, and below Red Bluff Diversion Dam

- Juvenile rearing and emigration (year-round)
  - Flows below Red Bluff Diversion Dam, at the proposed Delevan Pipeline Intake Facilities, and at Rio Vista
  - Water temperatures below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and at Rio Vista

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on green sturgeon in the Sacramento River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

In addition to evaluating flows and water temperatures to assess potential impacts on winter-run Chinook salmon habitat, the following evaluations also were conducted:

- Egg survival (i.e., water temperature-related egg mortality) was evaluated using the SacEFT

White Sturgeon

Adult white sturgeon upstream spawning movements are apparently triggered by photoperiod (Israel et al., 2011) and increases in river flow (Israel et al., 2011). Adult white sturgeon initiate their upstream migration into the lower Sacramento River from the Delta and estuary during late fall and winter (Kohlhorst and Cech, 2001). The relatively larger adults migrate to a ~90 km section of the river to spawn between Knights Landing and several kilometers upstream of Colusa (Israel et al., 2011). The upper limit of suitable water temperatures for adult white sturgeon is reportedly 25°C (77°F) (Israel et al., 2011). White sturgeon spawning occurs from mid-February to late May when water temperatures are between 46°F and 72°F, with peak spawning activity occurring during March and April (Kohlhorst, 1976; Kohlhorst and Cech, 2001). White sturgeon egg incubation occurs between 11°C and 20°C (~52 – 68°F), with optimal egg incubation occurring at water temperatures ranging from 14°C to 16°C (~57 – 61°F) (Wang et al., 1987). Incubation water temperatures above 17°C (~63 °F) reportedly result in premature hatching and higher mortality (Wang et al., 1985, 1987). Cech et al. (1984) observed slow growth and some mortality in juvenile white sturgeon kept in water temperatures above 20 °C (68°F), while larger juveniles were reported to show signs of stress above 19°C (~66°F) (Geist et al., 2005).

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on white sturgeon in the Sacramento River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (November through May)
  - Flows at Hamilton City, Below the proposed Delevan Pipeline Intake Facilities, and at Rio Vista
  - Water temperatures at Hamilton City, Below the proposed Delevan Pipeline Intake Facilities, and at Freeport

- Adult spawning and embryo incubation (February through May)
  - Flows at Hamilton City, below the proposed Delevan Pipeline Intake Facilities, and at Verona
  - Water temperatures at Hamilton City, Below the proposed Delevan Pipeline Intake Facilities, and below the Feather River confluence

- Juvenile rearing and Emigration (year-round)
  - Flows below the proposed Delevan Pipeline Intake Facilities, at Wilkins Slough, and at Freeport
  - Water temperatures below the proposed Delevan Pipeline Intake Facilities, at Knight's Landing, and at Freeport

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on white sturgeon in the Sacramento River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Striped Bass

Adult striped bass are present in Central Valley rivers throughout the year, with peak abundance occurring during the spring months. Spawning may begin in April, but peaks during May and early-June (Moyle, 2002). In the Sacramento River, most striped bass spawning is believed to occur between Colusa and the mouth of the Feather River. Optimal water temperatures for striped bass adult spawning, embryo incubation, and initial rearing are reported to range from approximately 59°F to 68°F (Moyle, 2002).

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on striped bass in the Sacramento River for each of the following life stages, life history periodicities, and modeled locations:

- Adult spawning, embryo incubation and initial rearing period (April through June)
  - Flows below the proposed Delevan Pipeline Intake Facilities and at Verona
  - Water temperatures below the proposed Delevan Pipeline Intake Facilities and below the Feather River confluence

- Larvae, fry, and juvenile rearing and emigration (year-round)
  - Flows below the proposed Delevan Pipeline Intake Facilities and at Verona
  - Water temperatures below the proposed Delevan Pipeline Intake Facilities and below the Feather River confluence

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on striped bass in the Sacramento River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

American Shad

Adult American shad typically enter Central Valley rivers from April through early July (CDFG, 1986), with the majority of immigration and spawning occurring from mid-May through June (Urquhart, 1987). American shad spawn in the Sacramento River up to Red Bluff (Moyle, 2002). Most larvae and fry are transported from the spawning areas to the Delta within days of spawning. American shad are reported to spawn at water temperatures ranging from approximately 46°F to 79°F (USFWS, 1967), although optimal spawning temperatures are reported to range from about 60°F to 70°F (Bell, 1986; CDFG, 1980; Leggett and Whitney, 1972; Painter et al., 1978; Rich, 1987). The Sacramento River from Colusa to the northern Delta provides the primary summer nursery for American shad larvae and juveniles (CDFG, 2010). Because flows drive the transport of young downstream, during wet water years young American shad are concentrated further downstream into the northern Delta (CDFG, 2010). Outmigration of young American shad through the Delta reportedly occurs June through November (CDFG, 2010). In the Sacramento

River, juvenile American shad reportedly prefer water temperatures between 62.6ºF and 77ºF (17ºC and 25ºC) (Moyle, 2002).

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on American shad in the Sacramento River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and spawning (April through June)
  - Flows below Red Bluff Diversion Dam, at Verona, and at Freeport
  - Water temperatures below Red Bluff Diversion Dam, below the Feather River confluence, and at Freeport
- Larvae, fry, and juvenile rearing and emigration (year-round)
  - Flows below the proposed Delevan Pipeline Intake Facilities and at Verona
  - Water temperatures below the proposed Delevan Pipeline Intake Facilities and below the Feather River confluence

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on American shad in the Sacramento River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Sacramento Splittail

Sacramento splittail utilize the Sacramento River primarily as a migratory corridor to inundated floodplains such as the Yolo Bypass where spawning, embryo incubation, and early juvenile rearing occur. The persistence of the Sacramento splittail population is thought to be dependent on the frequency and duration of floodplain inundation during spring. To evaluate the flow-related impacts of the NODOS Project alternatives on Sacramento splittail spawning, embryo incubation, and initial rearing, the frequency of Yolo Bypass inundation was evaluated under the NODOS Project alternatives, relative to the bases of comparison. This evaluation is described in detail for the Sacramento-San Joaquin Delta, below.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential water temperature-related on Sacramento splittail in the Sacramento River for each of the following life stages, life history periodicities, and modeled locations:

- Adult spawning (February through May) below the proposed Delevan Pipeline Intake Facilities and at Freeport

The assessment of potential water temperature-related impacts of the NODOS Project alternatives on Sacramento splittail in the Sacramento River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Hardhead

Hardhead generally occur in large, undisturbed low- to mid-elevation rivers and streams throughout the Sacramento River system (Moyle, 2002). Hardhead mature during their third year and often make spawning migrations in the spring into smaller tributary streams (Moyle, 2002). Hardhead are reportedly found in streams with summer water temperatures above 20°C (68°F) (Moyle, 2002), while water temperatures ranging from 65°F (~18°C) to 75°F (~24°C) are believed to be suitable (Cech et al., 1990). Preliminary work suggests that adult hardhead acclimated to water temperatures below 20°C prefer water temperatures at or above 20°C (Southern California Edison Company, 2007). Under laboratory conditions, juvenile hardhead preferred water temperatures ranging from 75.2°F to 82.4°F (24°C to 28°C) (Moyle, 2002). Hardhead reportedly spawn primarily during April and May (Reeves, 1964; Grant and Maslin, 1999), however, hardhead larvae have been collected in Clear Creek, Stony Creek, and Mud Creek during July (Wang and Reyes, 2007), indicating that spawning may occur during June. Suitable temperatures for spawning hardhead may range from 59°F to 64.4°F (15°C to 18°C) (Wang, 1986).

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on hardhead in the Sacramento River for each of the following life stages, life history periodicities, and modeled locations:

- Adults and Juveniles (year-round)
  - Flows below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and at Freeport
  - Water temperatures below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and at Freeport
- Adult spawning (April through June)
  - Flows below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and at Freeport
  - Water temperatures below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and at Freeport

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on hardhead in the Sacramento River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Pacific Lamprey

Adult Pacific lamprey typically migrate into freshwater streams between March and June (Moyle, 2002), but upstream migrations have been observed during January and February (Moyle, 2002. Moyle (2002) reported that Pacific lamprey embryos hatch in approximately 19 days at 15°C (59°F). Pacific lamprey eggs in a coastal Oregon stream reportedly incubated for 18 to 49 days, depending on water temperature (Brumo, 2006, as cited in BDCP, 2010), indicating that eggs could potentially be incubating as late as August. Pacific lamprey have been observed spawning as far upstream as Deer Creek in the Sacramento River system (Moyle, 2002). Pacific lamprey reportedly spawn where water temperatures are typically 12°C – 18°C (53.6°F – 64.4°F) (Moyle, 2002). Pacific lamprey laboratory studies and analyses in the Columbia River basin suggest that consistently high survival and low occurrence of embryonic developmental abnormalities occur as water temperatures increase from 10°C to 18°C (50°F – 64.4°F), with a significant decrease in survival and increase in developmental abnormalities at 22°C (~72 °F) (Meeuwig et. al., 2003). After hatching, ammocoetes eventually are washed downstream where they bury themselves in soft sand or mud (Moyle, 2002). The length of the Pacific lamprey ammocoete life stage is not known, but is estimated to be five to seven years (Moyle, 2002). Studies in the Snake River basin in Idaho found that Pacific lamprey larvae and juveniles are capable of surviving stream temperatures in excess of 20.0°C (Cochnauer and Claire, 2001). Meeuwig et al (2003) found a significant decrease in survival and increase in developmental abnormalities of Pacific lamprey larvae at 22°C (71.6°F) in a laboratory setting.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on Pacific lamprey in the Sacramento River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration (January through June)
  - Flows below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and at Freeport
- Adult spawning and embryo incubation (January through August)
  - Flows below Keswick Dam, below Red Bluff Diversion Dam, and below the proposed Delevan Pipeline Intake Facilities
  - Water temperatures Keswick Dam, below Red Bluff Diversion Dam, and below the proposed Delevan Pipeline Intake Facilities
- Ammocoete rearing (year-round)
  - Flows below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and at Freeport
  - Water temperatures Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and at Freeport

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on Pacific lamprey in the Sacramento River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

River Lamprey

The timing of river lamprey migrations in California is not well known, but they may initiate their upstream migration into freshwater during the fall, and spawn during the spring (Moyle, 2002). River lamprey reportedly spawn during the months of February through May (Moyle, 2002). Locations of river lamprey spawning are not accurately known within the Sacramento River. River lamprey are reported to spawn at water temperatures ranging from 55.4°F to 56.3°F (Wang, 1986). Moyle et al. (1995) indicate that river lamprey eggs and ammocoetes may require water temperatures that do not exceed 25°C (77°F). Ammocoetes may require sandy backwaters or stream edges in which to bury themselves where water quality is continuously high (Moyle, 2002). The length of the ammocoete life stage is not known, but is probably three to five years (Moyle, 2002). Ammocoete emigration may be associated with large pulse flows during the winter. After reaching the Delta, ammocoetes become macropthalmia.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on river lamprey in the Sacramento River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration (September through June)
  - Flows below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and at Freeport
- Adult spawning and embryo incubation (February through July)
  - Flows below Keswick Dam, below Red Bluff Diversion Dam, and below the proposed Delevan Pipeline Intake Facilities
  - Water temperatures Keswick Dam, below Red Bluff Diversion Dam, and below the proposed Delevan Pipeline Intake Facilities

- Ammocoete rearing (year-round)
  - Flows below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and at Freeport
  - Water temperatures Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and at Freeport

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on river lamprey in the Sacramento River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

California Roach

The California roach is generally found in small, warm intermittent streams throughout the Sacramento River drainage, and are most abundant in mid-elevation streams in the Sierra foothills (Moyle, 2002). Roach are tolerant of relatively high water temperatures (86°F to 95°F) and low oxygen levels (1 to 2 parts per million) (Taylor et al., 1982). California Roach reproduction typically occurs from March through June, depending on water temperature (Moyle, 2002). Eggs hatch within two to three days. Fry remain in the substrate interstices until they are free-swimming. Murphy (1943) states that roach spawning is determined by water temperature, which must be approximately 60°F (16°C) for spawning to be initiated.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on California roach in the Sacramento River for each of the following life stages, life history periodicities, and modeled locations:

- Adult spawning (March through June)
  - Flows below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and at Freeport
  - Water temperatures below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and at Freeport

- Adults and other life stages (year-round)
  - Flows below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and at Freeport
  - Water temperatures below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and at Freeport

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on California roach in the Sacramento River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Largemouth Bass

Warmwater game fishes, including black basses, crappies, other sunfishes, and catfishes support recreational fishing throughout the Sacramento River system. Many warmwater game fishes, including largemouth bass, bluegill and other sunfishes, and bullheads are most abundant in sloughs and river backwaters, particularly in disturbed areas with large pools with dense aquatic vegetation (Moyle, 2002).

Because warmwater game fishes have similar life history characteristics and generally have similar habitat requirements, largemouth bass were evaluated as an indicator of potential impacts that could occur on warmwater game fishes including smallmouth bass, crappies, other sunfishes, and catfishes.

Although habitat requirements are generally similar among warmwater game fishes, largemouth bass can be flushed out of streams under high flow conditions, but are typically able to find refuge in flooded areas, and quickly recolonize streams during low flow conditions (Moyle, 2002). Smallmouth bass, however, typically prefer stream habitats with flowing water and high dissolved oxygen levels (Moyle, 2002), while channel catfish prefer areas with a diversity of velocities and habitats (McMahonand Terrell, 1982).

Juvenile and adult game fishes are generally tolerant of elevated water temperatures. For example, the upper optimal water temperature for adult and juvenile largemouth bass growth is reportedly approximately 86°F, while adult and juvenile largemouth and smallmouth bass can possibly tolerate water temperatures as high as or greater than 95°F (Moyle, 2002). Sunfishes such as bluegill and green sunfish can reportedly tolerate water temperatures as high as or greater than 100°F (Moyle, 2002). Adult channel catfish can reportedly tolerate water temperatures up to about 97°F to 100°F (Moyle, 2002), while juvenile channel catfish can tolerate water temperatures below 95ºF (McMahon and Terrell, 1982). White catfish can reportedly survive in water temperatures of about 84°F to 88ºF (Moyle, 2002).

Because simulated Sacramento River water temperatures under the NODOS Project alternatives are not anticipated to reach or exceed the upper water temperature thresholds for warmwater game fishes, no evaluation of potential water temperature-related impacts was conducted. However, because water temperatures preferred during spawning are substantially lower than adult and juvenile water temperature thresholds, an evaluation of water temperature-related impacts on spawning largemouth bass was conducted.

Largemouth bass nest building reportedly begins at water temperatures of 59°F to 60.8°F, while spawning may continue until water temperatures reach approximately 75.2°F (Moyle, 2002). Because the timing of largemouth bass spawning depends on water temperature, spawning timing may differ depending on ambient flow and temperature conditions. Lee (1999) reports that the March through June period likely encompasses the majority of largemouth bass spawning in California.

Comparisons of modeling output for the NODOS Project Alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on largemouth bass in the Sacramento River for each of the following life stages, life history periodicities, and modeled locations:

- Adults and other life stages (year-round)
  - Flows below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and at Freeport

- Adult spawning (March through June)
  - Water temperatures below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and at Freeport

The assessment of potential flow- and water temperature-related impacts of the NODOS Project Alternatives on largemouth bass in the Sacramento River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

12B.2.7 Feather River

As described in the Affected Environment section of Chapter 12 Aquatic Biological Resources, the Feather River Watershed in the Secondary Study Area includes DWR's Lake Oroville and the lower Feather River extending from the Fish Barrier Dam to the confluence with the Sacramento River.

For this DEIR/EIS, the fisheries impact assessment focused on the hydrologic changes, including flows and water temperatures associated with implementation of the NODOS Project. Because the NODOS Project alternatives may result in changes to Feather River flows and water temperatures, the impact assessment focused on these and other habitat-based elements. Taking into account species-specific habitat requirements, operational components of the NODOS Project alternatives were assessed to evaluate potential impacts on identified fish species of primary management concern and associated aquatic habitat.

The analytical framework for the Feather River Watershed, including the impact assessment methodology, impact indicators, and significance criteria used to assess the potential impacts of the NODOS Project alternatives, are described below.

12B.2.7.1 Lake Oroville

Due to the effects of stratification described in the Affected Environment section of Chapter 12 Aquatic Biological Resources, Lake Oroville has been said to contain a "two-story" fishery, supporting both coldwater and warmwater fisheries that are thermally segregated for most of the year. After Lake Oroville destratifies in the fall, the two fishery components mix in their habitat utilization (FERC, 2006).

Operational changes at Oroville Dam have the potential to alter the timing and magnitude of reservoir drawdown, which could affect fish habitat through the management of the amount of cold water for downstream releases into the lower Feather River and changes in Lake Oroville water surface elevations necessary for flood control, power generation, and water releases downstream (FERC, 2006). Cold water is taken from Lake Oroville's hypolimnion for releases to the downstream fishery in the main channel of the lower Feather River, thereby potentially limiting the amount of cold water available for salmonids in Lake Oroville. Lake Oroville's warm-water fishery is a regionally important self-sustaining fishery and supports both centrarchids and ictalurids. The black bass fishery is the most significant, both in terms of angler effort and economic impact on the area. Warmwater fish species present in Lake Oroville use the warm upper layer of the reservoir and nearshore littoral habitats throughout most of the year (DWR, 2007). Seasonal changes in reservoir storage, as they affect reservoir water surface elevation, can directly affect the reservoir's warmwater fisheries resources by reducing the availability of nearshore littoral habitats used for spawning and rearing, thereby reducing warmwater fish spawning and rearing success and subsequent year-class strength. In addition, decreases in reservoir water surface elevation during the primary spawning period for warmwater fish nest building may result in reduced initial year-class strength as a result of nest "dewatering" (DWR, 2007).

Implementation of the NODOS Project alternatives could result in alterations to storage levels and water surface elevations in Lake Oroville. Differences in storage and water surface elevations (and fluctuations) potentially could affect reservoir fish species. Parameters used to determine potential impacts include:

- End-of-month reservoir storage levels under the alternatives compared to bases of comparison
- End-of-month water surface elevations under the alternatives compared to bases of comparison

The following guilds of species (Table 12B-7) were evaluated for Lake Oroville:

Table 12B-7
Fish Species of Primary Management Concern Evaluated for Lake Oroville

Common Name	Status
• Coldwater Fisheries (e.g., land-locked Coho salmon[2], trout)	Recreational importance
• Warmwater Fisheries (e.g., black bass, spotted bass, largemouth bass, striped bass, crappie, bluegill, bullhead catfish, shad, yellow perch)	Recreational importance

Coldwater Fish Species

Reduced reservoir storage could reduce the reservoir's coldwater pool volume, thereby reducing the quantity of habitat available to coldwater fish species.

Substantial reductions in reservoir storage are considered to result in substantial reductions in coldwater pool volume and, therefore, in habitat availability for coldwater fish. Impacts on coldwater fish species in Lake Oroville are identified by evaluating changes in reservoir storage as an indicator of cold water pool availability from April through November as described for Trinity Lake, above. Specifically, to assess the potential impacts of implementation of the NODOS Project alternatives on coldwater fisheries resources in Lake Oroville, the following outputs for end-of-month storage from April through November were evaluated: (1) long-term averages; (2) averages by water year type; and (3) the cumulative probability distributions.

Warmwater Fish Species

Because reservoir warmwater fish species (including largemouth bass, smallmouth bass, spotted bass, green sunfish, bluegill, crappie, and catfish) use the warm upper layer of the reservoir and nearshore littoral habitats, seasonal changes in reservoir storage, as it affects reservoir water surface elevation, and the rates at which water surface elevation change during specific periods of the year, can directly affect warmwater fish nesting and spawning success. Reduced water surface elevations can potentially reduce the availability of nearshore littoral habitats used by warmwater fish for rearing, thereby potentially reducing rearing success, and subsequent year-class strength. In addition, decreases in reservoir water surface elevation during the primary spawning period for warmwater fish nest building may result in reduced initial year-class strength through warmwater fish nest "dewatering."

To assess the potential impacts of implementation of the NODOS Project alternatives on warmwater fisheries resources in Lake Oroville, the approach described above for Trinity Lake was used.

12B.2.7.2 Lower Feather River

The lower Feather River commences at the Low Flow Channel (LFC), which extends eight miles from the Fish Barrier Dam (RM 67) to the Thermalito Afterbay Outlet (RM 59). Historically, under an agreement with CDFG, Feather River flows between the Thermalito Diversion Dam and the Thermalito Afterbay Outlet were regulated at 600 cfs, except during flood events when flows have reached as high as 150,000 cfs (DWR, 1983). Under the FERC Relicensing Settlement Agreement flows in the LFC are regulated at 700 cfs during most of the year and at 800 cfs for a portion of the year to enhance anadromous salmonid spawning habitat except for water temperature control purposes and during flood

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[2] Coho salmon occur within the Feather River Basin because of stocking programs and are managed for their recreational importance only (FERC 2006).

events when flows can be increased. Water is released through a powerhouse, then through the Fish Barrier Dam into the LFC. The Thermalito Afterbay has a dual purpose as an afterbay for upstream peaking power releases to ensure constant river and irrigation canal flows and as a warming basin for irrigation water being diverted to rice fields (NMFS, 2009a). Thus, water temperatures in the approximately 14 miles of salmon spawning area from the Thermalito Afterbay Outlet to the mouth of Honcut Creek (referred to as the High Flow Channel or HFC) are always higher than those in the eight miles of the low-flow section (USFWS, 1995).

Through the Oroville Facilities FERC Relicensing, operational changes would increase the minimum instream flow from the historic 600 cfs to 700 cfs in the LFC during most of the year to increase the amount of available anadromous spawning habitat and decrease water temperatures. During the Chinook salmon spawning season (generally from September through March) the minimum instream flows in the LFC would be increased to 800 cfs (FERC, 2006; SWRCB, 2010). FERC (2006) indicates that facility modifications, if approved, would be completed within 10 years of license issuance and a five-year testing period would follow the facilities modifications to test the adequacy of modifications to achieve water temperature objectives.

The majority of the LFC flows through a single channel contained by stabilized levees. Side-channel or secondary channel habitat is limited, occurring primarily in the Steep Riffle (located 2 miles upstream of the Thermalito Afterbay Outlet) and Eye Riffle areas between RM 60-61. The channel banks and streambed consist of armored cobble as a result of periodic flood flows and the absence of gravel recruitment. However, there are nine major riffles with suitable spawning size gravel, and approximately two-thirds of the natural Chinook salmon spawning in the lower Feather River occurs in the LFC, which extends between the Fish Barrier Dam and the Thermalito Afterbay Outlet (DWR, 2007; NMFS, 2009a). Releases are made from the coldwater pool in Lake Oroville and this cold water generally provides suitable water temperatures for spawning in the LFC (DWR, 2001).

The remaining amount (approximately one-third) of Chinook salmon spawning in the lower Feather River occurs in the HFC, which is located downstream of the Thermalito Afterbay Outlet to Honcut Creek (RM 59-44) (DWR, 2007; NMFS, 2009a). Flows in the HFC are maintained between the minimum flow and a flow no greater than 2,500 cfs from October 15 through November 30 to prevent Chinook salmon redd dewatering in the event that flows were to decrease during the egg incubation period (FERC, 2006). The HFC also is an important migration corridor for both juvenile and adult anadromous fish (NMFS, 2004).

Releases from the Thermalito Afterbay Outlet vary according to operational requirements, and the flow regime in the reach of the Feather River extending from the Thermalito Afterbay Outlet (RM 59) to the confluence of the Feather and Sacramento rivers (RM 0) varies depending on runoff and month (FERC, 2006).

According to SWRCB (2010), studies have shown it is unlikely that adult Chinook salmon can use the lower Feather River below the Thermalito Afterbay Outlet except as a migration corridor. As a result of elevated water temperatures, increased incidence of disease, developmental abnormalities, increased in-vivo egg mortality, and temporary cessation of Chinook salmon and steelhead migration could occur in some areas of the lower Feather River (SWRCB, 2010).

There are several temperature objectives for the Feather River downstream of the Thermalito Afterbay Outlet. From May through August, water temperatures must be suitable for shad, striped bass, and other warmwater fish. During the fall months (e.g., after September 15), water temperatures must be suitable for fall-run Chinook (DWR, 1983; DWR, 2007).

To protect spring-run Chinook salmon and steelhead, NMFS (2004, 2009) established water temperature targets for the lower Feather River at the Feather River Fish Hatchery and for the LFC, which is monitored near Robinson Riffle (RM 61.6). Water temperature targets for the LFC at the Robinson Riffle, located near where the LFC meets the HFC, specify that mean daily water temperatures shall not exceed 65°F from June 1 to September 30 (SWRCB, 2010). From June 1 through September 30, DWR is required to control Feather River water temperatures at river mile 61.6 (Robinson Riffle in the LFC) unless DWR consults with the Feather River Technical Team and receives approval from NMFS to deviate from the BO temperature requirement (DWR, 2007).

The Feather River Fish Hatchery water supply is diverted directly from the Thermalito Diversion Pool, which receives cold, hypolimnetic water (which rarely exceeds mid to high fifties (°F)) from Lake Oroville. Because the hatchery's water supply comes from stored water in the Thermalito Diversion Pool and does not come directly from the Feather River, it is not subject to the thermal warming impacts associated with downstream in-channel transport. Thus, the hatchery and the Thermalito Diversion Pool were not specifically evaluated in this assessment.

Fish Species of Primary Management Concern

The lower Feather River is utilized by a number of fish species of primary management concern (Table 12B-8), primarily as habitat during one or more of their life stages, but also as a migration corridor to upstream habitat in other river systems (e.g., the Yuba River). Changes in SWP/CVP operations under the NODOS Project alternatives could potentially alter seasonal Lake Oroville operations and, thus, alter Feather River flows and water temperatures, which could change the relative habitat availability for fish species that are present in the lower Feather River.

Table 12B-8
Fish Species of Primary Management Concern Evaluated for the Lower Feather River

Common Name	Status
• Central Valley spring-run Chinook salmon	Federally and State threatened
• Central Valley fall-run Chinook salmon	Federal species of concern State species of special concern Recreational and/or commercial importance
• Central Valley steelhead	Federally threatened Recreational and/or commercial importance
• Southern DPS of North American green sturgeon	Federally threatened State species of special concern
• White Sturgeon	Recreational and/or commercial importance
• River lamprey	State species of special concern
• Pacific lamprey	Federal species of concern
• Sacramento splittail	State species of special concern
• Hardhead	State species of special concern
• California roach	State species of special concern
• American shad	Recreational and/or commercial importance
• Striped bass	Recreational and/or commercial importance
• Warmwater game fish*	Recreational and/or commercial importance

*Largemouth bass were evaluated as an indicator species in this DEIR/EIS analysis to reflect potential Project-related impacts on warmwater game fishes

Note:
DPS = distinct population segment

For these reasons, species-specific impact assessments were warranted for the lower Feather River and were conducted for the following species.

Species-Specific Analytical Approach

The potential for changes in flows and water temperatures resulting from implementation of the NODOS Project alternatives to impact fish resources of the Feather River are dependent on the species-specific habitat and physiological requirements. Therefore, species-specific flow and water temperature assessment methodologies for the lower Feather River fisheries analyses are discussed below.

Spring-run Chinook Salmon

The Central Valley spring-run Chinook salmon ESU is federally and State listed as threatened. NMFS (2005) designated critical habitat for the ESU.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on spring-run Chinook salmon in the Feather River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (March through October)
  - Flows below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
  - Water temperatures below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
- Adult spawning and embryo incubation (September through February)
  - Flows below the Fish Barrier Dam and below the Thermalito Afterbay Outlet
  - Water temperatures below the Fish Barrier Dam and below the Thermalito Afterbay Outlet
- Juvenile rearing and emigration (year-round)
  - Flows below the Fish Barrier Dam and below the Thermalito Afterbay Outlet
  - Water temperatures below the Fish Barrier Dam and below the Thermalito Afterbay Outlet
- Smolt emigration (October through June)
  - Flows below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
  - Water temperatures below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on Central Valley spring-run Chinook salmon in the Feather River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

In addition to evaluating flows and water temperatures to assess potential impacts on spring-run Chinook salmon habitat, the following evaluations also were conducted:

- Potential flow-related impacts on Chinook salmon spawning habitat availability (WUA) was evaluated by comparing the monthly percentage of maximum WUA that would occur under the NODOS Project alternatives, relative to the bases of comparison. Because no clear distinction between spring- and fall-run Chinook salmon spawning can be derived from lower Feather River

Chinook salmon carcass survey data, the WUA analysis used to analyze potential impacts on the two runs was combined into one expanded spawning season that was inclusive of all Chinook salmon spawning in the lower Feather River.

- Total early life stage mortality for Chinook salmon was evaluated using the Reclamation Salmon Mortality Model. Because no clear distinction between spring-run and fall-run Chinook salmon spawning could be derived from lower Feather River Chinook salmon carcass survey data, the lower Feather River Salmon Mortality Model analysis was assumed to represent the analysis for both runs.

Fall-run Chinook Salmon

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on fall-run Chinook salmon in the Feather River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (July through December)
  - Flows below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
  - Water temperatures below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
- Adult spawning (October through December)
  - Flows below the Fish Barrier Dam and below the Thermalito Afterbay Outlet
  - Water temperatures below the Fish Barrier Dam and below the Thermalito Afterbay Outlet
- Embryo Incubation (October through March)
  - Flows below the Fish Barrier Dam and below the Thermalito Afterbay Outlet
  - Water temperatures below the Fish Barrier Dam and below the Thermalito Afterbay Outlet
- Juvenile rearing and emigration (November through June)
  - Flows below the Fish Barrier Dam and below the Thermalito Afterbay Outlet
  - Water temperatures below the Fish Barrier Dam and below the Thermalito Afterbay Outlet

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on Central Valley fall-run Chinook salmon in the Feather River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

In addition to evaluating flows and water temperatures to assess potential impacts on fall-run Chinook salmon habitat, the following evaluations also were conducted:

- Potential flow-related impacts on Chinook salmon spawning habitat availability (WUA) was evaluated by comparing the monthly percentage of maximum WUA that would occur under the NODOS Project alternatives, relative to the bases of comparison). Because no clear distinction between spring- and fall-run Chinook salmon spawning can be derived from lower Feather River Chinook salmon carcass survey data, the WUA analysis used to analyze potential impacts on the two runs was combined into one expanded spawning season that was inclusive of all Chinook salmon spawning in the lower Feather River.

- Total early life stage mortality for Chinook salmon was evaluated using the Reclamation Salmon Mortality Model. Because no clear distinction between spring-run and fall-run Chinook salmon spawning could be derived from lower Feather River Chinook salmon carcass survey data, the lower Feather River Salmon Mortality Model analysis was assumed to represent the analysis for both runs.

Steelhead

The majority of natural steelhead spawning in the Feather River is reported to occur in the LFC, particularly in the upper reaches near Hatchery Ditch, although limited steelhead spawning also occurs below the Thermalito Afterbay Outlet (DWR, 2007). The residence time of adult steelhead in the Feather River after spawning and the extent of adult steelhead post-spawning mortality are unknown (NMFS, 2009a). However, studies have confirmed that juvenile rearing (and probably adult spawning) is most concentrated in small secondary channels within the LFC (NMFS, 2009a).

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on steelhead in the Feather River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (August through April)
  - Flows below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
  - Water temperatures below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
- Adult spawning and embryo incubation (December through May)
  - Flows below the Fish Barrier Dam and below the Thermalito Afterbay Outlet
  - Water temperatures below the Fish Barrier Dam and below the Thermalito Afterbay Outlet
- Embryo incubation (October through March)
  - Flows below the Fish Barrier Dam and below the Thermalito Afterbay Outlet
  - Water temperatures below the Fish Barrier Dam and below the Thermalito Afterbay Outlet
- Juvenile rearing and emigration (year-round)
  - Flows below the Fish Barrier Dam and below the Thermalito Afterbay Outlet
  - Water temperatures below the Fish Barrier Dam and below the Thermalito Afterbay Outlet
- Smolt emigration (October through May)
  - Flows below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
  - Water temperatures below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on Central Valley steelhead in the Feather River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

In addition to evaluating flows and water temperatures to assess potential impacts on steelhead habitat, the following evaluation also was conducted:

- Potential flow-related impacts on steelhead spawning habitat availability (WUA) was evaluated by comparing the monthly percentage of maximum WUA that would occur under the NODOS Project alternatives, relative to the bases of comparison.

Green Sturgeon

DWR (2005b) reports that sturgeon do not typically enter the mouth of the lower Feather River at flows lower than approximately 5,000 cfs, and sturgeon are observed neither commonly nor consistently in the Feather River (DWR, 2007). However, according to NMFS (2005), green sturgeon adults have been observed periodically in small numbers in the Feather River and spawning in the Feather River is suspected to have occurred in the past due to the continued presence of adult green sturgeon in the river downstream of Oroville Dam (NMFS, 2009a). The occasional capture of larval green sturgeon in outmigrant traps suggests that green sturgeon spawn in the Feather River (Moyle, 2002).

Potential natural and man-made passage barriers in the lower Feather River may limit the movement of sturgeon into the Feather River during low-flow years (Beamesderfer et al., 2004). Potential barriers include Shanghai Bench (a natural geologic feature), an artificial rock weir structure at Sunset Pumps, and Steep Riffle (a natural feature) (NMFS, 2009a). According to DWR (2007), three potential physical upstream migration barriers (i.e., Shanghai Bench, the Sunset Pumps, and Steep Riffle) for sturgeon in the Feather River were identified by a team of selected sturgeon passage experts (e.g., UCD, NMFS, USFWS, CDFG) during representative low-flow conditions (approximately 2,074 cfs during November 2002) and high-flow conditions (approximately 9,998 cfs during July 2003).

Shanghai Bench, a clay riffle located between RM 26 and RM 25, has been identified as the most likely physical flow-related impediment to upstream migration of green sturgeon in the Feather River. Under low flow conditions (~2000 cfs), the waterfalls at Shanghai Bench measure approximately three to five feet in vertical height, stretch across much of the main river channel and exhibit velocities estimated at greater than 3.3 fps (Niggemyer and Duster, 2003). The waterfall at Shanghai Bench becomes a riffle at approximately 5,100 cfs, and may become passable to sturgeon (DWR, 2005b).

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on green sturgeon in the Feather River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (February through December)
  - Flows below the Fish Barrier Dam, at Shanghai Bench, and at the mouth of the Feather River
  - Water temperatures below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River

- Adult spawning and embryo incubation (March through August)
  - Flows below the Thermalito Afterbay Outlet
  - Water temperatures below the Thermalito Afterbay Outlet

- Juvenile rearing (year-round)
  - Flows below the Thermalito Afterbay Outlet and at the mouth of the Feather River
  - Water temperatures below the Thermalito Afterbay Outlet and at the mouth of the Feather River

- Juvenile emigration (May through September)

  - Flows below the Thermalito Afterbay Outlet, at Shanghai Bench, and at the mouth of the Feather River
  - Water temperatures below the Thermalito Afterbay Outlet and at the mouth of the Feather River

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on green sturgeon in the Feather River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

White Sturgeon

Although both green and white sturgeon are native to California, white sturgeon are more commonly observed in the Feather River (DWR, 2005a), and are known to spawn in the Feather River (Moyle, 2002).

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on white sturgeon in the Feather River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (November through May)
  - Flows below the Fish Barrier Dam, at Shanghai Bench, and at the mouth of the Feather River
  - Water temperatures below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River

- Adult spawning and embryo incubation (February through May)
  - Flows below the Fish Barrier Dam, at Shanghai Bench, and at the mouth of the Feather River
  - Water temperatures below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River

- Juvenile rearing (year-round)
  - Flows below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
  - Water temperatures below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on white sturgeon in the Feather River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

River Lamprey

River lamprey life history periodicities and habitat requirements in the lower Feather River are similar to those previously discussed for the Sacramento River (for additional information, also see the Affected Environment section of Chapter 12 Aquatic Biological Resources).

Comparisons of modeling output for the NODOS Project Alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on river lamprey in the Feather River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration (September through June)
  - Flows below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
- Adult spawning and embryo incubation (February through July)
  - Flows below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
  - Water temperatures below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
- Ammocoete rearing and emigration (year-round)
  - Flows below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
  - Water temperatures below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on river lamprey in the Feather River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Pacific Lamprey

Pacific lamprey life history periodicities and habitat requirements in the lower Feather River are similar to those previously discussed for the Sacramento River (for additional information, also see the Affected Environment section of Chapter 12 Aquatic Biological Resources).

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on Pacific lamprey in the Feather River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration (January through June)
  - Flows below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
- Adult spawning and embryo incubation (January through August)
  - Flows below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
  - Water temperatures below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
- Ammocoete rearing and emigration (year-round)
  - Flows below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
  - Water temperatures below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on Pacific lamprey in the Feather River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Sacramento Splittail

Sacramento splittail spawning, embryo incubation, and initial rearing life stages in the lower Feather River occur from February through May. Sacramento splittail spawning in the lower Feather River has been reported to occur predominantly on flooded vegetated benches. To evaluate ongoing impacts of the Oroville Facilities on splittail spawning, an approach that relies on evaluating usable flooded area (UFA) as function of river stage was developed and is described in DWR's FERC Relicensing Report SPF 3.2 Task 3B, *Assessment of Potential Project Effects on Splittail Habitat* (DWR, 2004). Because the relationship between UFA and stage has not been updated, it was not utilized as part of this evaluation. However, the principles of the UFA-stage relationship do apply to the flow-based impact assessment approach utilized in this DEIR/EIS. Specifically, substantial (10% or greater) changes in flow during the February through May period under the NODOS Project alternatives, relative to the bases of comparison, also could change the amount of UFA available to spawning splittail. Therefore, this analysis evaluated substantial changes in flow as an indicator of potential changes in UFA, and thus, as an indicator of potential impact on splittail spawning.

Based on a literature review of thermal tolerance studies and field observations, DWR (2004) determined that water temperatures between 45°F and 75°F constituted the range of suitable splittail spawning water temperatures. Thus, for this DEIR/EIS, water temperature index values of 45°F and 75°F were established as evaluation guidelines to indicate whether Sacramento splittail would be substantially affected.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/ No Action Alternative), were conducted to identify potential impacts on splittail in the Feather River for the following life stage, life history periodicity, and modeled location:

- Adult spawning (February through May)
  - Flows at the mouth of the Feather River
  - Water temperatures at the mouth of the Feather River

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on Sacramento splittail in the Feather River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Hardhead

Hardhead life history periodicities and habitat requirements in the lower Feather River are similar to those previously discussed for the Sacramento River (for additional information, also see the Affected Environment section of Chapter 12 Aquatic Biological Resources).

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on hardhead in the Feather River for each of the following life stages, life history periodicities, and modeled locations:

- Adults and juveniles (year-round)
  - Flows below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
  - Water temperatures below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River

- Adult spawning (April through June)
  - Flows below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
  - Water temperatures below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on hardhead in the Feather River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

California Roach

California roach life history periodicities and habitat requirements in the lower Feather River are similar to those previously discussed for the Sacramento River (for additional information, also see the Affected Environment section of Chapter 12 Aquatic Biological Resources).

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on California roach in the Feather River for each of the following life stages, life history periodicities, and modeled locations:

- Adult spawning (March through June)
  - Flows below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
  - Water temperatures below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River

- Adults and other life stages (year-round)
  - Flows below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River
  - Water temperatures below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on California roach in the Feather River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

American Shad

Despite being non-native, American shad are considered an important sport fish in the Central Valley. Shad have remarkable abilities to navigate and to detect minor changes in their environment (Leggett, 1973). American shad populations in the Central Valley are regional in nature, and high spring flows in tributaries relative to mainstem rivers appear to attract spawning shad into Central Valley tributaries, including the lower Feather River. Shifting of proportional flows (lower Feather River flows/Sacramento River flows) may simply re-allocate shad from the Sacramento River to the lower Feather River, or vice versa. Such shifting of proportional flows may provide for localized angling opportunities, and may not be associated with Central Valley shad production.

The American shad adult spawning period in the lower Feather River occurs from April through June (DWR, 2007). Although homing is generally assumed in the Sacramento River and its tributaries, there is some evidence that numbers of first-time spawning (i.e., "virgin") fish are proportional to flows of each river at the time the shad arrive (Painter et al., 1978). Water temperature is an important factor influencing the timing of spawning. American shad are reported to spawn at water temperatures ranging from approximately 46°F to 79°F (USFWS, 1967), although optimal spawning temperatures are reported to range from about 60°F to 70°F (Bell, 1986; CDFG, 1980; Leggett and Whitney, 1972; Painter et al., 1978; Rich, 1987). The 1983 Agreement between DWR and CDFG established a narrative water temperature objective for the Feather River downstream of the Thermalito Diversion Dam and Thermalito Afterbay Outlet that requires water temperatures downstream of the Thermalito Afterbay Outlet that are suitable for shad, striped bass, and other warmwater species from May through August (DWR, 2007; FERC, 2006). Season-long American shad juvenile rearing reportedly occurs in the Feather River below Yuba City (USFWS, 1995).

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on American shad in the Feather River for each of the following life stages, life history periodicities, and modeled locations:

- Adult spawning, embryo incubation, and initial rearing (April through June)
  - Flows below the Thermalito Afterbay Outlet and at the mouth of the Feather River
  - Water temperatures below the Thermalito Afterbay Outlet and at the mouth of the Feather River
- Larvae, fry, and juvenile rearing and emigration (July through November)
  - Flows below the Thermalito Afterbay Outlet and at the mouth of the Feather River
  - Water temperatures below the Thermalito Afterbay Outlet, and at the mouth of the Feather River

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on American shad in the Feather River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Striped Bass

Also non-native to California, striped bass are an important sport fish in the Central Valley. Striped bass spawning and initial rearing in the lower Feather River extends from April through June (DWR, 2007). As discussed above, the 1983 Agreement between DWR and CDFG established a narrative water temperature objective for the Feather River that requires water temperatures downstream of the Thermalito Afterbay Outlet that are suitable for shad, striped bass, and other warmwater species from May through August. Based on various studies, the water temperature range in which spawning occurs is reported to be between about 59°F and 68°F (Bell, 1991; Hassler, 1988; Hill et al., 1989; Moyle, 2002).

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on striped bass in the Feather River for each of the following life stages, life history periodicities, and modeled locations:

- Adult spawning, embryo incubation, and initial rearing (April through June)
  - Flows below the Thermalito Afterbay Outlet and at the mouth of the Feather River
  - Water temperatures below the Thermalito Afterbay Outlet and at the mouth of the Feather River
- Larvae, fry, and juvenile rearing and emigration (year-round)
  - Flows below the Thermalito Afterbay Outlet and at the mouth of the Feather River

  – Water temperatures below the Thermalito Afterbay Outlet, and at the mouth of the Feather River

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on American shad in the Feather River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Largemouth Bass

Warmwater game fishes, including black basses, crappies, other sunfishes, and catfishes support recreational fishing throughout the Sacramento River system, including the Feather River. Many warmwater game fishes, including largemouth bass, bluegill and other sunfishes, and bullheads are most abundant in sloughs and river backwaters, particularly in disturbed areas with large pools with dense aquatic vegetation (Moyle, 2002). Because warmwater game fishes have similar life history characteristics and generally have similar habitat requirements, largemouth bass were evaluated as an indicator of potential impacts that could occur on warmwater game fishes including smallmouth bass, crappies, other sunfishes, and catfishes.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on largemouth bass in the Feather River for each of the following life stages, life history periodicities, and modeled locations:

- Adults and other life stages (year-round)
  - Flows below the Thermalito Afterbay Outlet and at the mouth of the Feather River
- Adult spawning (March through June)
  - Water temperatures below the Thermalito Afterbay Outlet and at the mouth of the Feather River

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on largemouth bass in the Feather River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

12B.2.8 American River

The American River Watershed in the Secondary Study Area includes Folsom Lake and the lower American River, extending from Nimbus Dam to the confluence with the Sacramento River.

For this DEIR/EIS, the lower American River impact assessment focused on the hydrologic changes, including flows and water temperatures, associated with implementation of the NODOS Project. Several fish species of primary management concern are sensitive to changes in both river flows and water temperatures throughout the year. Because the NODOS Project alternatives may result in changes in water temperatures and river flows, the impact assessment focused on these and other habitat-based elements. Taking into account species-specific habitat requirements, operational components of the NODOS Project alternatives were assessed to evaluate potential impacts on identified fish species of primary management concern and associated aquatic habitat.

The analytical framework for the lower American River, including the impact assessment methodology, impact indicators, and significance criteria used to assess the potential impacts of the NODOS Project alternatives, are described below.

12B.2.8.1 Folsom Lake

NODOS Project operations could potentially alter storage levels and water surface elevations in Folsom Lake. Fluctuations in the reservoir in response to operations and changes in runoff patterns, potentially can affect reservoir fish (Table 12B-9) due to alterations in the timing and magnitude of reservoir drawdowns.

Table 12B-9
Fish Species of Primary Management Concern Evaluated for Folsom Lake

Common Name	Status
• Coldwater Fisheries (e.g., trout)	Recreational importance
• Warmwater Fisheries (e.g., largemouth bass, spotted bass, striped bass, crappie, bluegill, bullhead, catfish)	Recreational importance

Implementation of the NODOS Project alternatives could result in alterations to storage levels and water surface elevations in Folsom Lake. Differences in storage and water surface elevations (and fluctuations) potentially could affect reservoir fish species. Parameters used to determine potential impacts included:

- End-of-month reservoir storage levels under the alternatives compared to bases of comparison
- End-of-month water surface elevations under the alternatives compared to bases of comparison

The following guilds of species were evaluated in Folsom Lake:

Coldwater Fisheries

During the April through November period when Folsom Lake is thermally stratified, coldwater fish (e.g., rainbow trout) within the reservoir reside primarily within the reservoir's metalimnion and hypolimnion, or cold-water pool, where water temperatures remain suitable. Reservoir cold-water pool size generally decreases as reservoir storage decreases, although not always in direct proportion because of the influence of reservoir basin morphometry.

Substantial reductions in reservoir storage are considered to result in substantial reductions in coldwater pool volume and, therefore, in habitat availability for coldwater fish. Impacts on coldwater fish species in Folsom Lake were identified by evaluating changes in reservoir storage as an indicator of cold water pool availability from April through November as described for Trinity Lake, above. Specifically, to assess the potential impacts of implementation of the NODOS Project alternatives on coldwater fisheries resources in Folsom Lake, the following outputs for end-of-month storage from April through November were evaluated: (1) long-term averages; (2) averages by water year type; and (3) the cumulative probability distributions.

Warmwater Fisheries

Because warm-water fish species in Folsom Lake (including largemouth bass, smallmouth bass, spotted bass, green sunfish, bluegill, crappie, and catfish) use the warm upper layer of the reservoir and nearshore littoral habitats throughout most of the year, seasonal changes in reservoir storage, as it affects reservoir water surface elevation (feet msl), and the rates at which water surface elevation change during specific periods of the year, can directly affect the reservoir's warm-water fish. Reduced water surface elevations can potentially reduce the availability of nearshore littoral habitats used by warm-water fish for rearing. In addition, decreases in reservoir water surface elevation during the primary spawning period for warm-water fish nest building may result in reduced initial year-class strength through warm-water fish nest "dewatering."

To assess the potential impacts of implementation of the NODOS Project alternatives on warmwater fisheries resources in Folsom Lake, the approach described for Trinity Reservoir, above, was used. Specifically, the following outputs for end-of-month water surface elevation during the March through June period were evaluated: (1) long-term averages; (2) averages by water year type; and (3) the cumulative probability distributions.

12B.2.8.2 Lower American River

Flows and water temperatures in the lower American River are controlled by operations of Folsom Lake. The impact evaluation on fishery resources requires an understanding of fish species' life histories and life stage-specific environmental requirements (see the Affected Environment section of Chapter 12 Aquatic Biological Resources), and the ability to meet them in the lower American River. For example, Folsom Lake's coldwater pool is important to lower American River fall-run Chinook salmon and steelhead. Seasonal releases from the reservoir's coldwater pool provide thermal conditions in the lower American River that support annual in-river production of these salmonid species. Folsom Lake's coldwater pool is typically not large enough to allow for cold-water releases during the warmest months (July through September) to provide maximum thermal benefits to lower American River steelhead, and cold-water releases during October and November that would maximally benefit fall-run Chinook salmon immigration and holding, spawning, and embryo incubation. Consequently, management of the reservoir's cold-water pool on an annual basis is essential to providing thermal benefits to both fall-run Chinook salmon and steelhead, within the constraints of cold-water pool availability.

Folsom Lake, because of its proximity to the Delta, is often used by Reclamation to make releases when additional Delta outflow is required to meet Delta salinity standards. Consequently, Folsom Lake storage can be reduced, resulting in reduced cold-water pool volume. A reduced cold-water pool in Folsom Lake may result in releases from Nimbus Dam that are warmer and have the potential to exceed suitable water temperature ranges for fish species of primary management concern in the lower American River.

Species of Primary Management Concern

The lower American River is used by numerous fish species (Table 12B-10) for one or more life stages, and seasonal changes in releases from Folsom Lake could affect flows and water temperatures in the lower American River during portions of the year. For these reasons, species-specific impact assessments were warranted for the lower American River and were conducted for the following species.

As previously discussed, these species are the focus of evaluation due either to the importance of their commercial and/or recreational fisheries (e.g., American shad and striped bass) and/or because they are a special status species (i.e., currently listed the federal ESA and/or California ESA, or are a Federal Species of Concern or a State Species of Special Concern). Because the species selected for species-specific assessments include those sensitive to changes in both river flow and water temperature throughout the year, an evaluation of potential impacts on these species was believed to reasonably encompass the range of potential effects on lower American River fish resources that could occur with implementation of the NODOS Project alternatives.

Table 12B-10
Fish Species of Primary Management Concern Evaluated for the Lower American River

Common Name	Status
• Central Valley spring-run Chinook salmon (non-natal rearing only)	Federally and State threatened
• Central Valley fall-/late fall-run Chinook salmon	Federal species of concern State species of special concern Recreational and/or commercial importance
• Central Valley steelhead	Federally threatened Recreational and/or commercial importance
• Southern DPS of North American green sturgeon	Federally threatened State species of special concern
• Hardhead	State species of special concern
• River lamprey	State species of special concern
• Pacific lamprey	Federal species of concern
• Sacramento splittail	State species of special concern
• California roach	State species of special concern
• American shad	Recreational and/or commercial importance
• Striped bass	Recreational and/or commercial importance
• Warmwater game fish*	Recreational and/or commercial importance

*Largemouth bass were evaluated as an indicator species in this DEIR/EIS analysis to reflect potential Project-related impacts on warmwater game fishes

Note:
DPS = distinct population segment

Species-Specific Analytical Approach

The potential for changes in flows and water temperatures resulting from implementation of the NODOS Project alternatives to impact fish resources of the lower American River are dependent on the species-specific habitat and physiological requirements. Therefore, species-specific flow and water temperature assessment methodologies for the lower American River fisheries assessment are discussed below.

Spring-run Chinook Salmon

The lower American River does not support a spawning population of spring-run Chinook salmon.

The analysis of potential impacts on spring-run Chinook salmon in the lower American River was based on the individual life stage (i.e., non-natal juvenile rearing) for which critical habitat has been designated by NMFS. NMFS designated critical habitat for the Central Valley spring-run Chinook salmon ESU on September 2, 2005. The critical habitat designation includes the reach of the lower American River extending from the outfall of the Natomas East Main Drainage Canal (NEMDC) downstream to the confluence with the Sacramento River (70 FR 52488; September 2, 2005). This section of the lower American River was included in the critical habitat designation because it may be used during high winter flows for non-natal rearing and refugia by multiple populations of spring-run Chinook salmon originating from other rivers in the Central Valley. The spring-run Chinook salmon juvenile outmigration period in the lower Sacramento River reportedly occurs from November through April (NMFS, 1997), which corresponds to the time period when high winter flows typically occur. Therefore, the impact assessment in this DEIR/EIS considered the potential for flow-and water temperature-related changes to affect non-natal spring-run Chinook salmon rearing in the lower American River during the November through April period.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on spring-run Chinook salmon in the American River for each of the following life stages, life history periodicities, and modeled locations:

- Non-natal juvenile rearing (November through April)
  - Flows at the mouth of the American River
  - Water temperatures at the mouth of the American River

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on spring-run Chinook salmon in the American River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Fall-run Chinook Salmon

The majority of fall-run Chinook salmon redds are constructed from Ancil Hoffman Park at RM 16 upstream to the Nimbus Hatchery weir (approximately river mile (RM) 23), assuming that spawning occurs nearby or upstream of the location of observed carcasses (Vincik and Kirsch, 2009). Because Watt Avenue represents the lower American River location above which approximately 98 percent of fall-run Chinook salmon spawning occurs (PCWA and Reclamation, 2001), Watt Avenue was used as the location for both flow and water temperature analyses for spawning.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on fall-run Chinook salmon in the lower American River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (September through December)
  - Flows at Watt Avenue and at the mouth of the lower American River
  - Water temperatures at Watt Avenue and at the mouth of the lower American River

- Adult spawning (October through December)
  - Flows at Watt Avenue
  - Water temperatures at Watt Avenue

- Embryo incubation (October through March)
  - Flows at Watt Avenue
  - Water temperatures at Watt Avenue

- Juvenile rearing and outmigration (January through June)
  - Flows at Watt Avenue and at the mouth of the lower American River
  - Water temperatures at Watt Avenue and at the mouth of the lower American River

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on fall-run Chinook salmon in the lower American River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

In addition to evaluating flows and water temperatures to assess potential impacts on fall-run Chinook salmon habitat, the following evaluations also were conducted:

- Potential flow-related impacts on Chinook salmon spawning habitat availability (WUA) was evaluated by comparing the monthly percentage of maximum WUA occurring under the NODOS Project alternatives, relative to the bases of comparison.
- Total early life stage mortality for Chinook salmon was evaluated using the Reclamation Salmon Mortality Model.

Steelhead

Because Watt Avenue represents the lower American River location above which approximately 95 percent of steelhead spawning occurs, Watt Avenue was used as the location for both flow and water temperature analyses for spawning.

Steelhead may rear in freshwater for one to two years before undergoing smoltification. Some individuals may rear in their natal streams, while others may volitionally or non-volitionally move downstream to enter the mainstem rivers, where they continue to rear until reaching a size at which smoltification is initiated, as observed by many young-of-the-year (YOY) steelhead captured in rotary screw traps (RSTs) in the Yuba, Feather, and lower American rivers. The small sizes of juvenile steelhead captured at the RSTs support the presumption that these juvenile fish have not yet undergone smoltification, but instead are moving out of the river into downstream rearing habitat. Therefore, habitat conditions for YOY downstream moving juveniles were assessed using the juvenile rearing water temperature index values, whereas separate water temperature index values were used for the smolt emigration lifestage.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on steelhead in the lower American River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (November through April)
  - Flows at Watt Avenue and at the mouth of the lower American River
  - Water temperatures at Watt Avenue and at the mouth of the lower American River
- Adult spawning (January through April)
  - Flows at Watt Avenue
  - Water temperatures at Watt Avenue
- Embryo incubation (January through May)
  - Flows at Watt Avenue
  - Water temperatures at Watt Avenue
- Juvenile rearing and emigration (year-round)
  - Flows below Nimbus Dam, at Watt Avenue, and at the mouth of the lower American River
  - Water temperatures below Nimbus Dam, at Watt Avenue, and at the mouth of the lower American River

- Smolt emigration (January through June)
  - Flows at Watt Avenue and at the mouth of the lower American River
  - Water temperatures at Watt Avenue and at the mouth of the lower American River

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on steelhead in the lower American River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

In addition to evaluating flows and water temperatures to assess potential impacts on steelhead habitat, the following evaluations also were conducted:

- Potential flow-related impacts on steelhead spawning habitat availability (WUA) was evaluated by comparing the monthly percentage of maximum WUA occurring under the NODOS Project alternatives, relative to the bases of comparison.

Green Sturgeon

Green sturgeon use of the lower American River is unknown, and lower American River fish surveys conducted by CDFG have not collected green sturgeon (Federal Register, 2008). More recently however, NMFS' final rule designating critical habitat for green sturgeon (NMFS, 2009b) states that critical habitat is designated to include "*…From the Sacramento I-Street Bridge… upstream to Keswick Dam… including the waters encompassed by the Yolo Bypass and the Sutter Bypass areas and the lower American River from the confluence with the mainstem Sacramento River upstream to…State Route 160 bridge over the American River.*"

Therefore, to be cautious regarding potential impacts of the NODOS Project alternatives, green sturgeon were evaluated in this impact assessment. Green sturgeon life history periodicities evaluated in the lower American River were based on reported green sturgeon life history periodicities in the Sacramento River.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on green sturgeon in the lower American River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration and holding (February through December)
  - Flows at the mouth of the lower American River
  - Water temperatures at the mouth of the lower American River

- Adult spawning and egg incubation (March through August)
  - Flows at the mouth of the lower American River
  - Water temperatures at the mouth of the lower American River

- Juvenile rearing and emigration (year-round)
  - Flows at the mouth of the lower American River
  - Water temperatures at the mouth of the lower American River

The assessment of potential flow- and water temperature-related impacts of the NODOS Project alternatives on green sturgeon in the lower American River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Hardhead

As reported by Moyle (2002), hardhead prefer clear, deep (>80 cm) pools and runs with sand-gravel-boulder substrates and slow water velocities (20-40 cm/sec) (Mayden et al., 1991; Knight, 1985; Alley, 1977a, b). However, little is known about life stage-specific water temperature requirements of hardhead.

Hardhead mature during their third year and often make spawning migrations, which occur in the spring into smaller tributary streams (Moyle, 2002). Most hardhead spawning is reportedly restricted to foothill streams (Wang and Reyes, 2007). Hardhead reportedly spawn primarily during April and May (Reeves, 1964; Grant and Maslin, 1999), but may spawn into July in Sacramento River tributaries and into August in San Joaquin River tributaries (Wang and Reyes, 2007). Suitable temperatures for spawning hardhead may range from 59°F to 64.4°F (Wang, 1986). Spawning behavior has not been documented, but hardhead are believed to elicit mass spawning in gravel riffles (Moyle, 2002).

In Brown et al. (1992), larval hardhead were reportedly found in late May in the lower American River. In addition, hardhead were captured as early as November in CDFG emigration surveys using RSTs (Snider et al., 1997; Snider and Titus, 2000).

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on hardhead in the lower American River for each of the following life stages, life history periodicities, and modeled locations:

- Adults and other life stages immigration and holding (year-round)
  - Flows at Watt Avenue
  - Water temperatures at Watt Avenue
- Adult spawning (April through June)
  - Flows at Watt Avenue
  - Water temperatures at Watt Avenue

The assessment of potential flow- and water temperature-related impacts of implementation of the NODOS Project alternatives on hardhead in the lower American River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

River Lamprey

Most lamprey spawning observed in the lower American River have been reported as Pacific lamprey (Hannon and Deason, 2008). However, river lampreys reportedly occur in RST collections in the lower American River. Both Pacific and river lamprey exhibit an anadromous, predatory life history pattern. Because river lamprey is a special status species (California Species of Special Concern) and river lampreys have been reported to occur in the lower American River, they were evaluated in this DEIR/EIS.

River lamprey life history information specific to the lower American River is lacking, although some information is reported for California. For example, adults migrate back into freshwater in the fall and spawn from April to June in small tributary streams (Wang, 1986). River lamprey are reported to spawn at water temperatures ranging from 55.4°F to 56.3°F (Wang, 1986), after which, the adults die. Studies addressing the thermal requirements of early life stages of Pacific and river lamprey have been conducted for the Columbia River Basin (Meeuwig et al., 2003). However, river lampreys were not assessed due to their scarcity and consequent inability to evaluate their early life stage thermal requirements. Laboratory studies and analyses did suggest, however, that consistently high survival and low occurrence of embryonic developmental abnormalities occur in Pacific lamprey at water temperatures ranging from 50°F to 64.4°F, with a significant decrease in survival and increase in developmental abnormalities at 71.6°F. Presumably, the adults need clean, gravelly riffles in permanent streams for spawning, while the ammocoetes (i.e., larvae) require sandy backwaters or stream edges in which to bury themselves, where water quality is continuously good and water temperatures do not exceed 77°F. Ammocoetes begin their transformation into adults when they are about 12 centimeters (cm) (4.7 inches) total length (TL), during the summer. The process of metamorphosis may take nine to ten months, the longest known for any lamprey species. Lampreys in the final stages of metamorphosis congregate immediately upriver from saltwater and enter the ocean in late spring. Adults apparently only spend three to four months in saltwater, where they grow rapidly, reaching 25 cm to 31 cm (9.8 to 12.2 inches) TL (Moyle, 2002). River lamprey life history periodicities evaluated in the lower American River were based on reported green sturgeon life history periodicities in the Sacramento River.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on river lamprey in the lower American River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration (September through June)
  - Flows below Nimbus Dam, at Watt Avenue, and at the mouth of the lower American River
  - Water temperatures below Nimbus Dam, at Watt Avenue, and at the mouth of the lower American River
- Adult spawning and embryo incubation (February through July)
  - Flows below Nimbus Dam, at Watt Avenue, and at the mouth of the lower American River
  - Water temperatures below Nimbus Dam, at Watt Avenue, and at the mouth of the lower American River
- Ammocoete rearing and emigration (year-round)
  - Flows below Nimbus Dam, at Watt Avenue, and at the mouth of the lower American River
  - Water temperatures below Nimbus Dam, at Watt Avenue, and at the mouth of the lower American River

The assessment of potential flow- and water temperature-related impacts of implementation of the NODOS Project alternatives on river lamprey in the lower American River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Pacific Lamprey

Most lamprey spawning observed in the lower American River have been reported as Pacific lamprey (Hannon and Deason, 2008). However, river lampreys reportedly occur in RST collections in the lower American River. Both Pacific and river lamprey exhibit an anadromous, predatory life history pattern. Because Pacific lamprey are a special status species (federal Species of Concern) and have been reported to occur in the lower American River, they were evaluated in this DEIR/EIS. Pacific lamprey life history periodicities evaluated in the lower American River were based on reported green sturgeon life history periodicities in the Sacramento River.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on Pacific lamprey in the lower American River for each of the following life stages, life history periodicities, and modeled locations:

- Adult immigration (January through June)
  - Flows below Nimbus Dam, at Watt Avenue, and at the mouth of the lower American River
  - Water temperatures below Nimbus Dam, at Watt Avenue, and at the mouth of the lower American River
- Adult spawning and embryo incubation (January through August)
  - Flows below Nimbus Dam, at Watt Avenue, and at the mouth of the lower American River
  - Water temperatures below Nimbus Dam, at Watt Avenue, and at the mouth of the lower American River
- Ammocoete rearing and emigration (year-round)
  - Flows below Nimbus Dam, at Watt Avenue, and at the mouth of the lower American River
  - Water temperatures below Nimbus Dam, at Watt Avenue, and at the mouth of the lower American River

The assessment of potential flow- and water temperature-related impacts of implementation of the NODOS Project alternatives on Pacific lamprey in the lower American River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Sacramento Splittail

Splittail may spawn in the lower American River in low numbers, with the majority of potential spawning occurring in the lower sections of the river (i.e., downstream of RM 12). Consequently, potential altered river flows from implementation of the NODOS Project alternatives could impact the availability of potential splittail spawning habitat within the lower American River by reducing the amount of riparian vegetation that would be inundated during the splittail spawning season (February through May).

The lower American River from RM 5 to the confluence with the Sacramento River is largely influenced by the water surface elevation of the Sacramento River. Therefore, the extent to which splittail spawning habitat, particularly inundated riparian vegetation, would be available along this lower reach of the river channel would be often controlled by the Sacramento River stage. Conversely, river stage in the portion of the river between RM 8 and RM 12, which is characterized by abundant backwater habitat, is controlled primarily by lower American River flows. The frequency and duration of riparian vegetation flooding in this area and, therefore, the quality and quantity of potential splittail spawning habitat has the potential to be impacted by reduced flows. Similar to the Feather River, a relationship between UFA and flow was developed during 1999 and is not utilized in this analysis because the relationship has not been updated based on recent historic flows. However, the principles of the UFA-stage relationship do apply to the flow-based impact assessment approach utilized in this DEIR/EIS. Specifically, substantial (10% or greater) changes in flow during the February through May period under the NODOS Project alternatives, relative to the bases of comparison, also could change the amount of UFA available to spawning splittail. Therefore, this analysis evaluated substantial changes in flow as an indicator of potential changes in UFA, and thus, as an indicator of potential impact on splittail spawning.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on splittail in the lower American River for the following life stage, life history periodicity, and modeled location:

- Adult spawning (February through May)
  - Flows at the mouth of the lower American River
  - Water temperatures at the mouth of the lower American River

The assessment of potential flow- and water temperature-related impacts of implementation of the NODOS Project alternatives on Sacramento splittail in the lower American River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

California Roach

California roach life history periodicities and habitat requirements in the lower American River are similar to those previously discussed for the Sacramento River (for additional information, also see the Affected Environment section of Chapter 12 Aquatic Biological Resources).

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on California roach in the lower American River for each of the following life stages, life history periodicities, and modeled locations:

- Adult spawning (March through June)
  - Flows at Watt Avenue
  - Water temperatures at Watt Avenue
- Adults and other life stages (year-round)
  - Flows at Watt Avenue
  - Water temperatures at Watt Avenue

The assessment of potential flow- and water temperature-related impacts of implementation of the NODOS Project alternatives on California roach in the lower American River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Striped Bass

Striped bass life history periodicities and habitat requirements in the lower American River are similar to those previously discussed for the Sacramento River (for additional information, also see the Affected Environment section of Chapter 12 Aquatic Biological Resources).

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on striped bass in the lower American River for each of the following life stages, life history periodicities, and modeled locations:

- Adult spawning, embryo incubation and initial rearing period (April through June)
  - Flows at Watt Avenue and at the mouth of the lower American River

  - Water temperatures at Watt Avenue and at the mouth of the lower American River

- Larvae, fry, and juvenile rearing and emigration (year-round)
  - Flows at Watt Avenue and at the mouth of the lower American River
  - Water temperatures at Watt Avenue and at the mouth of the lower American River

The assessment of potential flow- and water temperature-related impacts of implementation of the NODOS Project alternatives on striped bass in the lower American River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

American Shad

American shad life history periodicities and habitat requirements in the lower American River are similar to those previously discussed for the Sacramento River (for additional information, also see the Affected Environment section of Chapter 12 Aquatic Biological Resources).

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on American shad in the lower American River for each of the following life stages, life history periodicities, and modeled locations:

- Adult spawning, embryo incubation and initial rearing period (April through June)
  - Flows at Watt Avenue and at the mouth of the lower American River
  - Water temperatures at Watt Avenue and at the mouth of the lower American River

- Larvae, fry, and juvenile rearing and emigration (July through November)
  - Flows at Watt Avenue and at the mouth of the lower American River
  - Water temperatures at Watt Avenue and at the mouth of the lower American River

The assessment of potential flow- and water temperature-related impacts of implementation of the NODOS Project alternatives on American shad in the lower American River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

Largemouth Bass

Warmwater game fishes, including black basses, crappies, other sunfishes, and catfishes support recreational fishing throughout the Sacramento River system, including the lower American River. Many warmwater game fishes, including largemouth bass, bluegill and other sunfishes, and bullheads are most abundant in sloughs and river backwaters, particularly in disturbed areas with large pools with dense aquatic vegetation (Moyle, 2002). Because warmwater game fishes have similar life history characteristics and generally have similar habitat requirements, largemouth bass were evaluated as an indicator of potential impacts that could occur on warmwater game fishes including smallmouth bass, crappies, other sunfishes, and catfishes.

Comparisons of modeling output for the NODOS Project alternatives, relative to the bases of comparison (Existing Conditions and the No Project/No Action Alternative), were conducted to identify potential impacts on largemouth bass in the lower American River for each of the following life stages, life history periodicities, and modeled locations:

- Adults and other life stages (year-round)
  - Flows at Watt Avenue
- Adult spawning (March through June)
  - Water temperatures at Watt Avenue

The assessment of potential flow- and water temperature-related impacts of implementation of the NODOS Project alternatives on largemouth bass in the lower American River, relative to the bases of comparison, included evaluation of: (1) long-term averages; (2) averages by water year type; and (3) cumulative probability distributions.

12B.2.9 Sacramento-San Joaquin Delta, Yolo Bypass, Suisun Bay, San Pablo Bay, and San Francisco Bay

Historical modification of ecosystem processes and functions in the Delta and throughout the Sacramento and San Joaquin River watersheds have influenced the current aquatic habitat conditions, which directly affects special-status species and other species of primary management concern (i.e., recreationally and commercially important species). The Delta was once a vast marsh and floodplain intersected by meandering channels and sloughs that provided habitat for a rich diversity of fish, wildlife, and plants. The Delta of today is a system of artificially channeled, dredged, and leveed waterways constructed into static geometries, initially constructed by local farmers to support farming, and later used, to protect urban development against flooding and to convey water supplies to cities and farms in the Bay Area, San Joaquin Valley, and southern California.

Aquatic habitat conditions are the result of a combination of unaltered discharges from surface water and groundwater flowing into the Delta, and managed releases from reservoirs. Flows in the Delta vary seasonally and annually with rainfall, run-off, and water supply management. The volume and distribution of water in the watershed influence aquatic habitat, communities, and important ecological processes and functions.

The majority of fish species in the Delta use the Tidal Perennial Aquatic community (see Affected Environment and the CALFED Ecosystem Restoration Program Plan for detailed description of the aquatic communities in the Delta). Delta aquatic communities are used by fish for foraging, spawning, egg incubation and larval development, juvenile nursery areas, and migratory corridors. Most Delta resident fish species spend their entire lives in the Tidal Perennial Aquatic community while other fishes in the Delta may spend certain seasons or part of their lives in different areas of the community, based on physical factors such as salinity, turbidity, DO, flow rates, and water temperature.

Use of the various aquatic habitats within the Delta by individual species is often determined by multiple physical factors (e.g., flow, salinity, wind, tide, and temperature), many of which vary at multiple temporal scales (Kimmerer, 2004). Resident and migratory fish use Delta aquatic habitats for spawning, rearing, foraging, and escape cover. Striped bass, delta smelt, Sacramento splittail, and many resident Delta fish use this habitat for rearing and as adults (CALFED, 2000). Young steelhead and Chinook salmon forage in these productive waters as fry and juveniles to gain weight and improve condition before entering the ocean.

In the Delta, saline coastal oceanic water is mixed and diluted by flowing fresh water of rivers. This mix of fresh and oceanic water forms a salinity gradient that varies by area and location with seasonal variations in freshwater inflow and tidal action. This gradient drives the location of species that depend on salinity, such as estuarine vegetation, and delta smelt and longfin smelt. The location of this gradient reportedly varies on multiple time scales as a result of multiple processes — daily tides, monthly lunar cycle, intra-annual (seasonal) flow patterns, and interannual flow variation from interannual rainfall variation, and long-term global climate change (Kimmerer, 2004). During low-flow periods, the salinity gradient is maintained at locations that provide for freshwater in the Delta at levels that maintain human uses. Historically, the salinity gradient was generally farther downstream than it now occurs under similar hydrologic conditions.

When floodplain habitat is inundated, it serves as shallow open water habitat for pelagic fish species, including Sacramento splittail, salmonids, and benthic fish species, including sturgeon.

Riparian forest canopy on the banks of estuaries and rivers stabilize channels; help shape submerged aquatic habitat structure; benefit the aquatic environment by contributing shade, overhead canopy, and instream cover for fish; and reduce river water temperature (CALFED, 2000).

As reported in the Pelagic Organism Decline Progress Report: 2007 Synthesis of Results (Baxter et al., 2008), habitat for pelagic fish species is comprised of open water, largely away from shorelines and vegetated inshore areas. These areas are used for the majority of the life cycle needs of the pelagic fish species except perhaps during spawning. Pelagic open water habitat includes the deeper areas of many of the larger channels in the Delta, in addition to large embayments such as Suisun Bay. Pelagic fish habitat is characterized by physical and chemical properties, including salinity, turbidity, and water temperature, and biological properties such as prey production. Thus, pelagic fish habitat suitability in the estuary is influenced by variation in freshwater flow (e.g., Delta outflow) (Jassby et al., 1995; Bennett and Moyle, 1996; Kimmerer, 2004).

Several fish species use a variety of behaviors to maintain themselves within open-water areas where water quality and food resources are favorable (Bennett et al., 2002). Delta smelt, longfin smelt, striped bass, and threadfin shad distribute themselves at different concentrations of salinity within the estuarine salinity gradient (Feyrer et al., 2007; Kimmerer, 2002a), indicating that at any point in time, salinity is a major factor affecting their geographic distributions. Because of the importance that salinity has on fish distribution in the estuary, the term “Low-Salinity Zone” (LSZ) within the San Francisco Estuary was created and is defined as the area within the estuary where salinity is approximately 0.5 to 6.0 parts per thousand (ppt). X2 (i.e., roughly the center of the LSZ), is defined as salinity of around 2.0 ppt (Kimmerer, 2002b). The term X2 is used to define the distance from the Golden Gate Bridge upstream to where salinity near the bottom of the water column is approximately 2.0 ppt. Salinity between two and about 30 ppt is roughly linearly distributed between X2 and the mouth of the estuary (Kimmerer, 2002b). X2 reflects the physical response of the San Francisco Estuary to changes in flow and provides a geographic frame of reference for estuarine conditions (Kimmerer, 2002b). The estuary responds to freshwater flow on a time scale of two weeks, as characterized by the statistical relationship between X2 location and flow (Kimmerer, 2004). Because the location of X2 relies upon a number of physical parameters including river flows, water diversions and tides, its position shifts over many kilometers on a daily and seasonal cycle. Over the course of a year, the location of X2 can range from San Pablo Bay during high river flow periods, up into the Delta during the summer.

According to CDFG (2010), the available data and information indicates: (1) many fish and aquatic species’ abundances are related to water flow timing and quantity (or the location of X2); (2) for many fish and aquatic species, more water flow translates into greater species production or abundance; (3) fish and aquatic species are adapted to use the water resources of the Delta during all seasons of the year, but for many species, important life history stages or processes consistently coincide with increased winter-spring flows; and (4) the source, quality, and timing of water flows through the estuary influences the production of Chinook salmon in both the San Joaquin River and Sacramento River basins (CDFG, 2010). However, Delta outflow is affected by multiple factors and conditions, many of which are involved in hypothesized mechanisms for X2 relationships (Kimmerer, 2004). Therefore, the presence of an X2 relationship does not necessarily imply anything about the conditions at the location where the salinity is near two ppt (Kimmerer, 2004).

The NODOS Project alternatives have the potential to influence aquatic habitat conditions by potentially altering Delta inflow and water export operations. Therefore, aquatic habitat conditions and export operations (e.g., fish salvage operations) were evaluated to identify potential impacts on Delta fish species of primary management concern.

12B.2.9.1 Species of Focused Evaluation

The assemblages of fish in the Delta and watersheds upstream include a mixture of native and introduced species. Although there is limited knowledge of the ecology of native fishes in the past, the historical assemblages of fish upstream of and in the Delta were different from the current assemblages (Moyle, 2002). For example, the Sacramento perch, once abundant in sloughs off main channels, was extirpated from the Delta (Rutter, 1908). Conversely, a large number of nonnative species of fish have been either intentionally (e.g., striped bass, channel catfish, American shad, threadfin shad, and largemouth bass) or unintentionally (e.g., goldfish) introduced into the system.

Although there are many species that inhabit the Delta for all or part of their life cycles, the following fish species of primary management concern were considered for detailed evaluation in the Delta because they are State or federally listed as threatened or endangered, proposed for State or federal listing as threatened or endangered, classified as candidates for future State or federal listing, State species of special concern, or were considered commercially or recreationally important. These species included:

- Delta smelt
- Longfin smelt
- Chinook salmon (spring, fall, late fall, and winter-runs)
- Central Valley steelhead
- Green sturgeon
- White sturgeon
- Sacramento splittail
- River lamprey
- Pacific lamprey
- American shad
- Striped bass
- Warmwater game fishes

12B.2.9.2 Species Dismissed from Detailed Evaluation

California roach, a California Species of Special Concern, is reported to be distributed in the Sacramento and San Joaquin river drainages, except the Pit River, as well as tributaries to San Francisco Bay (Moyle, 2002). The species also is reported to be generally found in small, warm, intermittent streams, and are most abundant in mid-elevation streams in the Sierra foothills and in the lower reaches of some coastal streams (Moyle, 2002; Moyle et al., 1982). Based on these descriptions it is possible that

California roach could historically have occurred in the Delta. However, based on evaluation of recent and historical fish surveys in the Delta, as well as historical salvage data, it is unlikely that California roach occur in appreciable numbers in the Delta. Specifically, only two roach were reported in salvage data collected at the SWP and CVP fish salvage facilities between 1959 and 2005 (BDAT, 2010). Therefore, it is anticipated that water operations would not substantively impact roach in the Delta. Thus, no further evaluation of California roach in the Delta was conducted.

Hardhead, a California Species of Special Concern, is widely distributed throughout the Sacramento-San Joaquin River system, although it is absent from the valley reaches of the San Joaquin River (Moyle, 2002). Hardhead generally occur in large, undisturbed low- to mid-elevation rivers and streams of the region (Moyle, 2002). The precise historical distribution and abundance patterns of hardhead are unknown, but the presence of their remains in Indian middens (i.e., a mound or deposit containing shells, animal bones, and other refuse) suggests that they were common in the general Delta region when the Delta was still a largely undisturbed intertidal swamp (Bay Institute, 1998). However, based on evaluation of recent and historical fish surveys in the Delta, it is unlikely that hardhead occur in appreciable numbers in the Delta. Specifically, very few hardhead were reported in salvage data collected at the SWP and CVP fish salvage facilities. For example, from April 1, 2000, through March 31, 2003, the average annual salvage of hardhead at the Tracy Fish Facility was four individuals (Reclamation, 2009). Between 1993 and 2000, only 38 Hardhead were counted at the SWP and CVP fish salvage facilities (BDAT, 2010). Therefore, it is anticipated that water operations would not substantively impact hardhead in the Delta. Thus, no further evaluation of hardhead in the Delta was conducted.

Northern anchovy and starry flounder are managed as “monitored species” by the Coastal Pelagic Species Fishery Management Plan and the Pacific Coast Groundfish Fishery Management Plan of the Pacific Fishery Management Council (PFMC), respectively, and are subject to Essential Fish Habitat consultation as a result (Reclamation, 2008).

Northern anchovy occur from British Columbia to Baja California (Reclamation, 2008) and are reported to be common in surveys of the lower tidal portions of Sacramento and San Joaquin rivers (Reclamation, 2008). However, because of their salinity requirements, northern anchovy have not been recorded above brackish water within these systems. This species typically is found from seawater to mesohaline waters (moderately brackish with salinity range of 5 to 18 ppt) and occasionally in oligohaline areas (brackish water with low salinity range of 0.5 to 5 ppt) (Reclamation, 2008).

Reclamation (2008) determined that because the northern anchovy is primarily a marine species and integrated SWP/CVP operations have little impact on marine conditions, it is unlikely that changes in SWP/CVP operations would affect the northern anchovy. Northern anchovy made up less than one percent of the total fish captured by otter trawl and beach seine in Suisun Marsh between 1979 and 1999 (Reclamation, 2008). However, this species was the 4th most common fish larvae collected in a 1991 survey of Suisun Bay and also are common in San Pablo Bay (Reclamation, 2008). Reclamation also reported that there are no records of northern anchovy salvage at the SWP/CVP fish salvage facilities (Reclamation, 2008). Therefore, it is anticipated that water operations would not substantively impact northern anchovy in the Delta. Thus, no further detailed evaluation of northern anchovy in the Delta was conducted.

The starry flounder is known to occur in coastal waters of the Pacific and Arctic oceans and connecting seas. In the eastern Pacific, the southern limit of its range is the mouth of the Santa Ynez River (Santa Barbara County, California) to as far north as the Alaskan Peninsula (Reclamation, 2008). In northern

California, this species can occur as far east as Suisun Bay and the lower portion of the San Joaquin River in the Delta. Further, Reclamation (2008) considered starry flounder primarily a marine and estuarine species.

Starry flounder is one of the most common flatfish in the San Francisco Bay and Delta and an important component of the nearshore (inner continental shelf and shallow sublittoral) communities (Reclamation, 2008). Starry flounder distributions tend to shift with growth, with younger juveniles being typically found in fresh or brackish water of Suisun Bay, Suisun Marsh, and the Delta while older juveniles range from brackish to marine water of Suisun and San Pablo Bays, and adults tend to live in shallow marine waters within and outside the San Francisco Bay before returning to estuaries to spawn (Reclamation, 2008).

Starry flounder are not targeted by central California commercial fisheries. Most individuals are taken as incidental catch by bottom trawls, gill nets, and trammel nets. Recreational catch typically occurs by hook and line methods from piers, boats, and shore in estuarine and rocky areas (Reclamation, 2008).

Salvage of starry flounder has been documented at the SWP and CVP fish salvage facilities in the Delta. Specifically, it has been reported that fish salvage records for the Sacramento-San Joaquin Delta between 1981 and 2002 indicated average monthly salvage of 187 fish per month at CVP and 77 at SWP (Reclamation, 2008). Recent salvage data indicate that substantially fewer starry flounder have been salvaged. Specifically, salvage data obtained from the CDFG Salvage FTP website during 2010 from 1995 through 2006 showed that most starry flounder salvage at both facilities occurred during May through July. During 2008 and 2009 CDFG salvage data indicate that most starry flounder salvage occurred during April and May. At the time of data retrieval 2007 data were unavailable. Average monthly starry flounder salvage at the SWP and CVP facilities combined from 1995 through 2006 was 51 fish during May, 79 fish during June, and 30 fish during July (data from CDFG FTP website). During 2008 through 2009 average combined SWP and CVP starry flounder salvage was 10 and 12 fish during April and May, respectively. Additionally, the next highest average salvage estimate was four fish salvaged during March, April, and August. However, the highest single month salvage estimate occurred during June 1997 with an average of 427 fish salvaged at both facilities combined. The highest single month starry flounder salvage at either facility was 696 fish at the CVP facility during May 1997. Because starry flounder are not listed as threatened or endangered under the state or federal Endangered Species Acts, as Species of Special Concern by CDFG or Species of Concern by USFWS, are not targeted by commercial fisheries, do not support a large recreational fishery, and are generally salvaged in relatively low numbers, no further evaluation of starry flounder in the Delta was conducted.

12B.2.9.3 Fish Salvage and Entrainment Loss

The fish salvage and entrainment loss analysis provided estimates of salvage under the NODOS Project alternatives and bases of comparison at the Skinner Fish Protection Facility (SWP) and Tracy Fish Collection Facility (CVP) for species identified at each facility. In general, simulated salvage of a species was estimated by calculating historical salvage densities (available from CDFG), and multiplying those historical salvage densities by simulated export volumes under the NODOS Project alternatives and the bases of comparison (Existing Conditions and the No Project/No Action Alternative). Estimated changes in salvage at the export facilities were compared by month and water year type under the NODOS Project alternatives, relative to the bases of comparison.

Because entrainment at the SWP and CVP facilities is a function of the number of individuals in the Delta, historical salvage densities were normalized for some species based on corresponding historical population estimates. Specifically, for well studied species including striped bass and delta smelt, historic population estimates are available for the same years as available salvage densities. For those species where reputable population estimates were not available or where the relationship between a species' population abundance index (i.e., FMWT index) and salvage of the species was not statistically significant (see Appendix 12I), no historical abundance normalization was conducted.

Detailed description of the approach used to estimate salvage losses for multiple species is provided in Appendix 12I.

12B.2.9.4 Species-Specific Analytical Approach

<u>Delta Smelt</u>

Delta smelt are endemic to the Bay-Delta estuary (Moyle, 2002). Delta smelt primarily are found downstream of Isleton on the Sacramento River, downstream of Mossdale on the San Joaquin River, and in Suisun Bay and Suisun Marsh. Delta smelt adults occur primarily in the tidally influenced low salinity region of Suisun Bay and the freshwater regions of the Delta and the Sacramento and San Joaquin rivers (Moyle, 2002). The downstream location of the low salinity habitat for delta smelt is typically located in Suisun Bay, extending farther to the west in response to high delta outflows and farther to the east in response to low delta outflows. Delta smelt have been collected in Carquinez Strait, the Napa River, and even as far downstream as San Pablo Bay in wet years (Moyle, 2002). During September or October, adults begin upstream movement towards freshwater sloughs and channels of the western Delta to spawn. Spawning takes place between February and July, but appears to be greatest during mid-April and May (Bennett, 2005). Spawning can occur in the Sacramento River as far upstream as Sacramento, the Mokelumne River system, and the Cache Slough region (Moyle, 2002). Since 1982, the center of adult delta smelt abundance in the fall has been the northwestern Delta in the channel of the Sacramento River near Decker Island. In any month, two or more life stages (adult, larvae, and juveniles) of delta smelt have the potential to be present in Suisun Bay (Wang, 1991; DWR and Reclamation, 1994; Moyle, 2002). Delta smelt are also found seasonally in Suisun Marsh.

Egg and Embryo

Based on reported Delta smelt spawning timing, evaluation of potential impacts on Delta smelt eggs and embryos was conducted for the period of February through May (Moyle, 2002, USFWS, 2008).

Water Temperature

Water temperature reportedly is an important factor in the development of eggs and newly hatched delta smelt (Swanson and Cech, 1995; Bennett, 2005). Recent studies show that optimal delta smelt hatching success and larval survival in aquaculture occurs at 15°C to 17°C (Bennett, 2005). While incubation temperatures below 15°C have generally lower hatching success, water temperatures exceeding 20°C decrease the egg incubation period, mean hatch length, time to first-feeding, as well as larval feeding success, resulting in higher mortality (Bennett, 2005). Therefore, delta smelt spawning success may be variable when temperatures fall below 15°C, but may be more sharply limited by water temperatures that are above 20°C (Bennett, 2005). Temperatures above 20°C during spring can also lead to higher mortality of newly spawned larvae (Bennett, 2005).

Although water temperature is an important factor in the egg development and hatching success of delta smelt, the NODOS Project alternatives would have limited opportunity to affect water temperatures in the Delta. Specifically, diversions at the proposed Delevan Pipeline Intake Facilities and flows returning to the Sacramento River from the proposed Sites Reservoir would be a relatively small proportion of the flow in the Sacramento River. Additionally, the proposed Delevan Pipeline Intake Facilities would be approximately 100 river miles from areas in which delta smelt generally spawn. Therefore, diversion of up to 2,000 cfs and release of up to 1,500 cfs at the proposed Delevan Pipeline Intake/Discharge Facilities is not likely to directly appreciably alter water temperature in the Sacramento River near delta smelt spawning and embryo incubation areas. However, changes in SWP and CVP reservoir releases and operations at the South Delta pumping facilities could potentially alter Delta inflow and outflow in the Sacramento River, which could potentially alter residence times and water temperatures in delta smelt spawning areas.

Monthly Sacramento River water temperatures at Freeport were simulated under the NODOS Project alternatives and bases of comparison using Reclamation's average monthly water temperature model. For purposes of impact assessment, average monthly water temperatures at Freeport were evaluated for the period of February through May (Moyle, 2002, USFWS, 2008) under the NODOS Project alternatives, relative to the bases of comparison. Specifically, because egg and embryo hatching success and survival decreases below 15°C (59°F) and above 20°C (68°F), exceedance probability distributions were utilized to calculate the proportion of time that water temperatures would occur within this range under the NODOS Project alternatives, relative to the bases of comparison.

Larvae

Based on the reported onset of delta smelt spawning and embryo incubation durations, evaluation of potential impacts on delta smelt eggs and embryos is conducted for the period of March through June (Moyle, 2002, USFWS, 2008).

Water Temperature

Similar to the egg and embryo life stage, delta smelt larval survival reportedly is optimized when water temperatures are within the range of approximately 15°C to 20°C (Bennett, 2005), and decreases when temperatures rise above 20°C (Swanson and Cech, 1995; Bennett, 2005). Different portions of the Delta experience different water temperature conditions, with water temperatures increasing in the central and south Delta more than they do in the northern Delta or Suisun Bay. Because the Delta has a large water surface area and covers a large geographic extent water temperature is influenced by ambient weather and climatic conditions to a greater degree than operation of the SWP and CVP facilities, it is unlikely that the NODOS Project alternatives would influence water temperatures in the Delta substantially during the March through June analytical period. However, changes in flows associated with the NODOS Project alternatives and operations at the South Delta pumping facilities could potentially alter Delta inflow and outflow in the Sacramento River, which could potentially alter Delta water residence times and temperatures, which could potentially alter Delta water temperatures and potentially impact delta smelt larvae.

Monthly Sacramento River water temperatures at Freeport were simulated under the NODOS Project alternatives and bases of comparison using Reclamation's average monthly water temperature model. For purposes of impact assessment, average monthly water temperatures at Freeport were evaluated for the period of March through June (Moyle, 2002, USFWS, 2008) under the NODOS Project alternatives, relative to the bases of comparison. Specifically, because egg and embryo hatching success and survival decreases below 15°C (59°F) and above 20°C (68°F), exceedance probability distributions were utilized to calculate the proportion of time that water temperatures would occur within this range under the NODOS Project alternatives, relative to the bases of comparison.

Entrainment

Larval delta smelt are considered weak swimmers that reportedly exercise some control of their position in the Delta through vertical migrations in the water column (Bennett, 2005), and are commonly found in very low salinity water (BDCP, 2010). Their initial distribution in the Delta is dependent on the location of spawning. Larval delta smelt are generally observed in the Delta between March and June, with a peak between April and May (BDCP, 2010). The fish screens associated with the fish salvage facilities are not effective for fish less than 20 mm in length, and any screened larval delta smelt likely suffer high rates of mortality during the collection, handling, transport, and release phases of the salvage process (BDCP, 2010). Therefore, larval delta smelt entrained at the SWP and CVP facilities are generally presumed to be lost.

OMR Flows

USFWS (2008) identifies actions to protect larval and juvenile delta smelt from entrainment at the SWP and CVP export facilities (see RPA Action 3 in USFWS, 2008), which are initiated when water temperatures reach 12°C at three monitoring stations in the Delta, or when a spent delta smelt female is caught. Old River and Middle River (OMR) flows during this phase were to be maintained more positive than -1,250 to -5,000 cfs based on a 14-day running average, which would be in effect until June 30 or when the 3-day-mean water temperature at Clifton Court Forebay is 25°C (USFWS, 2008).

In reviewing the OMR flow restrictions in USFWS (2008), the National Research Council (2010) found that the available data did not allow for a "…confident identification of the threshold values to use…", and recommended that the implementation of the OMR flow restrictions be accompanied by monitoring, adaptive management, and additional analyses. In addition, the United States District Court of the Eastern District of California's 2010 ruling on the Consolidated Delta Smelt Cases (San Luis & Delta-Mendota Water Authority, et al. v. Salazar, et al., No. 1:09-CV-407 OWW DLB (E.D. Cal. filed March 3, 2009)) remanded the OMR flow restrictions associated with the USFWS (2008) RPA Action 3 because USFWS (2008) developed the OMR flow criteria using raw Delta smelt salvage data, rather than salvage data normalized to the delta smelt population. Therefore, no evaluation delta smelt entrainment using OMR flow criteria described in USFWS (2008) was conducted to identify potential impacts of the NODOS Project alternatives on delta smelt. However, because delta smelt larvae are reportedly weak swimmers and likely are subject to non-volitional movement, changes in OMR flows associated with the NODOS Project alternatives were evaluated, relative to the bases of comparison.

Although the U.S. District Court ruled that substantively science-based OMR flow criteria are not currently available for use in operating the SWP and CVP, SWRCB (2010) and CDFG (2010) recommended that OMR flows be more positive than -1,500 cfs during March through June of dry and critically dry years to protect the delta smelt population from entrainment at the SWP and CVP export facilities during years with relatively low Delta outflow. Therefore, for purposes of assessing potential impacts of implementing the NODOS Project alternatives, flows less than (i.e., more negative) -1,500 cfs were used as an indicator of potential impact on delta smelt. Specifically, the percentage of time from March through June when OMR flows would be less than -1,500 cfs during dry and critical years under the NODOS Project alternatives was evaluated, relative to the bases of comparison.

Turbidity

Sub-adult and adult delta smelt densities are positively correlated with turbidity (BDCP, 2010), which indicates that turbidity is an important component of sub-adult and adult delta smelt habitat. Because it is hypothesized that high turbidity allows for increased predator avoidance, turbidity could potentially also be an important component of larval delta smelt habitat. However, because turbidity can be localized and is influenced by multiple factors, modeling turbidity associated with implementation of the NODOS Project alternatives is problematic and currently not available. Therefore, no further evaluation of potential changes in turbidity and subsequent potential impacts on delta smelt was conducted.

Transport *F*lows

Larval delta smelt may rely upon flow patterns to facilitate their movement from one area to another when conditions in their existing location become unsuitable. The geographic distribution of larval and early juvenile life stages of delta smelt reportedly appears to be influenced by freshwater inflows to the Delta during the late winter and spring. It has been hypothesized that higher Delta inflows result in faster larval planktonic transport rates from the upstream spawning habitat to the downstream estuarine portions of the Delta. Specifically, this movement occurs from the Delta downstream to the low-salinity zone, generally located downstream of the confluence of the Sacramento and San Joaquin rivers or in Suisun Bay (Bennett, 2005). The importance of transport flows for larval delta smelt is dependent on the distribution of larvae in the Delta and ambient water temperature and food supply conditions. If water temperatures are suitable and food supply is sufficient to provide adequate nourishment during the period when delta smelt first begin feeding (five to eight days after hatching), transport flows would likely be unimportant. However, when water temperatures become too warm (i.e., exceed 22°C) or food supplies in the area where delta smelt hatch are inadequate, transport flows likely are more important. Because food quantity is generally higher in the low-salinity zone compared to upstream areas, it is expected that delta smelt would be in more suitable conditions if they move into this region before exogenous feeding begins.

Additionally, although there is no known positive correlation between Delta outflow and delta smelt abundance, Delta outflow does reportedly have significant positive effects on several measures of delta smelt habitat (SWRCB, 2010), and spring outflow is positively correlated with spring abundance of *Eurytemora affinis* (SWRCB, 2010), an important delta smelt prey item. Therefore, potential impacts associated with changes in Delta outflow resulting from implementation of the NODOS Project alternatives could occur.

Effects on the downstream transport of larval delta smelt are estimated by evaluating simulated average monthly Delta outflow during the latter portion (May and June) of the larval delta smelt evaluation period when water temperatures in the Central and South Delta begin to warm. Higher Delta outflow is generally assumed to be a result of greater inflow and increased movement of water through the Delta, thus resulting in increased transport and survival of larval delta smelt.

Food Availability

Production of larval and juvenile delta smelt reportedly is food limited in the Delta and food limitation during these life stages is an important contributing cause of the species' recent declines and an impediment to its recovery (Sommer et al., 2007). Suppressed food supply during late spring and early summer (roughly May through June) may be contributing to reduced growth rates of larval and juvenile delta smelt, which have declined in connection with recent declines in the abundance of key copepod species (Sweetnam, 1999; Bennett, 2005). In recent decades significant changes have been reported in the composition of the phytoplankton community within Suisun Bay and the interior Delta (Brown, 2009). Diatoms of the genus *Thalassiosira*, which are important in the diet of calanoid copepods (an important food item of delta smelt), have declined substantially, while the abundance of less favorable phytoplankton, such as flagellates, green algae, a cyanobacteria have increased. Smaller, slower growing smelt reportedly are generally subject to higher rates of predation and are ultimately less fecund as adults. Changes in SWP and CVP operations associated with the NODOS Project alternatives may affect food availability by changing Delta residence time and nutrient concentrations.

Juvenile

Evaluation of potential impacts on delta smelt juveniles was conducted for the period of May through July (Moyle, 2002, USFWS, 2008).

Water Temperature

Water temperature tolerance thresholds for juvenile delta smelt are not commonly reported in readily available literature. However, survival of newly spawned larvae and older delta smelt appear to decrease at temperatures over 20 °C (Swanson and Cech, 1995, Bennett, 2005). Additionally, delta smelt of all sizes are found in the main channels of the Delta and Suisun Marsh and the open waters of Suisun Bay, where the waters are well oxygenated and temperatures are relatively cool, usually lower than 20°C to 22°C in summer. Specifically, over 90 percent of juvenile and pre-adult delta smelt caught in the CDFG Summer Townet Survey and CDFG Fall Mid-Water Trawl Survey were collected at water temperatures lower than 20°C (Bennett, 2005). Additionally, water temperatures over approximately 25°C are reportedly lethal for delta smelt, and can constrain delta smelt habitat, particularly during summer and early fall (2005).

Monthly Sacramento River water temperatures at Freeport were simulated under the NODOS Project alternatives and bases of comparison using Reclamation’s average monthly water temperature model. For purposes of conducting an impact assessment on delta smelt juveniles, average monthly water temperatures at Freeport were evaluated for the period of May through July (Moyle, 2002, USFWS, 2008) under the NODOS Project alternatives, relative to the bases of comparison. Specifically, because egg and embryo hatching success and survival decreases below 15°C (59°F), it was assumed that juvenile growth and survival also would be reduced. Additionally, because over 90 percent of juvenile delta smelt are found in CDFG surveys at water temperatures below 20°C (68°F), exceedance probability distributions were utilized to calculate the proportion of time that water temperatures would occur within this range under the NODOS Project alternatives, relative to the bases of comparison.

Entrainment

Salvage operations at the SWP and CVP export facilities (the John E. Skinner Fish Protective Facility and Tracy Fish Collection Facility, respectively) are performed to reduce the number of fish adversely impacted by entrainment. Salvage estimates are defined as the number of fish entering a salvage facility, and salvaged fish are subsequently returned to the Delta through a trucking and release operation. Because the survival of species that are sensitive to handling is believed to be low, increased salvage is potentially considered an adverse impact and decreased salvage is considered a beneficial impact on Delta fisheries.

Juvenile delta smelt reportedly range from 25 mm to 40 mm in length (Bennett, 2005). Post-larval delta smelt begin to attain this size during approximately mid-May (BDCP, 2010). Juvenile delta smelt in the central and south Delta are more vulnerable to entrainment by the SWP and CVP facilities relative to juveniles in the North Delta or Suisun Bay. As water temperatures in the central and south Delta become warmer during May and June, juveniles in this region are believed to move to Suisun Bay or the confluence area, where conditions are more suitable (Nobriga et al., 2008, as cited in BDCP, 2010).

Estimating juvenile delta smelt entrainment risk under the NODOS Project alternatives, relative to bases of comparison, included calculating average monthly delta smelt salvage densities (i.e., individuals per volume water exported) using historical average monthly salvage densities for water years 1996 through 2009, and CALSIM II-simulated export volumes at the SWP and CVP facilities. The delta smelt FMWT abundance index was used to correct/normalize salvage for estimated population size. Because historical salvage densities do not distinguish between adult and juvenile delta smelt, the analysis did not distinguish between life stages.

Turbidity

Sub-adult and adult delta smelt densities are positively correlated with turbidity (BDCP, 2010), which indicates that turbidity is an important component of sub-adult and adult delta smelt habitat. Because it is hypothesized that high turbidity allows for increased predator avoidance, turbidity could potentially also be an important component of larval delta smelt habitat. However, because turbidity can be localized and is influenced by multiple factors, modeling turbidity associated with implementation of the NODOS Project alternatives is problematic and currently not available. Therefore, no further evaluation of potential changes in turbidity and subsequent potential impacts on delta smelt was conducted.

Food Availability

Analysis of food availability for delta smelt juveniles was identical to the analysis conducted for delta smelt larvae, and is described above.

Rearing Habitat

Delta smelt rearing habitat suitability increases when the location of the Low Salinity Zone during the fall is downstream of the confluence of the Sacramento and San Joaquin rivers (SWRCB, 2010). This corresponds to Delta outflow being greater than approximately 7,500 cfs between September and November, which would have to be achieved by release of water from upstream reservoirs during most years (CDFG, 2010). USFWS (2008) recommended that the Low Salinity Zone be maintained in Suisun Bay during the fall of above normal and wet water years. Specifically, the USFWS (2008) RPA Action 4 prescribed an X2 location of 74 RKm during wet water years, and an X2 location of 81 RKm during above normal water years. This action was restricted to wetter water years to ensure that sufficient cold water pool availability remained for steelhead and salmon during drier water years (USFWS, 2008). In review of USFWS (2008), the National Research Council (2010) concluded that the fall X2 criteria were conceptually sound, but expressed concern over the uncertainty associated with the potential benefits to the delta smelt population. CDFG (2010) agreed with USFWS (2008) and the National Research Council (2010) that the fall X2 criteria “should be implemented within an adaptive framework, including competing studies designed to clarify the mechanism(s) underlying the effects of fall habitat on the delta smelt population, and a comprehensive review of the outcomes of the action and its effectiveness” (p. 71). Presumably based on USFWS (2008), CDFG (2010) recommended that X2 be maintained in between 74 RKm and 81 RKm between September and November during wet and above normal water year types.

The U.S. District Court of the Eastern District of California's 2010 ruling on the Consolidated Delta Smelt Cases (San Luis & Delta-Mendota Water Authority, et al. v. Salazar, et al., No. 1:09-CV-407 OWW DLB (E.D. Cal. filed March 3, 2009)) remanded the fall X2 criteria associated with the USFWS (2008) RPA Action 4 because the Court determined that its development was based on comparing simulated CALSIM II X2 location to modeled historical Dayflow X2 location without adequate calibration of CALSIM II and Dayflow, and that there was inadequate justification for the identification of the specific X2 locations (74 RKm and 81 RKm). However, the Court did agree that X2 has a measurable effect on delta smelt abiotic habitat and that there is adequate evidence to "…consider X2 a proxy for critical habitat and to structure management prescriptions around X2" (p. 116-117). Therefore, no evaluation of X2 criteria was conducted to identify the potential impacts of the NODOS Project alternatives on delta smelt. However, because X2 location is considered an indicator of delta smelt habitat availability, an evaluation of changes in X2 location under the NODOS Project alternatives, relative to the bases of comparison, was conducted.

Although the U.S. District Court ruled that substantively science-based X2 criteria are not currently available for use in operating the SWP and CVP, changes in X2 location reportedly do affect habitat suitability. Specifically, Feyrer et al. (2010 as cited in BDCP, 2010) concluded that, as X2 location increases, predicted delta smelt habitat declines, but the association is nonlinear and changes in X2 location mainly affect habitat suitability between about RKm 65 and RKm 80 (Feyrer et al., 2010 as cited in BDCP, 2010). Therefore, changes in X2 location of 0.5 km or more were evaluated specifically between RKm 65 and RKm 80 under the NODOS Project alternatives, relative to the bases of comparison.

Adult

Evaluation of potential impacts on delta smelt adults was conducted for the period of December through May (Moyle, 2002, USFWS, 2008).

Water Temperature

Delta smelt of all sizes are found in the main channels of the Delta and Suisun Marsh and the open waters of Suisun Bay, where the waters are well oxygenated and temperatures are relatively cool, usually lower than 20°C to 22°C in summer. Additionally, delta smelt spawning success appears to be confined to water temperatures between about 15 to 20°C (Bennett, 2005) and over 90 percent delta smelt caught in the CDFG Summer Townet Survey and CDFG Fall Mid-Water Trawl Survey were collected at water temperatures lower than 20°C (Bennett, 2005). Water temperatures over approximately 25°C are reportedly lethal for delta smelt, and can constrain delta smelt habitat, particularly during summer and early fall (Bennett, 2005).

Monthly Sacramento River water temperatures at Freeport were simulated under the NODOS Project alternatives and bases of comparison using Reclamation's average monthly water temperature model. For purposes of conducting an impact assessment on delta smelt adults, average monthly water temperatures at Freeport were evaluated for the period of December through May (Moyle, 2002, USFWS, 2008) under the NODOS Project alternatives, relative to the bases of comparison. Because delta smelt spawning success reportedly appears to be confined to water temperatures between about 15 to 20°C (Bennett, 2005) exceedance probability distributions were utilized to calculate the proportion of time that water temperatures would occur within this range under the NODOS Project alternatives, relative to the bases of comparison.

Entrainment

Because historical delta smelt salvage densities are not reported by life stage, they do not distinguish between juveniles and adults. Therefore, analysis of potential impacts of the NODOS Project alternatives on delta smelt adults was conducted utilizing the approach described for juvenile delta smelt, above (i.e., normalized salvage densities).

OMR Flows

In addition to conducting analysis of adult delta smelt salvage, an evaluation of OMR flows also was conducted. The USFWS (2008) Biological Opinion on the Proposed Coordinated Operations of the Central Valley Project and State Water Project provides net negative OMR flow restrictions to protect spawning adult delta smelt. The USFWS (2008) RPA Action 1 restricts OMR flow during the fall to -2,000 cfs for 14 days when a turbidity or salvage trigger has been met; both triggers have previously been correlated with the upstream movement of spawning adult delta smelt. RPA Action 2 is initiated immediately after Action 1 to protect adult delta smelt after migration, but prior to spawning, by restricting net OMR flows to between -1,250 and -5,000 cfs, based on the recommendations of the Smelt Working Group (USFWS, 2008).

SWRCB (2010) references USFWS (2008) in stating that the -5,000 cfs OMR flow threshold is appropriate for delta smelt because it is the level where population losses consistently exceed 10 percent (USFWS, 2008, SWRCB, 2010). The U.S. District Court of the Eastern District of California’s 2010 ruling on the Consolidated Delta Smelt Cases (San Luis & Delta-Mendota Water Authority, et al. v. Salazar, et al., No. 1:09-CV-407 OWW DLB (E.D. Cal. filed March 3, 2009)) remanded the OMR flow restrictions associated with the USFWS (2008) RPA Action 1 and 2 (in addition to Action 3) because USFWS (2008) developed the OMR flow criteria for Actions 1 and 2 using raw delta smelt salvage data, rather than salvage data normalized to the delta smelt population, and because the court determined that USFWS (2008) did not provide adequate quantitative or qualitative justification for the upper or lower limits of the Action 2 OMR flow criteria (i.e., -5,000 cfs to -1,250 cfs). Therefore, no further evaluation of delta smelt adult entrainment using USFWS (2008) OMR flow criteria was conducted to identify potential impacts of the NODOS Project alternatives on delta smelt.

Although the U.S. District Court ruled that substantively science-based OMR flow criteria are not currently available for use in operating the SWP and CVP, SWRCB (2010) and CDFG (2010) recommended that OMR flows be more positive than -5,000 cfs between December and February of all water year types to protect upstream migrating adult delta smelt. Therefore, for purposes of assessing potential impacts of implementing the NODOS Project alternatives, flows less than (i.e., more negative) -5,000 cfs were used as an indicator of potential impact on migrating adult delta smelt. Specifically, the percentage of time from December through February when OMR flows would be less than -5,000 cfs under the NODOS Project alternatives was evaluated, relative to the bases of comparison.

Turbidity

Sub-adult and adult delta smelt densities are positively correlated with turbidity (BDCP, 2010), which indicates that turbidity is an important component of sub-adult and adult delta smelt habitat. Because it is hypothesized that high turbidity allows for increased predator avoidance, turbidity could potentially also be an important component of larval delta smelt habitat. However, because turbidity can be localized and is influenced by multiple factors, modeling turbidity associated with implementation of the NODOS

Project alternatives is problematic and currently not available. Therefore, no further evaluation of potential changes in turbidity and subsequent potential impacts on delta smelt was conducted.

Food Availability

Analysis of food availability for delta smelt juveniles was identical to the analysis conducted for DELTA smelt larvae, and is described above.

Longfin Smelt

Populations of longfin smelt occur along the Pacific Coast of North America, from Hinchinbrook Island, Prince William Sound, Alaska to the San Francisco estuary (Lee et al., 1980). Although individual longfin smelt have been caught in Monterey Bay (Moyle, 2002), available data suggest that the Bay-Delta population is the southernmost, and also the largest, spawning population in California.

Longfin smelt larvae have a widespread distribution in the San Francisco Estuary and are detected each year in the Western Delta, Suisun Bay, and Suisun Marsh (Baxter, 1999). Larval longfin smelt are also frequently caught in San Pablo Bay and they are sometimes caught in the Central and South Bays, and the Eastern and Southern Delta (Baxter, 1999). In many years, longfin smelt are caught in the Napa River Estuary as well. Larval sampling in the South Bay is not extensive enough to characterize the presence or abundance (if any) of larval longfin smelt.

Longfin smelt are widespread within the Delta and, historically, they were found seasonally in all of its major open water habitats and Suisun Marsh. Longfin smelt are believed to spawn at the transition zone between freshwater and saltwater, but exact spawning locations and conditions that support egg deposition and incubation are unknown. Spawning almost certainly occurs in the Sacramento River mainstem, probably near Rio Vista and downstream.

Egg/Embryo

Spawning longfin smelt scatter adhesive eggs on sand substrates from December through May, (CDFG, 2010).

Water Temperature

Studies document a relationship between hatching success/developmental rate and water temperature, DO, or salinity for the longfin smelt population of this Estuary are not readily available. The only known study on this topic (Lake Washington population) found that longfin smelt eggs hatched in approximately 42 days at about 45°F (7°C) (Dryfoos, 1965). Because the San Francisco Estuary population is at the southern edge of the species' range, it is possible that this population has evolved a tolerance for warmer temperatures than would be experienced further north.

Because reputable information regarding longfin smelt egg/embryo water temperature tolerances is not readily available, water temperature ranges for delta smelt eggs/embryos were used as indicators of potential impact associated with implementation of the NODOS Project alternatives. Specifically, because delta smelt egg and embryo hatching success and survival decreases below 15°C (59°F) and above 20°C (68°F), exceedance probability distributions were utilized to calculate the proportion of time that water temperatures would occur within this range under the NODOS Project alternatives, relative to the bases of comparison, and were evaluated from December through April.

Larvae and Juvenile

Based on analyses conducted by CDFG (2009), for purposes of analyzing potential impacts of implementing the NODOS Project alternatives on longfin smelt larvae and juveniles, the analytical period evaluated was December through June.

Water Temperature

Juvenile longfin smelt reportedly attempt to migrate to avoid water temperatures greater than 20 °C (Baxter et al., 2009). The distribution of larval smelt (and the subsequent distribution of juveniles) is generally within San Pablo Bay or Suisun Bay depending on outflow conditions (DWR, 2009).

Because reputable information regarding longfin smelt larvae and juvenile water temperature tolerances is not readily available, the upper limit of the water temperature range for delta smelt larvae and juveniles is used as an indicator of potential impact associated with implementation of the NODOS Project alternatives. Specifically, because delta smelt larval survival reportedly is optimized when water temperatures are within the range of approximately 15°C to 20°C, exceedance probability distributions were utilized to calculate the proportion of time that water temperatures would occur below 20°C under the NODOS Project alternatives, relative to the bases of comparison, and were evaluated from December through June.

Entrainment – SWP/CVP

Young longfin smelt are thought to be influenced by tidal and net currents while migrating downstream. Larval longfin smelt, which are less than 20 mm, pass through the louvers and are not counted or salvaged at the SWP or CVP export facilities (SWRCB, 2010; CDFG, 2010). Entrainment of larval longfin smelt is reported to likely be greatest during March and April (SWRCB, 2010). High export pumping rates can cause reverse OMR flows, which can passively move all age groups of longfin smelt, particularly larvae, toward the export facilities (SWRCB, 2010). Young longfin smelt are most vulnerable to entrainment during drier water years with low Delta outflow, and high net negative OMR flows (SWRCB, 2010; CDFG, 2010). CDFG (2009)'s particle tracking modeling for larval longfin smelt predicted that larval entrainment at the SWP may be two to 10 percent during the relatively low outflow conditions that were modeled, assuming that input data approximated actual longfin smelt hatching densities and that the PTM modeling with surface-oriented particles roughly represented movement of longfin smelt larvae (CDFG, 2009). However, CDFG (2009) report that such a high percentage of larvae entrained would only be expected during periods of low downstream transport flows during which Qwest was generally negative. Despite a high negative net OMR flow, particle entrainment substantially decreased when the Sacramento River flows at Rio Vista increased above approximately 40,000 cfs (CDFG, 2010). Entrainment of particles was generally low at flows of 55,000, despite very high exports and negative OMR flows (CDFG, 2009). If these high flow conditions occurred throughout the primary hatching period of January through March, the expected percentage of larvae entrained at the SWP would be less than one percent, given the assumed relative San Joaquin River spawning densities (CDFG, 2009).

CDFG (2009) reportedly identified a significant relationship between spring (April through June) net negative OMR flows and total SWP and CVP juvenile longfin smelt salvage. Juvenile longfin smelt salvage reportedly increased rapidly as OMR flows became more negative than -2,000 cfs (CDFG, 2009). However, as winter and spring, or only spring outflows increased (shifting X2 downstream), the salvage of juvenile longfin smelt reportedly decreased significantly. Grimaldo (as cited in CDFG, 2009) found that the best models explaining inter-annual winter (December through March) salvage of longfin smelt included combining Old and Middle River flows. Plotting combined salvage on average December through March OMR flows indicates rapidly increasing salvage of OMR flows approaching, and more negative than -5000 cfs (CDFG, 2009).

CDFG (2009) suggests that the pelagic nature of larval and juvenile longfin smelt and their similar responses to outflows and OMR flows indicate that similar actions would benefit both life stages, including periodic pulse flows through the central Delta during January through June to transport larvae and juveniles away from the region of entrainment risk, and less negative OMR flows.

CDFG (2010) recommend the following OMR flow criteria to benefit longfin smelt:

- At no time should OMR flows be more negative than -5,000 cfs during December through March.
- During April and May of dry and critical water years OMR flows should be more positive than -1,500 cfs when the longfin smelt FMWT index is more than 500, and should be positive when the longfin smelt FMWT index is less than 500.

Therefore, changes in the frequency with which mean monthly OMR flows would be greater than -5,000 cfs during December through March were evaluated under the NODOS Project alternatives, relative to the bases of comparison. In addition, changes in the frequency with which mean monthly OMR flows would be greater than -1,500 cfs and greater than 0 cfs were evaluated during April and May of dry and critical water years under the NODOS Project alternatives, relative to the bases of comparison.

In addition to evaluating OMR flows, potential changes in entrainment of juvenile longfin smelt (> 20 mm) at the SWP and CVP facilities were evaluated utilizing the simulated export volume and historical salvage density approach described for juvenile delta smelt, but used salvage densities specific to longfin smelt.

Transport Flows

Longfin smelt abundance has been reported to be positively correlated with Delta outflow (as measured by X2 position) (Sommer et al., 2007; Rosenfeld and Baxter, 2007; Kimmerer et al., 2009). Kimmerer et al. (2009) related the log of the longfin smelt annual abundance index for each of three surveys (i.e., Fall Midwater Trawl, Bay Midwater Trawl, and Bay Otter Trawl) to X2 location averaged over several spring months when longfin smelt are most vulnerable to freshwater flow effects. Increased habitat quantity associated with increased Delta outflow may contribute to an increase in longfin smelt abundance, however, the primary mechanism for the positive relationship between longfin smelt abundance and Delta outflow is not well understood (Kimmerer et al., 2009). Kimmerer et al. (2009) hypothesize that it may be related to the shift by young longfin smelt toward greater depth at higher salinity, possibly implying a retention mechanism. The effects of transport flows (i.e., Delta outflow) on larval longfin smelt are estimated by evaluating potential changes in simulated X2 location. CDFG (2010) recommend that X2 location be maintained between 64 km and 75 km during January through June in order to provide longfin smelt with low salinity habitat within or downstream of Suisun Bay.

Simulated mean monthly X2 location exceedance probability distributions were evaluated during January through June to examine the change in frequency with which mean monthly X2 location would be maintained at or downstream of 75 RKm during January through June under the NODOS Project alternatives, relative to the bases of comparison. Exceedance probability distributions were evaluated over the entire simulation period and specifically over the lowest 25 percent of the cumulative probability distribution (i.e., low flow conditions).

Although CDFG (2009) describes the longfin smelt larvae evaluation period as December through May, CDFG (2010) provide X2 location recommendations during January through June to protect multiple life stages of longfin smelt including larvae, juveniles, and adults.

Food Availability

Food limitation for longfin smelt in the estuary is reportedly an important contributing cause of their recent declines and also is thought of as a substantial impediment to their recovery (Sommer et al., 2007). Rosenfield and Baxter (2007) observed that the response of both age-1 and age-2 longfin smelt to Delta outflow was muted after the Corbula clam introduction. Orsi and Mecum (1996) noted that the primary prey species for juvenile longfin smelt (*Neomysis mercedis*) had been similarly affected by the clam introduction as a result of the clam's grazing on phytoplankton and copepods. Changes in SWP and CVP operations under the NODOS Project alternatives, relative to the bases of comparison, have the potential to affect food availability by changing Delta residence time and nutrient concentrations.

Adult

Based on the identified presence of newly-hatched larvae, and an assumed 25-day incubation period, CDFG (2009) estimates that longfin smelt likely spawn during November through April, with a peak in January.

Water Temperature

Longfin smelt spawning is believed to occur in the Sacramento River mainstem near Rio Vista and downstream (DWR, 2009). As water temperatures drop below 18°C during the fall, maturing adult longfin smelt migrate from the lower estuary to the LSZ and congregate prior to spawning (CDFG, 2009a). Spawning reportedly starts when water temperatures drop below 16°C, and becomes consistent when water temperatures drop below 13°C (CDFG, 2009a). Moyle (2002) states longfin smelt inhabiting the Bay-Delta estuary are thought to spawn in freshwater or slightly brackish water over sandy or gravel substrates at temperatures ranging from 7 to 14.5 °C (44.6 to 58.1 °F) (Moyle, 2002).

Movement patterns based on catches in CDFG fishery sampling suggest that longfin smelt actively avoid water temperatures greater than 22°C (72°F). In addition, sampling data suggest that longfin smelt do not occupy areas with temperatures greater than 22°C (72 °F) in combination with salinities greater than 26 ppt.

Entrainment - SWP/CVP

Entrainment of adult longfin smelt at the SWP and CVP facilities is reportedly believed to be low in all water years except for during dry and critically dry water years, potentially because adults are not found in the vicinity of the pumping facilities during wetter water years.

Potential changes in entrainment of adult longfin smelt at the SWP and CVP facilities follow the simulated export volume and historical salvage density approach described for delta smelt, but were evaluated during December through March and used salvage densities specific to longfin smelt. Longfin smelt salvage counts were not normalized for population abundance using the FMWT index due to a statistically insignificant correlation (see Appendix 12I).

In addition, as discussed above, CDFG (2010) recommended that OMR flows be no more negative than -5,000 cfs at any time during January through March, to protect adult and juvenile longfin smelt from being entrained. The frequency with which OMR flows would be -5,000 cfs or higher during December through March were compared under the NODOS Project alternatives relative to the bases of comparison.

Food Availability

Adult longfin smelt prey primarily on the small shrimp *Neomysis mercedis* (Moyle, 2002). As discussed above, food availability may be a limiting factor for the longfin smelt population in the estuary. Changes in water operations under the NODOS Project alternatives, relative to the bases of comparison, have the potential to affect food availability by changing Delta residence time and nutrient concentrations.

Winter-run Chinook Salmon

Fry and Juvenile

Winter-run Chinook salmon juvenile rearing and outmigration through the Delta was evaluated during the months of November through May (NMFS, 2009a).

Entrainment, Delta Emigration Survival, Through-Delta Survival

The evaluation of winter-run Chinook salmon entrainment losses, pre-screen mortality, and through-Delta survival under the NODOS Project alternatives, relative to the bases of comparison, was conducted as part of the analysis provided by the Delta Passage Model (DPM). Specifically, the DPM reports through-Delta survival, which incorporates pre-screen mortality and entrainment (and salvage) losses at the SWP and CVP export facilities.

Inputs to the Delta Passage Model include simulated average monthly Sacramento River flow entering Sutter and Steamboat Sloughs, and Georgiana Slough, OMR flows, SWP and CVP south Delta exports, Delta outflow, and other flow parameters. Detailed discussion of the DPM is provided in Appendix 12M.

Life Cycle Modeling

IOS was used to estimate overall population level effects on winter-run Chinook salmon under the NODOS Project alternatives, relative to the bases of comparison. The IOS model incorporates the DPM's through-Delta survival as part of the returning adult spawner estimate. Additional detail regarding IOS is provided in Appendix 12L.

Spring-Run Chinook Salmon

Fry and Juveniles

Juvenile spring-run Chinook salmon were evaluated in the Delta during the months of November through June (NMFS, 2009a).

Entrainment, Delta Emigration Survival, Through-Delta Survival

Estimated juvenile spring-run Chinook salmon entrainment losses, pre-screen mortality, and through-Delta survival were evaluated under the NODOS Project alternatives, relative to the bases of comparison using the same method as described for juvenile winter-run Chinook salmon.

Fall and Late Fall-Run Chinook Salmon

Fry and Juveniles

Juvenile fall-run Chinook salmon were evaluated in the Delta during November through June. Juvenile late fall-run Chinook salmon were evaluated in the Delta during November through June.

Entrainment, Delta Emigration Survival, Through-Delta Survival

Estimated juvenile fall- and late fall-run Chinook salmon entrainment losses, pre-screen mortality, and through-Delta survival were evaluated under the NODOS Project alternatives, relative to the bases of comparison, using the same method as described for juvenile winter-run Chinook salmon.

Adults (San Joaquin Basin)

OMR Flows

Simulated mean monthly changes in the magnitude of OMR reverse flows under the NODOS Project alternatives were evaluated, relative to the bases of comparison, during December through February. To prevent straying of adult San Joaquin Basin Chinook salmon, CDFG (2010) recommend that OMR flows be greater than -5,000 cfs during December through February. Exceedance probability distributions were evaluated to identify changes in OMR flows under the NODOS Project alternatives. Specifically, the percentage of time from December through February when OMR flows would be less than -5,000 cfs under the NODOS Project alternatives was evaluated, relative to the bases of comparison.

Central Valley Steelhead

Juvenile

Steelhead outmigration and rearing in the Delta was evaluated during the months of October through July (NMFS, 2009a).

Entrainment – SWP/CVP

Simulated juvenile steelhead entrainment losses at the south Delta export facilities were estimated using the same method as described for delta smelt (i.e., salvage analysis utilizing historical salvage densities and simulated exports). However, steelhead salvage densities were not normalized to population abundance estimates due to the absence of accurate and complete estimates of juvenile steelhead production and adult escapement. Therefore, this analysis assumed that the risk of juvenile steelhead entrainment loss under the NODOS Project alternatives would be directly proportional to the expanded historical monthly juvenile steelhead salvage density at each of the export facilities.

Delta Emigration and Rearing Habitat

The assessment of potential changes in steelhead rearing habitat in the Delta included evaluation of changes in: (1) seasonal flows in the lower Sacramento River (at Rio Vista); (2) Yolo Bypass inundation (utilizing flow from the bypass to the Sacramento River as an indicator of inundation); (3) Delta outflow; and (3) OMR flows.

Long-term average flows, average flows by water year type, and monthly exceedance probability distributions (October through July) of simulated Sacramento River flow at Rio Vista were compared under the NODOS Project alternatives, relative to the bases of comparison.

Steelhead and other fishes are reported to utilize the Yolo Bypass for rearing, and it is believed that the Yolo Bypass provides high quality rearing habitat as a result of high nutrient and invertebrate production when it is inundated. To evaluate rearing habitat in the Yolo Bypass, flow out of the bypass was used as an indicator of floodplain inundation and changes in Yolo Bypass flow under the NODOS Project alternatives was evaluated, relative to the bases of comparison.

Hydrodynamic conditions in the interior Delta likely affect the quality and availability of juvenile salmonid rearing habitat. Two general indicators of habitat conditions within the interior Delta were used to assess potential changes in juvenile salmonid rearing habitat conditions: (1) Delta outflow; and (2) OMR reverse flows. Decreased flows through the Delta may decrease the migration rate of juvenile salmonids moving downstream, increasing their exposure time to unsuitable water temperatures, entrainment into the interior Delta, entrainment in water diversions, contaminants, and predation (CDFG, 2010). Changes in CALSIM II-simulated mean monthly Delta outflow during October through July were evaluated under the NODOS Project alternatives, relative to the bases of comparison. While there are no known statistical relationships between Delta outflow and juvenile steelhead survival or adult abundance, it was assumed that an increase in Delta outflow may contribute to improved rearing conditions and survival of juvenile steelhead in the Delta and Suisun Bay. Monthly probability of exceedance distributions of Delta outflow were compared under the NODOS Project alternatives, relative to the bases of comparison.

The behavioral response and effects of reducing OMR reverse flows on juvenile steelhead migration, rearing, survival, and growth are not clearly known. However, for the purposes of this analysis it was assumed that a reduction in OMR reverse flows may contribute to improved rearing and emigration conditions for juvenile steelhead in the interior Delta. Specifically, it is likely that recommendations to reduce impacts of negative and low OMR flows on Chinook salmon also would reduce impacts on Central Valley steelhead. Specifically, to reduce the risk of juvenile Chinook salmon entrainment and straying into the central Delta, CDFG (2010) recommend that OMR flows be greater than 2,500 cfs during November through June. However, because there is no specific OMR flow recommendation for steelhead, probability of exceedance distributions of CALSIM II-simulated mean monthly OMR reverse flows were compared under the NODOS Project alternatives and evaluated relative to the bases of comparison. Simulated mean monthly changes in the magnitude of OMR reverse flows were compared under the NODOS Project alternatives, relative to the bases of comparison during October through July.

Adult

Seasonal Flows - Attraction

Adult steelhead migrate upstream through the Delta on spawning migrations. The NODOS Project alternatives may change the proportion of water reaching the Delta that originates in the Sacramento River, relative to the San Joaquin River watershed. Quantitative information on the relationship between Sacramento and San Joaquin river flow and adult steelhead attraction and upstream migration are not available. Therefore, in the absence of quantitative relationships for adult steelhead a qualitative assessment was made based on the magnitude of flow changes estimated to occur in the lower Sacramento and San Joaquin river mainstems during the migration period were used.

Green Sturgeon

Juvenile

Entrainment

While little is known about the distribution of and movement of YOY and juvenile green sturgeon, observations suggest that they are distributed in the mainstem Sacramento River below Anderson, and in fresh and brackish portions of the north and interior Delta (Israel et al., 2011). Juvenile green sturgeon have been reported to be caught by anglers in the Sacramento River between Rio Vista and Chipps Island, in the Sacramento Deep Water Ship Channel, Montezuma Slough, the Napa River, Carquinez Strait, and Suisun Bay (Gleason et al., 2008).

Simulated juvenile green sturgeon entrainment losses at the south Delta export facilities were estimated using the same method as described for delta smelt (i.e., salvage analysis utilizing historical salvage densities and simulated exports). However, green sturgeon salvage densities were not normalized to population abundance estimates due to the absence of accurate and complete estimates of juvenile green sturgeon production and adult escapement. Therefore, this analysis assumed that the risk of juvenile green sturgeon entrainment loss under the NODOS Project alternatives would be directly proportional to the expanded historical monthly juvenile green sturgeon salvage density at each of the export facilities.

Rearing Habitat (Floodplain Inundation)

Green sturgeon and other fishes are reported to utilize the Yolo Bypass for rearing, and it is believed that the Yolo Bypass provides high quality rearing habitat as a result of high nutrient and invertebrate production when it is inundated. To evaluate rearing habitat in the Yolo Bypass, flow out of the bypass was used as an indicator of floodplain inundation and changes in Yolo Bypass flow under the NODOS Project alternatives was evaluated, relative to the bases of comparison.

White Sturgeon

Juvenile

Entrainment

Simulated juvenile white sturgeon entrainment losses at the south Delta export facilities were estimated using the same method as described for delta smelt (i.e., salvage analysis utilizing historical salvage densities and simulated exports). However, white sturgeon salvage densities were not normalized to population abundance estimates due to the absence of accurate and complete estimates of juvenile white sturgeon production and adult escapement. Therefore, this analysis assumed that the risk of juvenile white sturgeon entrainment loss under the NODOS Project alternatives would be directly proportional to the expanded historical monthly juvenile white sturgeon salvage density at each of the export facilities.

Rearing Habitat (Floodplain Inundation)

White sturgeon and other fishes are reported to utilize the Yolo Bypass for rearing, and it is believed that the Yolo Bypass provides high quality rearing habitat as a result of high nutrient and invertebrate production when it is inundated. To evaluate rearing habitat in the Yolo Bypass, flow out of the bypass was used as an indicator of floodplain inundation and changes in Yolo Bypass flow under the NODOS Project alternatives was evaluated, relative to the bases of comparison.

Sacramento Splittail

Egg/Embryo

Floodplain Habitat Availability

During winter and spring adult splittail move upstream onto floodplains to forage and spawn (Meng and Moyle, 1995; Sommer et al., 1997). Splittail spawn generally between late-February and early July (Moyle, 2002), laying their eggs on submerged vegetation. Age-0 splittail abundance has been significantly correlated to mean Delta outflow during February through May, and to the number of days of Yolo Bypass floodplain inundation (Meng and Moyle, 1995; Sommer et al., 1997). Evaluation of floodplain habitat availability in the Yolo Bypass addresses all splittail life stages due to the importance of floodplain habitat to all life stages.

Flows through the Yolo Bypass of about 10,000 cfs reportedly may potentially provide the greatest area of shallow habitat in the Yolo Bypass (Fleenor et al., 2010). NMFS' (2009) draft recovery plan for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley Steelhead recommends that Yolo Bypass be inundated during the spring with at least 8,000 cfs to fully activate the floodplain. As reported by BDCP (2010), 30 days is the estimated minimum length of time required for the development of splittail eggs to emigrating juveniles, based on estimated values reported in the literature. Year-class abundance of splittail is reportedly primarily determined by floodplain spawning and rearing habitat conditions during February 1 through June 30 (BDCP, 2010). SWRCB (2010) and CDFG (2010) recommend that the Yolo Bypass be inundated for at least 30 consecutive days between late-February and May of wet and above normal water years to benefit splittail spawning and recruitment.

Splittail floodplain habitat availability was evaluated by comparing CALSIM II-simulated mean monthly Yolo Bypass flow (downstream of Fremont and Sacramento weirs) under the NODOS Project alternatives, relative to the bases of comparison, during February through May of wet and above normal water years. Although CALSIM II-simulated mean monthly flows do not necessarily indicate the duration of inundation of the Yolo Bypass, the frequency of inundation was evaluated. Additionally, although NMFS (2009) indicated that the floodplain is fully activated at 8,000 cfs it was assumed that increases in inundation frequency, regardless of flow volume in the bypass, would provide additional habitat for splittail even if the floodplain was not fully activated. Therefore, analysis of Yolo Bypass flows under the NODOS Project alternatives, relative to the bases of comparison, did not specifically focus on flows above 8,000 cfs.

Larvae

Floodplain Habitat Availability

Potential changes in splittail larvae floodplain habitat availability under the NODOS Project alternatives relative to the bases of comparison was evaluated under splittail eggs/embryos, above.

Food Availability

Inundated floodplains provide suitable conditions (i.e., warm water temperatures, shallow water, and long residence time) for development of plankton and other food resources for splittail larvae. Chironomid abundance is particularly high in the Yolo Bypass, where the larvae emerge quickly after the floodplain begins to be inundated, and are especially abundant during the flood stage (Sommer et al., 2004, Benigno and Sommer, 2008, as cited in BDCP, 2010).

Potential changes in food availability for larval splittail were evaluated by comparing simulated mean monthly Yolo Bypass flows during February through May under the NODOS Project alternatives, relative to the bases of comparison. Higher mean monthly flows in the Yolo Bypass were assumed to result in increased food availability in the Yolo Bypass.

Juvenile

Floodplain Habitat Availability

Potential changes in juvenile splittail floodplain habitat availability under the NODOS Project alternatives relative to the bases of comparison were evaluated under splittail eggs/embryos, above.

Entrainment – SWP/CVP

YOY splittail are salvaged at the SWP and CVP facilities primarily from late May through mid-July during their downstream migrations from upstream floodplains to tidal rearing habitat in Suisun Marsh and Suisun Bay, however, during wet water years salvage may continue into July (Moyle et al., 2004). Juvenile splittail salvage is highest during wet water years, when the abundance of juveniles is generally largest due to favorable floodplain spawning and rearing conditions (Sommer et al., 1997). Survival rates of salvaged juvenile splittail are not known, however. Until studies demonstrate otherwise, it reportedly should be assumed that a high percentage of juveniles die during the holding and transport process (Moyle et al., 2004).

Juvenile splittail moving towards the SWP and CVP facilities also may suffer high predation rates in the exposed channels, particularly in Clifton Court Forebay (Moyle et al., 2004). Pre-screen losses of juvenile salmon have been estimated to be approximately 75 to 80 percent (BDCP, 2010), and based on the similarities in size and behavior between juvenile salmon and splittail; these loss rates may be similar for juvenile splittail (BDCP HCP). Pre-screen losses at the CVP facilities are assumed to be approximately 15 to 20 percent for salmonids (BDCP, 2010). However, pre-screen losses were assumed to be constant among the NODOS Project alternatives and were not evaluated further as part of this entrainment analysis.

Simulated juvenile splittail entrainment losses at the south Delta export facilities were estimated using the same method as described for delta smelt (i.e., salvage analysis utilizing historical salvage densities and simulated exports). However, splittail salvage densities were not normalized to population abundance estimates due to the absence of accurate and complete estimates of juvenile splittail production and adult escapement. Therefore, this analysis assumed that the risk of juvenile splittail entrainment loss under the NODOS Project alternatives would be directly proportional to the expanded historical monthly juvenile splittail salvage density at each of the export facilities.

Food Availability

Food availability for splittail juveniles may potentially be affected by potential changes in the frequency and duration of Yolo Bypass floodplain inundation. Potential changes in food availability for juvenile splittail associated with floodplain inundation under the NODOS Project alternatives, relative to the bases of comparison, were evaluated using the same method as described for splittail larvae food availability, above.

River and Pacific Lamprey

Macropthalmia

Because lamprey macropthalmia are difficult to identify and are not reported by species in historical salvage density estimates, river and Pacific lamprey macropthalmia were evaluated together.

Entrainment – SWP/CVP

Simulated lamprey macropthalmia losses at the south Delta export facilities were estimated using the same method as described for delta smelt (i.e., salvage analysis utilizing historical salvage densities and simulated exports). However, lamprey macropthalmia salvage densities were not normalized to population abundance estimates due to the absence of accurate and complete estimates of lamprey macropthalmia production and adult escapement. Therefore, this analysis assumed that the risk of lamprey macropthalmia entrainment loss under the NODOS Project alternatives would be directly proportional to the expanded historical monthly lamprey macropthalmia salvage density at each of the export facilities.

American Shad

Although salinity, simulated as electrical conductivity (EC), is an important habitat component for many species within the Delta, changes in salinity that could occur as a result of implementation of the NODOS Project alternatives likely would not adversely impact American shad. Specifically, adult American shad enter the Delta from San Francisco Bay via Suisun and Honker bays on spawning migrations and return to the ocean after spawning in freshwater. During this portion of their life cycle, individual fish are capable of tolerating a wide range of salinities. Therefore, changes in Delta salinity associated with implementation of the NODOS Project alternatives, likely would not adversely impact adult American shad. Juvenile American shad are reported to sometimes rear for extended periods in the Delta. However, little information exists regarding the distribution of juvenile American shad in the Delta throughout the extended rearing duration. Because juvenile American shad can select appropriate habitat as osmoregulatory and salinity tolerance changes occur as individual fish grow during their extended Delta rearing period, it is not likely that salinity is a limiting habitat component. Therefore, changes in salinity associated with implementation of the NODOS Project alternatives would not be likely to adversely affect rearing juvenile shad habitat availability, and were not further evaluated.

Eggs and Larvae

X2

CDFG (2010) recommended an X2 location between River Kilometer (RK) 75 to 64 (approximately equivalent to a net Delta outflow of 11,400 to 29,200 cfs) from April through June of all water years to support American shad egg and larval survival. Because the proposed Project and alternatives have little ability to limit flows at the high end of the recommended range (i.e., Delta outflow could be above 29,200 cfs regardless of proposed Project operations), potential effects on American Shad were evaluated by evaluating the frequency with which average monthly X2 location would be maintained at or downstream of 75 km during April through June under the NODOS Project alternatives, relative to the bases of comparison.

Juveniles and Adults

Salvage

Simulated salvage of American shad was estimated at the SWP and CVP export facilities by calculating historical salvage densities (during water years 1995 through 2009), and multiplying American shad salvage densities by simulated mean monthly export volumes under the NODOS Project alternatives, relative to the bases of comparison. Estimated changes in salvage of American shad at the export facilities were compared by month and water year type under the NODOS Project alternatives, relative to the bases of comparison.

Striped Bass

Most larvae and fry are transported from the spawning areas to the Delta within days of spawning. Mortality due to entrainment and reduced rearing habitat availability has been associated with SWP and CVP project-related effects on Delta hydrodynamics (Sommer et al., 2005).

Eggs and Larvae

X2

Changes in the upstream or downstream movement of simulated mean monthly X2 location year-round were compared under the NODOS Project Alternatives, relative to the bases of comparison. Simulated changes in X2 location were used to qualitatively estimate potential effects on striped bass survival and distribution within the Delta under the NODOS Project alternatives, relative to the bases of comparison.

Juveniles and Adults

Salvage

Simulated salvage of striped bass was estimated at the SWP and CVP export facilities by calculating historical salvage densities and multiplying striped bass salvage densities by export volumes under the NODOS Project alternatives and the bases of comparison, then evaluating any differences in estimated salvage. Striped bass salvage estimates were corrected using the FMWT abundance index for striped bass. Specifically, estimated changes in salvage of striped bass at the export facilities were compared by month and water year type under the NODOS Project alternatives, relative to the bases of comparison.

Warmwater Game Fishes

Black bass, crappies, and other sunfishes, as well as several species of catfish support recreational fishing throughout the Delta. Because many of these species have similar habitat requirements, largemouth bass were evaluated as an indicator of potential effects on warmwater game fishes in general.

Most warmwater game fish adult spawning in the lower reaches of the Central Valley rivers (Sacramento, Feather, American, Stanislaus, and San Joaquin rivers and Clear Creek) and in the Delta generally occurs from March through June. Some catfishes and sunfish reportedly begin spawning later than black bass and spawn into August (Moyle, 2002). In general, water temperature is an important habitat component influencing warmwater game fish spawning (Moyle, 2002). However, because the NODOS Project alternatives would have little opportunity to influence water temperatures in the Delta and the water temperature tolerance ranges for warmwater game fishes generally are wide, adult warmwater game fish spawning and water temperature as a habitat component in the Delta was not evaluated further.

Juveniles and Adults

X2

Although no published requirements for X2 location are available for largemouth bass (or warmwater game fishes in general), X2 location was evaluated as an indicator of freshwater habitat availability. Specifically, as X2 location moves upstream freshwater habitat is reduced, while as X2 location moves downstream freshwater habitat increases. Therefore, changes in the upstream or downstream movement of simulated mean monthly X2 location year-round were compared under the NODOS Project Alternatives, relative to the bases of comparison. Simulated changes in X2 location were used to qualitatively estimate potential effects on largemouth bass survival and distribution within the Delta under the NODOS Project alternatives, relative to the bases of comparison.

Salvage

Simulated salvage of representative warmwater game fish species were estimated at the SWP and CVP export facilities by calculating historical salvage densities, and multiplying species-specific salvage densities by export volumes under the proposed Project and alternatives relative to the bases of comparison. Estimated changes in salvage of representative warmwater game fish species at the export facilities were compared by month and water year type under the NODOS Project alternatives, relative to the bases of comparison.

12B.3 Primary Study Area

Construction of the proposed Project facilities within the Primary Study Area (refer to Figures 1-9A through 1-9C in Chapter 1 Introduction) could affect the following waterways: the Sacramento River, Grapevine Creek, Antelope Creek, Funks Creek, Stone Corral Creek, Hunters Creek, Colusa Basin Drain, T-C Canal, GCID Canal, Funks Reservoir, and local ponds and irrigation ditches (refer to Figure 12-6 in Chapter 12 Aquatic Biological Resources.

Construction-related impacts were evaluated based on their potential to result in habitat modification, turbidity, sedimentation, pressure wave (sound) transmission, and direct physical injury and/or mortality to fish.

Operations-related impacts were evaluated for the three proposed diversion sites on the Sacramento River based on their potential to result in fish screen impingement and entrainment. Additionally, potential changes in flows and water temperatures in Funks and Stone Corral creeks were evaluated.

12B.3.1 Construction-Related Impacts

Within the Primary Study Area, construction-related impacts could potentially occur as a result of direct contact of construction personnel, equipment, and/or debris, and generally would be limited to the area in the immediate vicinity of the construction disturbance area, and short distances downstream.

Two Sacramento River tributaries, Funks and Stone Corral creeks, would be impacted by the inundation of the proposed Sites Reservoir. These creeks are generally characterized by deeply incised channels that are largely devoid of riparian cover as a result of heavy cattle use. Within the reservoir footprint, the streams are ephemeral, are generally dry by May, and reportedly do not provide sustained cold-water habitat. These ephemeral streams may provide temporary cold-water habitat during fall and winter, but do not sustain populations of cold-water species. Chinook salmon reportedly have been observed in Antelope and Funks creeks during periods of high flow. USGS gage data on Stone Corral Creek (1958-1985) indicate that during normal and dry years the creek contains mostly zero to near zero flow, with positive flow from November through April during rain events. During wet years the creek contains sustained base flows in periods lasting several weeks following closely spaced rain events. Fishery surveys indicate the presence of several warmwater native and non-native species (CDFG, 2000) including:

- Funks Creek - hitch, largemouth bass, Sacramento pikeminnow, Sacramento sucker, sculpin
- Stone Corral Creek - bluegill, California roach, green sunfish, hitch, mosquitofish, Sacramento blackfish, Sacramento pikeminnow, Sacramento sucker

In addition to impacts on Funks and Stone Corral creeks associated with inundation of Sites Reservoir, potential construction-related impacts to other waterways could occur in the immediate vicinity of the construction disturbance area of other proposed Project facilities. The other potentially affected waterways include Grapevine Creek, Antelope Creek, Hunters Creek, the Colusa Basin Drain, and the Sacramento River.

Potential construction-related impacts to fish species and aquatic habitat that could occur would depend on the proximity of construction access routes, staging areas, and storage and disposal areas to waterways, timing of construction activities, the specific techniques used, and the specific minimization and avoidance measures implemented before, during, and after construction. It was assumed that some excavation, including grading and vegetation removal, would occur in the construction disturbance areas.

For each proposed Project facility, the assessment was based on several considerations, including the duration and extent of construction-related activities, as well as the proximity of construction-related activities to waterways. Construction-related impacts evaluated included: (1) changes in aquatic habitat quantity and quality; (2) changes in aquatic and riparian vegetation; and (3) changes in the composition of predator and prey fish community interactions within the immediate NODOS Project facility construction disturbance area.

The impact assessment considered the potential for general effects on fish to occur, as well as the potential for construction activities to affect a particular fish species that may be present in or adjacent to the construction disturbance area. Depending on the specific activity evaluated, the impact assessment considered either all, or a combination of, the elements listed below, as appropriate:

- Visual inspection of conditions within the immediate construction disturbance area and surrounding areas to determine habitat availability, use, and the potential for specific disturbance-related effects on listed fish species or aquatic habitat.

- Review of available maps and aerial photography to determine the proximity of the construction disturbance area to adjacent receiving waters.

- Evaluation of the sequencing, timing, extent (e.g., long-term or short-term duration), intensity, and severity of disturbance activities that would result from construction-related activities and the use of construction equipment.

- Determination of the potential for construction activities to adversely modify habitat, or appreciably diminish the value of designated or proposed critical habitat.

- Identification of avoidance measures and/or conservation measures to minimize potential construction-related impacts on sensitive life stages of fish species that may be present during construction.

12B.3.1.1 Topics Eliminated from Further Analytical Consideration

The following proposed Project facilities and activities were not included in the detailed analysis of construction-related impacts within the Primary Study Area because they would not be located within or adjacent to a waterway:

- Recreation Areas
- Sites Electrical Switchyard
- Tunnel from Sites Pumping/Generating Plant to Sites Reservoir Inlet/Outlet Structure
- Field Office Maintenance Yard
- Terminal Regulating Reservoir (TRR)
- GCID Canal Connection to the TRR
- TRR Pumping/Generating Plant
- TRR Electrical Switchyard
- TRR Pipeline
- TRR Pipeline Road
- Delevan Transmission Line
- Delevan Pipeline Electrical Switchyard

12B.3.1.2 Qualitative Evaluation of Potential Impacts

Conducting fully quantitative analyses of potential impacts on aquatic resources associated with construction activities requires information specific to each construction activity that often is not available at the time of environmental documentation. For example, to conduct an analysis of potential impacts associated with pile driving the following information would be required:

- Exact locations of pile driving (general locations are known)
- Specific noise levels associated with each individual pile hammer strike, which would require
  - Specific types of piles
  - Specific type of hammer
  - Geotechnical information to identify which equipment would be appropriate
- The number of piles being driven at a specific location
- The number of hammer strikes per pile
- The diurnal timing of pile driving (day or night)
- The seasonal timing of pile driving (specific construction time)
  - Species potentially present
- River flow during construction
- Whether construction activities would occur from the landward or river side of the facilities

Much of the information required to conduct quantitative analyses becomes available as design documents progress to final design stages and as contractors are selected to construct the facilities. Design and specific equipment information can then used to conduct subsequent analyses for use in permitting processes, including Endangered Species Act and Clean Water Act permitting processes.

The requirements for conducting analyses under CEQA and NEPA include utilizing the best available information to conduct impact assessments. In the absence of final design and equipment specifications, environmental documents often rely of the use of qualitative analyses, which rely on an understanding of potential impact mechanisms, general construction activities and timing, and a detailed understanding of species habitat utilization and life history characteristics. These qualitative analyses focus on the types of impacts that could occur on a species that could be present at a general location during a general time of year. For example, a qualitative analysis of potential impacts associated with pile driving in the Sacramento River upstream of Red Bluff Diversion Dam during June would conclude that potential impacts on winter-run Chinook salmon spawning could occur due to interrupted spawning activity, avoidance of potentially suitable spawning areas, and potential direct harm to individual fish as a result of exposure to underwater pressure waves. These impacts could potentially be substantial because most winter-run Chinook salmon spawn between Keswick Dam and Red Bluff Diversion Dam, and that spawning peaks during June.

Qualitative analyses utilized in this impact analysis rely on:

- Understanding of potential impact mechanisms associated with construction activities
- Understanding of types of construction equipment generally used during construction of specific facilities
- Understanding of species life history periodicity, habitat utilization, and response to impact mechanisms associated with construction activity

Discussion of potential impact mechanisms associated with construction activities that could occur under the NODOS Project alternatives that were evaluated (often qualitatively) as part of this impact assessment is provided below.

12B.3.1.3 Erosion, Sedimentation, and Turbidity

Increased erosion potentially could occur directly from grading and excavation activities, as well as indirectly due to a loss of vegetation associated with construction. Increased erosion could increase sedimentation and siltation, resulting in increased turbidity in waterways adjacent to proposed Project facility footprints, including the Sacramento River. Reportedly, increased sedimentation and siltation potentially could affect listed anadromous fish and their habitat by reducing egg and alevin survival, interfering with feeding activities, causing breakdown of social organization, and by reducing primary and secondary productivity. The magnitude of potential impacts on fish would be dependent upon the timing and extent of sediment loading, as well as flow in the stream before, during, and immediately following construction. Therefore, the impact assessment considered each of the aforementioned factors to qualitatively evaluate whether the NODOS Project would change conditions in the Sacramento River and other local creeks as a result of increased erosion, sedimentation, and turbidity, relative to the bases of comparison.

12B.3.1.4 Hazardous Materials and Chemical Spills

Activities associated with access routes, storage, staging areas, cofferdam, and Delevan Pipeline Intake Facilities construction, saddle dam construction, and installation of the Delevan Pipeline potentially could impair water quality if chemicals (e.g., hydrocarbon-based fuels and lubricants) or other construction materials are spilled or enter local waterways. In general, construction-related chemical spills could affect fish by increasing physiological stress, reducing biodiversity, altering primary and secondary production, and possibly causing direct mortality (NMFS and USFWS, 1998). Therefore, the impact assessment qualitatively evaluated the potential for hazardous materials and chemical spills to alter aquatic habitat conditions in the Sacramento River and other local waterways during NODOS Project construction, relative to the bases of comparison.

12B.3.1.5 Aquatic Habitat Modification

Because the Delevan Pipeline Intake Facilities would be anchored into the riverbed and a cofferdam would be necessary to allow dewatering during construction activities, substrate alteration and disturbance to the hyporheic zone within the river channel would occur during NODOS Project construction. Depending on the location and extent of substrate and hyporheic zone disturbance, potential effects on fisheries resources and aquatic habitat could include reduced inter-gravel spaces for use as refuge by fry, reduced macroinvertebrate production, reduced biodiversity, reduced exchange of nutrients between surface and subsurface waters and between aquatic and terrestrial ecosystems, and reduced potential for benthic invertebrate re-colonization of disturbed substrates. Therefore, the impacts assessment qualitatively evaluated the potential for NODOS Project construction (i.e., intake structure and the cofferdam) to alter substrate or disturb the hyporheic zone in the Sacramento River, relative to the bases of comparison.

Depending on the habitat type at and surrounding the location of the proposed intake facility, fish could temporarily be displaced or excluded from the immediate construction disturbance area through river channel alteration, riprap placement, and the removal of riparian habitat and instream woody materials (IWM). Activities such as river channel alteration and the removal of riparian vegetation and IWM, riprap placement and other in-stream work could potentially reduce biodiversity, macroinvertebrate production and recolonization of disturbed substrate, and the exchange of nutrients between surface and subsurface waters and between aquatic and terrestrial ecosystems.

The use of riprap in streams has been shown to affect natural river processes and functions by:

- Reducing recruitment of spawning gravels for salmonids
- Halting new accretion of point bars and other deposition areas where riparian vegetation can colonize
- Halting meander migration, which over time, reduces habitat renewal, diversity, and complexity
- Incising the thalweg of the river adjacent to the riprap lined area
- Filling in sloughs, tributary channels, and oxbow lake areas, causing loss of nearby wetland habitat and diversity
- Limiting lateral mobility of the channel, potentially reducing habitat complexity, including small backwaters and eddies
- Decreasing near-shore roughness, causing stream velocity to increase at a high rate with increasing discharge, potentially causing accelerated erosion of earthen banks downstream
- Reducing the contribution of allochthonous material to the stream by inhibiting plant growth adjacent to the stream

- Reducing recruitment of IWM to the stream system, potentially resulting in a range of negative effects

The evaluation of altered habitat conditions included consideration of changes in the evaluated species' use of available habitats associated with changes in specific habitat variables. The principles of the Standard Assessment Methodology (SAM) propose a technique for analyzing the value of aquatic habitat as it pertains to lifestage responses of focus species. Although the specific models were not used for assessment purposes in this document, the principles and concepts of habitat alteration associated with the NODOS Project alternatives were used in the evaluation of potential impacts to fish species of primary management concern. Habitat variables considered included structural features (bank slope, substrate size, instream woody material, riparian vegetation, and instream object cover), hydraulics (water depth and velocity), riparian habitat/overhanging shade/cover, and associated predation potential.

Construction of the intake structure potentially could require the removal of IWM from the river channel, thus resulting in a loss of refugia from predators and high flows, and causing reductions in pool-forming structures, and sediment and organic matter storage capacity. IWM is of particular importance to healthy riverine ecosystems, and reportedly may be the most important structural component promoting stable fisheries resources. Because IWM has a key role in maintaining both essential habitat complexity and refugia, potential loss of IWM could reduce available habitat quantity and quality.

Shaded Riverine Aquatic (SRA) habitat is defined as the nearshore aquatic area occurring at the interface between a river (or stream) and adjacent woody riparian habitat. SRA habitat is characterized as an area where the adjacent bank is composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water. It also is characterized by the presence of IWM, such as leaves, branches, roots and logs, as well as variable water depths, velocities, and currents. SRA habitat provides valuable feeding areas, escape cover, and reproductive cover for aquatic species (e.g., anadromous salmonids).

To determine the magnitude of potential disturbance and/or removal of SRA habitat associated with construction of the proposed intake facility, the total amount of available SRA habitat within the construction footprint was first calculated under Existing Conditions. The calculation was based on USFWS, NMFS, and CDFG habitat assessment protocols. According to the USFWS, the amount of available SRA habitat can be quantified through length and width measurements using the following formula:

$$SRA = L * W$$

Where: SRA = amount of available SRA habitat (L = length; W = width)

Length is defined as the distance along the riverbank of the area of concern. Width is defined as the average perpendicular distance from the interface of the water and the riverbank, extending out to the outermost extension of either the vegetative canopy overhanging the water or the living and/or dead vegetation within the water, whichever is greater. Width can range from as little as one to two feet, to as great as 50 to 60 feet. The relative width generally is a good indicator of overall habitat value. In most cases, there is a positive correlation between width and habitat value.

Using the dimensions of the proposed intake facility construction disturbance area, the impacts assessment estimated the anticipated SRA habitat loss that would occur during NODOS Project construction, relative to the bases of comparison. Additionally, the impacts assessment qualitatively evaluated the potential for NODOS Project construction (i.e., intake structure and the cofferdam) to directly remove existing IWM and alter the recruitment potential for IWM by removing SRA habitat.

Preliminary estimates, based on a GIS calculation, indicated that between approximately 0.5 and 0.8 acres of Fremont Cottonwood Riparian habitat that acts as SRA and an additional 0.7 and 0.9 acres or Valley Foothill Riparian habitat that acts as another source of potential IWM inputs to the Sacramento River would be removed (depending on the alternative) as a result of intake facility construction. Additionally, during a site visit conducted on February 23, 2011, one piece of IWM (between six and eight inches in diameter and approximately 20 feet long) was observed protruding from the river surface, while another piece of similar size was immediately adjacent to the bank and could function as IWM at higher flows. However, subsurface IWM could exist, but likely would occur in limited quantity based on the small amount of riparian habitat available as input material, the limited hydraulic complexity to cause IWM deposition, and the limited shoreline complexity to function as a repository for IWM.

12B.3.1.6 Hydrostatic Pressure Waves, Noise, and Vibration

In-river construction work associated with the cofferdam and the intake facility would involve equipment and activities that would produce pressure waves, and would create underwater noise and vibration, thereby temporarily altering in-river conditions during NODOS Project construction, relative to the bases of comparison. Of particular concern would be the noise associated with pile driving. The cofferdam would be installed by driving interlocking sheet piles into the river bottom with a pile driver beginning at the upstream end of the cofferdam area and proceeding downstream until the cofferdam is complete. If environmental conditions allow, sheet pilings would be vibrated into place during construction of the cofferdam to minimize underwater pressure waves (i.e., instream noise) and subsequent impacts on fish. Specifically, if sheet pilings were vibrated into place during construction of the cofferdam, resultant sound pressure waves would remain below the levels which would result in mortality or physical injury of fish.

Hydrostatic pressure waves and vibration generated by disturbance activities reportedly adversely affect all life stages of fish (Washington et al., 1992). Other studies (Fitch and Young, 1948; Teleki and Chamberlain, 1978; Yeleverton et al., 1975) suggest that adverse affects to fish resulting from hydrostatic pressure waves and vibration primarily are a function of species morphology and species physiology. Hydrostatic pressure waves could potentially rupture the swim bladders and other internal organs of all life stages of fish in the immediate construction disturbance area (Bonneville Power Administration, 2002; Jones & Stokes Associates, 2001; Washington et al., 1992). Additionally, noise and vibration generated by pile driving activities could potentially have sublethal effects on individual fish by causing movement into lower quality habitats (Bonneville Power Administration, 2002). Although understanding effects from pile driving activities on fish is evolving, it remains problematic. There is evidence that lethal effects can occur from pile driving, but accurately analyzing and addressing these impacts, as well as sublethal impacts (e.g., injury, temporary hearing threshold shifts, stress, and behavioral disturbance) is complicated by several factors. Sound levels and particle motion produced from pile driving can vary depending on pile type, pile size, substrate composition, and type of equipment used. Therefore, the impact assessment qualitatively evaluated whether NODOS Project construction would change conditions in the Sacramento River as a result of hydrostatic pressure waves and increased noise and vibration, relative to the bases of comparison.

It was assumed that pile driving of the support piers for the intake structure foundation would occur subsequent to the completion and dewatering of the cofferdam, so that the intake structure construction would be completed within the "dry" confines of the cofferdam. Sound pressure waves generated from construction activities within the confines of the cofferdam are expected to be attenuated to levels below which fish would be adversely affected. As stated in the BO for the Benicia Martinez New Bridge, "*Shallow water pile driving in fully dewatered cofferdams (no more than 0.3 m of standing water) are not anticipated to generate sufficient sound pressure levels capable of affecting fish*" (NMFS, 2003). Therefore, sound pressure waves generated from construction activities within the confines of the cofferdam were not further evaluated in the DEIR/S.

12B.3.1.7 Stranding and Entrainment Potential

Construction of the Delevan Pipeline Intake Facilities would require in-river dewatering, which may reportedly cause harm, injury, and mortality to fisheries resources by confining them to areas of increased water temperature, decreased dissolved oxygen concentration, and predation (Cushman, 1985). Because construction of the intake facility would require use of a cofferdam, fish could become trapped, or entrained[3], behind the cofferdam prior to its closure, and the removal of water associated with dewatering activities in the closed cofferdam potentially could result in stranding. The effects of stranding could include increased stress and direct mortality of stranded individuals. Therefore, the impact assessment qualitatively evaluated the potential for NODOS Project construction (i.e., cofferdam placement and removal) to strand and entrain fish in the Sacramento River, relative to the bases of comparison.

Ongoing operation of the fish screens associated with the GCID and T-C canal facilities, as well as the proposed Delevan Pipeline Intake Facilities, likely would not result in increased entrainment potential because the screens would be designed to comply with all applicable NMFS and CDFG criteria. Therefore, no further discussion of entrainment effects associated with operation of the fish screens is presented.

12B.3.1.8 Predation Risk

Placement of the cofferdam associated with construction of the Delevan Pipeline Intake Facilities, installation of the fish screen, and installation of the proposed Delevan Pipeline alignment at various stream crossings may increase the risk of predation on fish due to dewatering, sound disturbance due to increased underwater noise levels, and increased turbidity, all of which could increase predator opportunities or efficiencies.

Specifically, dewatering associated with cofferdam closure reportedly may confine fish and expose them to an increased risk of predation (NMFS, 2000). Typically, fish salvage operations are utilized when construction activities cause dewatering and confinement. However, fish salvage operations also can disorient and/or injure fish, further increasing the risk of predation following removal and subsequent release from the dewatered and/or confined project area (NMFS, 2003). Disorientation caused by noise associated with pile driving can temporarily disrupt normal fish behaviors, thereby increasing the risk of predation (NMFS, 2000; NMFS, 2003). Additionally, construction activities may increase turbidity, which in turn, could affect normal fish behavior. Deviation from normal behavior, associated with increased turbidity, reportedly increases the risk of predation (NMFS, 2003). However, it also has been reported that increased turbidity could potentially decrease piscine predation on fish. In a study conducted in the Fraser River it was found that juvenile Pacific salmon were less likely to encounter and be consumed by piscivorous fish predators in turbid waters relative to clear waters (Gregory and Levings, 1998).

[3] Entrainment, as it relates to construction activities, occurs when fish volitionally or non-volitionally enter the construction area to be dewatered.

The impact assessment qualitatively evaluated whether NODOS Project construction would alter habitat conditions in the Sacramento River and Primary Study Area streams that could potentially increase the risk of predation on fish species of primary management concern, relative to the bases of comparison.

12B.3.1.9 Fish Passage

Activities associated with Sites Reservoir construction and installation of the Delevan Pipeline could potentially result in fish passage barriers, which could prevent upstream or downstream movement of fish. Construction activities across the Colusa Basin Drain and Hunters Creek associated with installation of the Delevan Pipeline could result in completely or partially blocked stream channels which could physically limit the movement of resident fishes or cause increased turbidity or underwater noise, resulting in altered behavior. Additionally, installation of dams on Funks and Stone Corral creeks would physically limit movement, and potentially interfere with behavior by increasing noise and turbidity during the time period when the ephemeral streams would be flowing. Further, construction activities associated with filling Sites Reservoir could result in limiting movement of resident fishes in Grapevine and Antelope creeks. Therefore, the impact assessment qualitatively evaluated the potential for NODOS Project construction to create fish passage barriers in the Sacramento River and Primary Study Area streams, relative to the bases of comparison.

Construction on the Sacramento River (cofferdam installation and construction of the Delevan Pipeline Intake Facilities, as well as construction activities at the existing T-C Canal and GCID Canal intakes) would be confined to one side of the Sacramento River. Additionally, it is likely that construction would occur from the land side. Therefore, impacts on fish passage associated with construction activities adjacent to the Sacramento River are not anticipated and not discussed further.

12B.3.2 Operations- and Maintenance-related Impacts

The impact assessment methodology for the Primary Study Area addressed the operations and maintenance of Sites Reservoir and associated facilities, the Holthouse Reservoir Complex, and the points of diversion on the Sacramento River.

12B.3.2.1 Sites Reservoir

Because Sites Reservoir does not yet exist, comparison of operations under the NODOS Project alternatives to Existing Conditions or the No Project/No Action Alternative was not feasible. Similarly, while maintenance activities associated with the reservoir facilities could have the potential to impact reservoir fisheries resources, no reservoir fishery exists under Existing Conditions and would not exist under the No Project/No Action Alternative. Therefore, under CEQA and NEPA, no further analysis is required.

12B.3.2.2 Holthouse Reservoir Complex

Fish species composition in Funks Reservoir is assumed to be represented by the species identified in Funks Creek. Fifteen stations were sampled on Funks Creek between July 22, 1998, and January 8, 1999. Stations were evenly spaced between the Golden Gate damsite and the upper limit of flow in Funks Creek. Five species of fish were found in Funks Creek, including hitch, Sacramento pikeminnow, Sacramento sucker, sculpin, and one type of game fish - largemouth bass.

Although Funks Reservoir is not currently or regularly occupied by status species, it does contain one species of primary management concern, largemouth bass, which is valued for its recreational importance.

However, Funks Reservoir is located in a high security area with no public access. Because Funks Reservoir is not utilized as a recreational fishing reservoir and serves no recreational function, the recreational value of the largemouth bass population in the reservoir is limited.

Funks Reservoir is operated as a regulating afterbay/forebay for the T-C Canal. Under the NODOS Project alternatives, Funks Reservoir would be incorporated into the Holthouse Reservoir Complex, which also would function as a regulatory afterbay/forebay for the T-C Canal and a regulatory afterbay for Sites Reservoir. As a regulating afterbay/forebay, Funks Reservoir is operated to receive variable flows and, as a result, monthly storage and elevation fluctuate often. Under the NODOS Project alternatives, the Holthouse Reservoir Complex would continue to receive highly variable inflow and would continue to experience frequent surface elevation fluctuations. Therefore, the NODOS Project alternatives would not affect monthly mean storage or elevation, relative to Existing Conditions or the No Project/No Action Alternative. Consequently, no assessment of potential storage- or elevation-related impacts on fishery resources in the Holthouse Reservoir Complex is warranted.

12B.3.2.3 Funks Creek and Stone Corral Creek

Fisheries habitat conditions in Funks and Stone Corral creeks downstream of Golden Gate Dam and Sites Dam, respectively, under the NODOS Project alternatives would be expected to be altered relative to the bases of comparison. These streams are ephemeral (within the reservoir footprint), are generally dry by May, and do not sustain coldwater fisheries.

Fishery surveys performed in Funks and Stone Corral creeks indicated the presence of several warm-water native and nonnative species. Fifteen stations were sampled on Funks Creek between July 22, 1998, and January 8, 1999. Stations were evenly spaced between the Golden Gate Dam site and the upper limit of flow in Funks Creek. Streamflow was intermittent. Five species of fish were found in Funks Creek, including hitch, Sacramento pikeminnow, Sacramento sucker, sculpin, and one type of game fish - largemouth bass. The most common fish in Funks Creek was the hitch. The most diverse sampled sections of Funks Creek were in the lower reaches. The upper reaches of Funks Creek either lacked fish or only supported one species.

Eleven stations were sampled on Stone Corral Creek between July 15, 1998, and January 6, 1999. Stations were located from the damsite to approximately one mile upstream. Stone Corral Creek had the greatest diversity of fish, including bluegill, California roach, green sunfish, hitch, mosquitofish, Sacramento blackfish, Sacramento pikeminnow, and Sacramento sucker. The fish most common fish among the stations was the Sacramento pikeminnow followed by the hitch.

Habitat type evaluation on Funks Creek began at the Golden Gate Dam site on January 12, 1999, and proceeded upstream to a point just upstream of the mouth of Grapevine Creek on February 25, 1999. After this point, Funks Creek no longer contained water. Stone Corral Creek habitat typing began on February 10, 1999, and continued until the channel no longer contained water, just past the confluence with Antelope Creek. Creek flows varied widely with lack of rainfall, forcing activity to be suspended on some areas of Funks and Stone Corral creeks until further rain revived the stream flow. This suggests that streams on the floor of the Antelope Valley are intermittent and only flow during the summers of particularly wet years. Very little riparian vegetation exists on the banks of any of the creeks in the vicinity of the proposed Sites and Holthouse reservoirs, with the exceptions of the upper reaches of Antelope and Grapevine creeks. The lower reach of Stone Corral Creek is heavily dominated by bedrock, giving way to a more gravel base near the confluence with Antelope Creek.

While no anadromous salmonids are known to spawn in Funks and Stone Corral creeks, one spring-run Chinook salmon was observed in Antelope Creek during a survey of stock ponds and portions of the creeks in the Primary Stude Area conducted during 1998. Additionally, during June 2006 and 2007 Chinook salmon were observed in Funks Creek downstream of Funks Reservoir, while one Chinook salmon carcass and redd were observed upstream of Funks Reservoir during February 2009. Chinook salmon in Funks Creek were not observed during formal surveys, but were observed incidentally.

Funks Creek and Stone Corral Creek are intermittent and are generally ponded at the dam sites from Memorial Day through October. During the time when the creeks are ponded, remaining water is reported to be relatively warm and to have high EC values (greater than 3,000 µmohs/cm). Additionally, suitable spawning habitat does not reportedly exist downstream of Funks Reservoir and is not known to exist in Antelope Creek (Bogener, pers. comm., 2011). Based on these factors, it is not likely that either Funks Creek or Stone Corral Creek have the potential to support anadromous salmonid populations. Therefore, no further evaluation of potential impacts on anadromous salmonids in Funks and Stone Corral creeks was conducted.

Although potential construction-related impacts on fishes in Funks and Stone Corral creeks could occur, the NODOS Project alternatives include an action to maintain ephemeral flows in the creeks to keep fish in good condition, as required by Fish and Game Code 5937. Specifically, all alternatives considered in this DEIR/EIS would maintain a flow of five to ten cubic feet per second (cfs) in each creek during the average period when the creeks historically were flowing (generally November through May). Because the NODOS Project alternatives include provision to maintain flow patterns similar to general historic flow patterns, no adverse impacts on Funks and Stone Corral creeks associated with long-term operation of Sites Reservoir or the Holthouse Reservoir Complex are anticipated.

However, long-term operation of Sites Reservoir and the Holthouse Reservoir Complex would permanently remove portions of Funks and Stone Corral creeks. The impact assessment qualitatively evaluated the long-term loss of intermittent stream habitat and maintenance activities on habitat downstream of the Sites and Golden Gate dam sites, as well as downstream of the Holthouse Reservoir Complex.

Sacramento River Points of Diversion

Operation and maintenance activities associated with the NODOS Project alternatives could affect resident and anadromous fish species by causing impingement and entrainment, and by degrading water quality and available aquatic habitat. Impingement occurs when facility operations cause fish to become trapped on or against the surface of a fish screen due to the diverted flow's approach velocity exceeding fish swimming capability (Department of Fisheries and Oceans, 1995). Screen entrainment is defined as the voluntary or involuntary movement of fish through, under, or around the fish screen resulting in a loss of fish from the population. Entrainment is a function of screen mesh opening size and gaps between the screen frame and intake structure walls. Maintenance activities associated with the NODOS Project alternatives have the potential to disturb ground surfaces adjacent to the Delevan Pipeline Intake Facilities, and to disturb gravels and sediments on the river bottom. Such activities may increase sediment loading and turbidity within the Sacramento River. Potential impacts from impingement and entrainment include direct mortality and loss of fish from the population.

Fish impingement against the face of a fish screen usually can be avoided with proper fish screen placement and design. NMFS and CDFG specify fish screen design criteria. One criterion is that the approach velocity to a fish screen in a river or stream will not exceed 0.33 feet per second. Another consideration of fish screen design is the time that a fish is exposed to the screen face. The time that a fish is exposed to the screen face is inversely proportional to the relationship between screen length and sweeping velocity (i.e., water velocity parallel to screen face) and must be determined so that impingement is avoided. In the fish screen criteria, exposure time is dependent upon the magnitude of the sweeping velocity and is evaluated on a case-by-case basis. However, the Delevan Pipeline Intake Facilities would have a fish screen designed to meet all specified NMFS and CDFG design criteria. NMFS (2009a) stated the following:

> "NMFS assumes if fish screens are meeting current screening criteria they are 95 percent effective, or that it is likely that five percent of the fish that come in contact with the fish screen could be killed through repeated contact with the screen, impingement, or contact with the cleaning mechanism. Actual mortality to screens is probably much less, as measured at the RBDD Pilot Pumping Plant (Borthwick and Corwin, 2001 *op.cit*. SWP/CVP operations BA) and are more likely to represent less than one percent of the fish that come in contact with the screen. If the mortality from all screened diversions in the Sacramento River were summed it would be an insignificant amount when compared at the population level."

Because NMFS (2009a) indicated that fish screens designed to meet criteria would likely result in mortality of less than one percent of the fish coming into contact with the screens, no further evaluation of direct fish screen mortality is conducted.

Although the fish screen associated with the Delevan Pipeline Intake Facilities would be designed to meet all NMFS and CDFG criteria, and diversions and discharges would occur at flow rates that would allow adequate approach and sweeping velocities, potential indirect impacts on fish migrating past the screens could occur. For example, increased predation associated with diversion structures has been reported (Vogel et al., 1988), although quantifying predation potential is difficult and is likely site-specific. Contact with the fish screen could potentially cause disorientation of juvenile salmonids, thereby increasing susceptibility to predation, and screen structures themselves could create hydraulic or physical predator refuges. Therefore, the impact assessment qualitatively evaluated predation risk associated with ongoing operation of the Delevan Pipeline Intake Facilities.

Additionally, the impact assessment qualitatively evaluated whether long-term operation and maintenance activities would be anticipated to adversely affect fish through sedimentation associated with screen cleansing activities at the proposed intake facility, relative to the bases of comparison.

12B.4 Impact Indicators

The significance criteria described above do not provide quantitative thresholds against which construction-related actions and simulated hydrologic data can be compared to identify potential impacts. Therefore, impact indicators and evaluation guidelines were developed as a means to assess potential effects of the NODOS Project alternatives on aquatic biological resources. For the fisheries and aquatic resources impact assessment, indicators (e.g., water temperatures, flows) were used to evaluate whether the NODOS Project would have an impact on a fish species' habitat. The impact indicators and evaluation guidelines were developed based on an extensive review of fisheries literature, with special emphasis on research conducted in the Central Valley. Impact determinations were based on consideration of all evaluated impact indicators for all life stages for a particular species in a particular river or geographic region (e.g., the Delta, the Export Service Area). An impact was considered potentially significant if implementation of the NODOS Project alternatives would adversely affect an individual species/run, for its defined geographic area (e.g., the Feather River, lower American River, etc.), in consideration of all evaluated impact indicators for all life stages. Impact indicators for each of the study areas are provided below.

12B.4.1 Extended and Secondary Study Areas

Impact indicators used to evaluate the potential effects of implementation of the NODOS Project alternatives on fish species of primary management concern in the Extended and Secondary study area reservoirs are provided in Table 12B-11. Impact indicators used to evaluate the potential effects of implementation of the NODOS Project alternatives on fish species of primary management concern in the Trinity River, Clear Creek, Sacramento River, Feather River, American River, and the Sacramento-San Joaquin Delta within the Secondary Study Area are provided in Tables 12B-12 through 12B-78.

12B.4.1.1 Extended and Secondary Study Area Reservoirs

Table 12B-11
Impact Indicators Evaluated for Warmwater and Coldwater Fish Species in the Extended and Secondary Study Area Reservoirs

Life Stage	Evaluation Period	Impact Indicator	Indicator Value
Trinity, Shasta, Oroville, Folsom, and San Luis Reservoirs			
Warmwater Fish			
Spawning Success	March through June	Water surface elevations	A decrease in reservoir water surface elevation of six feet or more per month, relative to the basis of comparison, of sufficient frequency to substantially affect warmwater fish during the extended nesting season over the 82-year simulation period.
Coldwater Fish			
Coldwater Habitat Residence	April through November	Reservoir storage	A decrease in reservoir storage over the 82-year simulation period which would reduce the coldwater pool, relative to the basis of comparison, of sufficient magnitude or duration to adversely affect coldwater fish.

12B.4.1.2 Trinity River

Table 12B-12
Impact Indicators Evaluated for Coho Salmon in the Trinity River

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Adult Immigration and Holding	September through January	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River below Lewiston Dam	40		All Years
				52		All Years
				57		All Years
				60		All Years
				70		All Years
				77		All Years
			Trinity River at	40		All Years

Table 12B-12
Impact Indicators Evaluated for Coho Salmon in the Trinity River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
			Douglas City	52		All Years
				57		All Years
				60		All Years
				70		All Years
				77		All Years
			Trinity River at North Fork	40		All Years
				52		All Years
				57		All Years
				60		All Years
				70		All Years
				77		All Years
Adult Spawning and Embryo Incubation	October through May	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River below Lewiston Dam	40		All Years
				43		All Years
				48		All Years
				50		All Years
				56		All Years
				68		All Years
			Trinity River at Douglas City	40		All Years
				43		All Years
				48		All Years
				50		All Years
				56		All Years
				68		All Years
			Trinity River at North Fork	40		All Years
				43		All Years
				48		All Years
				50		All Years
				56		All Years
				68		All Years
Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River below Lewiston Dam	41		All Years
				48		All Years
				54		All Years
				57		All Years
				60		All Years
				64		All Years

Table 12B-12
Impact Indicators Evaluated for Coho Salmon in the Trinity River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
				70		All Years
				77		All Years
			Trinity River at Douglas City	41		All Years
				48		All Years
				54		All Years
				57		All Years
				60		All Years
				64		All Years
				70		All Years
				77		All Years
			Trinity River at North Fork	41		All Years
				48		All Years
				54		All Years
				57		All Years
				60		All Years
				64		All Years
				70		All Years
				77		All Years
Smolt Emigration	February through June	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River below Lewiston Dam	50		All Years
				59		All Years
				62		All Years
				70		All Years
			Trinity River at Douglas City	50		All Years
				59		All Years
				62		All Years
				70		All Years
			Trinity River at North Fork	50		All Years
				59		All Years
				62		All Years
				70		All Years

Note:
cfs = cubic feet per second

Table 12B-13
Impact Indicators Evaluated for Upper Klamath-Trinity River Spring-run Chinook Salmon in the Trinity River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration and Holding	April through September	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River below Lewiston Dam	60		All Years
				64		All Years
				68		All Years
			Trinity River at Douglas City	60		All Years
				64		All Years
				68		All Years
			Trinity River at North Fork	60		All Years
				64		All Years
				68		All Years
Adult Spawning and Egg Incubation	August through November	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River below Lewiston Dam	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Trinity River at Douglas City	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Trinity River at North Fork	56		All Years
				58		All Years
				60		All Years
				62		All Years
Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River below Lewiston Dam	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Table 12B-13
Impact Indicators Evaluated for Upper Klamath-Trinity River Spring-run Chinook Salmon in the Trinity River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
			Trinity River at Douglas City	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Trinity River at North Fork	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
Smolt Emigration	February through July	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature(°F)	Trinity River below Lewiston Dam	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Trinity River at Douglas City	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Trinity River at North Fork	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Note:
cfs = cubic feet per second

Table 12B-14
Impact Indicators Evaluated for Upper Klamath-Trinity River Fall-run Chinook Salmon in the Trinity River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration and Holding	August through December	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River below Lewiston Dam	60		All Years
				64		All Years
				68		All Years
			Trinity River at Douglas City	60		All Years
				64		All Years
				68		All Years
			Trinity River at North Fork	60		All Years
				64		All Years
				68		All Years
Adult Spawning and Egg Incubation	October through June	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River below Lewiston Dam	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Trinity River at Douglas City	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Trinity River at North Fork	56		All Years
				58		All Years
				60		All Years
				62		All Years
Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River below Lewiston Dam	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Table 12B-14
Impact Indicators Evaluated for Upper Klamath-Trinity River Fall-run Chinook Salmon in the Trinity River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
			Trinity River at Douglas City	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Trinity River at North Fork	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
Smolt Emigration	February through July	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River below Lewiston Dam	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Trinity River at Douglas City	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Trinity River at North Fork	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Note:
cfs = cubic feet per second

Table 12B-15
Impact Indicators Evaluated for Steelhead (Winter- and Summer-run) in the Trinity River

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Adult Immigration and Holding (Winter-run)	August through April	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River below Lewiston Dam	52		All Years
				56		All Years
				70		All Years
			Trinity River at Douglas City	52		All Years
				56		All Years
				70		All Years
			Trinity River at North Fork	52		All Years
				56		All Years
				70		All Years
Adult Immigration and Holding (Summer-run)	June through August	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River below Lewiston Dam	52		All Years
				56		All Years
				70		All Years
			Trinity River at Douglas City	52		All Years
				56		All Years
				70		All Years
			Trinity River at North Fork	52		All Years
				56		All Years
				70		All Years
Adult Spawning and Egg Incubation	December through June	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River below Lewiston Dam	52		All Years
				54		All Years
				57		All Years
				60		All Years
			Trinity River at Douglas City	52		All Years
				54		All Years
				57		All Years
				60		All Years
			Trinity River at North Fork	52		All Years
				54		All Years
				57		All Years
				60		All Years

Table 12B-15
Impact Indicators Evaluated for Steelhead (Winter- and Summer-run) in the Trinity River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River below Lewiston Dam	65		All Years
				68		All Years
				72		All Years
				75		All Years
			Trinity River at Douglas City	65		All Years
				68		All Years
				72		All Years
				75		All Years
			Trinity River at North Fork	65		All Years
				68		All Years
				72		All Years
				75		All Years
Smolt Emigration	February through July	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River below Lewiston Dam	52		All Years
				55		All Years
				59		All Years
			Trinity River at Douglas City	52		All Years
				55		All Years
				59		All Years
			Trinity River at North Fork	52		All Years
				55		All Years
				59		All Years

Note:
cfs = cubic feet per second

Table 12B-16
Impact Indicators Evaluated for Green Sturgeon in the Trinity River

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Adult Immigration and Holding	February through November	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River at North Fork	61		All Years
			Trinity River at North Fork	66		All Years
Adult Spawning	May through August	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River at North Fork	68		All Years
Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River at North Fork	66		All Years

Note:
cfs = cubic feet per second

Table 12B-17
Impact Indicators Evaluated for White Sturgeon in the Trinity River

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		
			Description	Value	%	Range
Adult Immigration and Holding	November through May	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River at North Fork	77		All Years
Adult Spawning	February through May	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River at North Fork	61		All Years
Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Trinity River below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River at North Fork	66		All Years

Note:
cfs = cubic feet per second

Table 12B-18
Impact Indicators Evaluated for Pacific Lamprey in the Trinity River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration	January through June	Monthly mean flow (cfs)	Trinity River Below Lewiston Dam		10	All Years
					10	Lower 25%
Adult Spawning and Egg Incubation	January through August	Monthly mean flow (cfs)	Trinity River Below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River Below Lewiston Dam	50-64*		All Years
			Trinity River at Douglas City	50-64		All Years
			Trinity River at North Fork	50-64		All Years
Ammocoete Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Trinity River Below Lewiston Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Trinity River Below Lewiston Dam	72		All Years
			Trinity River at Douglas City	72		All Years
			Trinity River at North Fork	72		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:
cfs = cubic feet per second

12B.4.1.3 Clear Creek

Table 12B-19
Impact Indicators Evaluated for Spring-run Chinook Salmon in Clear Creek

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration and Holding	April through October	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Clear Creek below Whiskeytown Dam	60		All Years
				64		All Years
				68		All Years
			Clear Creek at Igo	60		All Years
				64		All Years
				68		All Years
			Mouth of Clear Creek	60		All Years
				64		All Years
				68		All Years
Adult Spawning and Embryo Incubation	August through March	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Clear Creek below Whiskeytown Dam	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Clear Creek at Igo	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Mouth of Clear Creek	56		All Years
				58		All Years
				60		All Years
				62		All Years
Juvenile Rearing	August through April	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Clear Creek below Whiskeytown Dam	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Table 12B-19
Impact Indicators Evaluated for Spring-run Chinook Salmon in Clear Creek

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
			Clear Creek at Igo	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Mouth of Clear Creek	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
Juvenile Emigration	May through January	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Clear Creek below Whiskeytown Dam	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Clear Creek at Igo	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Mouth of Clear Creek	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Note:
cfs = cubic feet per second

Table 12B-20
Impact Indicators Evaluated for Fall-run Chinook Salmon in Clear Creek

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration and Holding	September through December	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Clear Creek below Whiskeytown Dam	60		All Years
				64		All Years
				68		All Years
			Clear Creek at Igo	60		All Years
				64		All Years
				68		All Years
			Mouth of Clear Creek	60		All Years
				64		All Years
				68		All Years
Adult Spawning and Embryo Incubation	September through March	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Clear Creek below Whiskeytown Dam	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Clear Creek at Igo	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Mouth of Clear Creek	56		All Years
				58		All Years
				60		All Years
				62		All Years
Juvenile Rearing	October through May	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	All Years
		Monthly mean water temperature (°F)	Clear Creek below Whiskeytown Dam	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Table 12B-20
Impact Indicators Evaluated for Fall-run Chinook Salmon in Clear Creek

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
			Clear Creek at Igo	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Mouth of Clear Creek	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
Juvenile Emigration	January through June	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	All Years
		Monthly mean water temperature (°F)	Clear Creek below Whiskeytown Dam	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Clear Creek at Igo	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Mouth of Clear Creek	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Note:
cfs = cubic feet per second

Table 12B-21
Impact Indicators Evaluated for Late Fall-run Chinook Salmon in Clear Creek

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Adult Immigration and Holding	December through April	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Clear Creek below Whiskeytown Dam	60		All Years
				64		All Years
				68		All Years
			Clear Creek at Igo	60		All Years
				64		All Years
				68		All Years
			Mouth of Clear Creek	60		All Years
				64		All Years
				68		All Years
Adult Spawning and Embryo Incubation	January through April	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Clear Creek below Whiskeytown Dam	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Clear Creek at Igo	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Mouth of Clear Creek	56		All Years
				58		All Years
				60		All Years
				62		All Years
Juvenile Rearing	February through May	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	All Years
		Monthly mean water temperature (°F)	Clear Creek below Whiskeytown Dam	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Table 12B-21
Impact Indicators Evaluated for Late Fall-run Chinook Salmon in Clear Creek

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
			Clear Creek at Igo	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Mouth of Clear Creek	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
Juvenile Emigration	April through June	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	All Years
		Monthly mean water temperature (°F)	Clear Creek below Whiskeytown Dam	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Clear Creek at Igo	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Mouth of Clear Creek	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Note:
cfs = cubic feet per second

Table 12B-22
Impact Indicators Evaluated for Steelhead in Clear Creek

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration and Holding	August through March	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Clear Creek below Whiskeytown Dam	52		All Years
				56		All Years
				70		All Years
			Clear Creek at Igo	52		All Years
				56		All Years
				70		All Years
			Mouth of Clear Creek	52		All Years
				56		All Years
				70		All Years
Adult Spawning and Embryo Incubation	December through May	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Clear Creek below Whiskeytown Dam	52		All Years
				54		All Years
				57		All Years
				60		All Years
			Clear Creek at Igo	52		All Years
				54		All Years
				57		All Years
				60		All Years
			Mouth of Clear Creek	52		All Years
				54		All Years
				57		All Years
				60		All Years
Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Clear Creek below Whiskeytown Dam	65		All Years
				68		All Years
				72		All Years
				75		All Years
			Clear Creek at Igo	65		All Years
				68		All Years
				72		All Years
				75		All Years

Table 12B-22
Impact Indicators Evaluated for Steelhead in Clear Creek

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
			Mouth of Clear Creek	65		All Years
				68		All Years
				72		All Years
				75		All Years

Note:
cfs = cubic feet per second

Table 12B-23
Impact Indicators Evaluated for River Lamprey in Clear Creek

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration	September through June	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
Adult Spawning and Egg Incubation	February through July	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Whiskeytown Dam	50-64*		All Years
			Clear Creek at Igo	50-64		All Years
			Mouth of Clear Creek	50-64		All Years
Ammocoete Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Whiskeytown Dam	72		All Years
			Clear Creek at Igo	72		All Years
			Mouth of Clear Creek	72		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:

cfs = cubic feet per second

Table 12B-24
Impact Indicators Evaluated for Pacific Lamprey in Clear Creek

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration	January through June	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
Adult Spawning and Egg Incubation	January through August	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Whiskeytown Dam	50-64*		All Years
			Clear Creek at Igo	50-64		All Years
			Mouth of Clear Creek	50-64		All Years
Ammocoete Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Whiskeytown Dam	72		All Years
			Clear Creek at Igo	72		All Years
			Mouth of Clear Creek	72		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:

cfs = cubic feet per second

Table 12B-25
Impact Indicators Evaluated for Hardhead in Clear Creek

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adults and Other Life Stages	Year-round	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Whiskeytown Dam	65-82*		All Years
			Clear Creek at Igo	65-82		All Years
			Mouth of Clear Creek	65-82		All Years
Adult Spawning	April through June	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Whiskeytown Dam	59-64		All Years
			Clear Creek at Igo	59-64		All Years
			Mouth of Clear Creek	59-64		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:
cfs = cubic feet per second

Table 12B-26
Impact Indicators Evaluated for California Roach in Clear Creek

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Adults and Other Life Stages	Year-round	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Whiskeytown Dam	86		All Years
			Clear Creek at Igo	86		All Years
			Mouth of Clear Creek	86		All Years
Adult Spawning	March through June	Monthly mean flow (cfs)	Whiskeytown Releases to Clear Creek		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Whiskeytown Dam	60		All Years
			Clear Creek at Igo	60		All Years
			Mouth of Clear Creek	60		All Years

Note:
cfs = cubic feet per second

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Table 12B-27
Impact Indicators Evaluated for Winter-run Chinook Salmon in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration and Holding	December through July	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below Red Bluff Diversion Dam (RBDD)		10	All Years
					10	Lower 25%
			Verona		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
			Rio Vista		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	60		All Years
				64		All Years
				68		All Years
			Below RBDD	60		All Years
				64		All Years
				68		All Years
			Feather River	60		All Years
				64		All Years
				68		All Years
			Freeport	60		All Years
				64		All Years
				68		All Years
Spawning, Egg Incubation, and Initial Rearing	April through August	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Bend Bridge		10	All Years
					10	Lower 25%
		Scaled composite weighted usable area (WUA) (% of maximum)	Keswick Dam to Bend Bridge		1	All Years
		Monthly mean water temperature (°F)	Below Keswick Dam	56		All Years
				58		All Years
				60		All Years
				62		All Years

Table 12B-27
Impact Indicators Evaluated for Winter-run Chinook Salmon in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
			Ball's Ferry	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Jelly's Ferry	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Bend Bridge	56		All Years
				58		All Years
				60		All Years
				62		All Years
Juvenile Rearing and Emigration	July through April	Monthly mean flow (cfs)	Below of Keswick Dam		10	All Years
					10	Lower 25%
			Below RBDD		10	All Years
					10	Lower 25%
			Verona		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
			Rio Vista		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Below RBDD	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Table 12B-27
Impact Indicators Evaluated for Winter-run Chinook Salmon in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
			Feather River	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Freeport	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Note:
cfs = cubic feet per second

Table 12B-28
Impact Indicators Evaluated for Spring-run Chinook Salmon in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration and Holding	February through September	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below Red Bluff Diversion Dam (RBDD)		10	All Years
					10	Lower 25%
			Verona		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
			Rio Vista		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	60		All Years
				64		All Years
				68		All Years
			Below RBDD	60		All Years
				64		All Years
				68		All Years
			Feather River Confluence	60		All Years
				64		All Years
				68		All Years
			Freeport	60		All Years
				64		All Years
				68		All Years
Spawning, Egg Incubation, and Initial Rearing	September through January	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Bend Bridge		10	All Years
					10	Lower 25%
			Below RBDD		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Ball's Ferry	56		All Years
				58		All Years
				60		All Years
				62		All Years

Table 12B-28
Impact Indicators Evaluated for Spring-run Chinook Salmon in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
			Jelly's Ferry	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Bend Bridge	56		All Years
				58		All Years
				60		All Years
				62		All Years
			RBDD	56		All Years
				58		All Years
				60		All Years
				62		All Years
Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below RBDD		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Below RBDD	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
Smolt Emigration	October through June	Monthly mean flow (cfs)	Below RBDD		10	All Years
					10	Lower 25%
			Verona		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
			Rio Vista		10	All Years
					10	Lower 25%

Table 12B-28
Impact Indicators Evaluated for Spring-run Chinook Salmon in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
		Monthly mean water temperature (°F)	Below RBDD	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Feather River Confluence	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Freeport	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Note:
cfs = cubic feet per second

Table 12B-29
Impact Indicators Evaluated for Fall-run Chinook Salmon in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration and Holding	July through December	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below Red Bluff Diversion Dam (RBDD)		10	All Years
					10	Lower 25%
			Verona		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
			Rio Vista		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	60		All Years
				64		All Years
				68		All Years
			Below RBDD	60		All Years
				64		All Years
				68		All Years
			Feather River Confluence	60		All Years
				64		All Years
				68		All Years
			Freeport	60		All Years
				64		All Years
				68		All Years
Spawning, Egg Incubation, and Initial Rearing	October through January	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Bend Bridge		10	All Years
					10	Lower 25%
		Scaled composite weighted usable area (WUA) (% of maximum)	Keswick Dam to RBDD		1	All Years
		Monthly mean water temperature (°F)	Below Keswick Dam	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Ball's Ferry	56		All Years
				58		All Years
				60		All Years
				62		All Years

Table 12B-29
Impact Indicators Evaluated for Fall-run Chinook Salmon in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
			Jelly's Ferry	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Bend Bridge	56		All Years
				58		All Years
				60		All Years
				62		All Years
Juvenile Rearing and Emigration	December through June	Monthly mean flow (cfs)	Below RBDD		10	All Years
					10	Lower 25%
			Verona		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
			Rio Vista		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below RBDD	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Feather River Confluence	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Freeport	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Note:
cfs = cubic feet per second

Table 12B-30
Impact Indicators Evaluated for Late Fall-run Chinook Salmon in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration and Holding	October through April	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below Red Bluff Diversion Dam (RBDD)		10	All Years
					10	Lower 25%
			Verona		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
			Rio Vista		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	60		All Years
				64		All Years
				68		All Years
			Below RBDD	60		All Years
				64		All Years
				68		All Years
			Feather River Confluence	60		All Years
				64		All Years
				68		All Years
			Freeport	60		All Years
				64		All Years
				68		All Years
Spawning, egg incubation, and initial rearing	January through May	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Bend Bridge		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Ball's Ferry	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Jelly's Ferry	56		All Years
				58		All Years
				60		All Years
				62		All Years

Table 12B-30
Impact Indicators Evaluated for Late Fall-run Chinook Salmon in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
			Bend Bridge	56		All Years
				58		All Years
				60		All Years
				62		All Years
Juvenile Rearing and Emigration	April through December	Monthly mean flow (cfs)	Below RBDD		10	All Years
					10	Lower 25%
			Verona		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
			Rio Vista		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below RBDD	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Feather River Confluence	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Freeport	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Note:
cfs = cubic feet per second

Table 12B-31
Impact Indicators Evaluated for Steelhead in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration and Holding	August through March	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below RBDD		10	All Years
					10	Lower 25%
			Verona		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
			Rio Vista		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	52		All Years
				56		All Years
				70		All Years
			Below RBDD	52		All Years
				56		All Years
				70		All Years
			Feather River Confluence	52		All Years
				56		All Years
				70		All Years
			Freeport	52		All Years
				56		All Years
				70		All Years
Spawning and Egg Incubation	December through April	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	52		All Years
				54		All Years
				57		All Years
				60		All Years
Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Bend Bridge		10	All Years
					10	Lower 25%
			Below RBDD		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	65		All Years
				68		All Years
				72		All Years
				75		All Years

Table 12B-31
Impact Indicators Evaluated for Steelhead in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
			Ball's Ferry	65		All Years
				68		All Years
				72		All Years
				75		All Years
			Jelly's Ferry	65		All Years
				68		All Years
				72		All Years
				75		All Years
			Bend Bridge	65		All Years
				68		All Years
				72		All Years
				75		All Years
			Below RBDD	65		All Years
				68		All Years
				72		All Years
				75		All Years
Smolt Emigration	October through May	Monthly mean flow (cfs)	Below RBDD		10	All Years
					10	Lower 25%
			Verona		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
			Rio Vista		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below RBDD	52		All Years
				55		All Years
				59		All Years
			Feather River Confluence	52		All Years
				55		All Years
				59		All Years
			Freeport	52		All Years
				55		All Years
				59		All Years

Note:
cfs = cubic feet per second

Table 12B-32
Impact Indicators Evaluated for Green Sturgeon in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Adult Immigration and Holding	February through December	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below Delevan Pipeline Intake		10	All Years
					10	Lower 25%
			Rio Vista		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	61		All Years
				66		All Years
			Below Delevan Pipeline Intake	61		All Years
				66		All Years
			Freeport	61		All Years
				66		All Years
Spawning and Egg Incubation	March through August	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below Red Bluff Diversion Dam (RBDD)		10	All Years
					10	Lower 25%
			Wilkins Slough		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	68		All Years
			Below RBDD	68		All Years
Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Below RBDD		10	All Years
					10	Lower 25%
			Below Delevan Pipeline Intake		10	All Years
					10	Lower 25%
			Rio Vista		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below RBDD	66		All Years
			Below Delevan Pipeline Intake	66		All Years
			Freeport	66		All Years

Note:
cfs = cubic feet per second

Table 12B-33
Impact Indicators Evaluated for White Sturgeon in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Adult Immigration and Holding	November through May	Monthly mean flow (cfs)	Hamilton City		10	All Years
					10	Lower 25%
			Below the Delevan Pipeline Intake		10	All Years
					10	Lower 25%
			Rio Vista		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Hamilton City	77		All Years
			Below the Delevan Pipeline Intake	77		All Years
			Freeport	77		All Years
Spawning and Egg Incubation	February through May	Monthly mean flow (cfs)	Hamilton City		10	All Years
					10	Lower 25%
			Below the Delevan Pipeline Intake		10	All Years
					10	Lower 25%
			Verona		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Hamilton City	61		All Years
			Below the Delevan Pipeline Intake	61		All Years
			Below the Feather River Confluence	61		All Years
Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Below the Delevan Pipeline Intake		10	All Years
					10	Lower 25%
			Wilkins Slough		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below the Delevan Pipeline Intake	66		All Years
			Knights Landing	66		All Years
			Freeport	66		All Years

Note:
cfs = cubic feet per second

Table 12B-34
Impact Indicators Evaluated for River Lamprey in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration	September through June	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below the Delevan Pipeline Intake		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
Adult Spawning and Egg Incubation	February through July	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below Red Bluff Diversion Dam (RBDD)		10	All Years
					10	Lower 25%
			Below the Delevan Pipeline Intake		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	50-64*		All Years
			Below RBDD	50-64		All Years
			Below the Delevan Pipeline Intake	50-64		All Years
Ammocoete Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below the Delevan Pipeline Intake		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	72		All Years
			Below the Delevan Pipeline Intake	72		All Years
			Freeport	72		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:
cfs = cubic feet per second

Table 12B-35
Impact Indicators Evaluated for Pacific Lamprey in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Adult Immigration	January through June	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below the Delevan Pipeline Intake		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
Adult Spawning and Egg Incubation	January through August	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below Red Bluff Diversion Dam (RBDD)		10	All Years
					10	Lower 25%
			Below the Delevan Pipeline Intake		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	50-64*		All Years
			Below RBDD	50-64		All Years
			Below the Delevan Intake	50-64		All Years
Ammocoete Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below the Delevan Pipeline Intake		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	72		All Years
			Below the Delevan Pipeline Intake	72		All Years
			Freeport	72		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:

cfs = cubic feet per second

Table 12B-36
Impact Indicators Evaluated for Hardhead in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adults and Other Life Stages	Year-round	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below the Delevan Pipeline Intake		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	65-82*		All Years
			Below the Delevan Pipeline Intake	65-82		All Years
			Freeport	65-82		All Years
Adult Spawning	April through June	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below the Delevan Pipeline Intake		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	59-64		All Years
			Below the Delevan Pipeline Intake	59-64		All Years
			Freeport	59-64		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:
cfs = cubic feet per second

Table 12B-37
Impact Indicators Evaluated for California Roach in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adults and Other Life Stages	Year-round	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below the Delevan Pipeline Intake		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	86		All Years
			Below the Delevan Pipeline Intake	86		All Years
			Freeport	86		All Years
Adult Spawning	March through June	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below the Delevan Pipeline Intake		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below Keswick Dam	60		All Years
			Below the Delevan Pipeline Intake	60		All Years
			Freeport	60		All Years

Note:
cfs = cubic feet per second

Table 12B-38
Impact Indicators Evaluated for American Shad in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Adult Spawning, Embryo Incubation, and Initial Rearing	April through June	Monthly mean flow (cfs)	Below Red Bluff Diversion Dam (RBDD)		10	All Years
					10	Lower 25%
			Verona		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below RBDD	60-70*		All Years
			Below the Feather River Confluence	60-70		All Years
			Freeport	60-70		All Years
Larvae, Fry, and Juvenile Rearing and Emigration	July through November	Monthly mean flow (cfs)	Below the Delevan Pipeline Intake		10	All Years
					10	Lower 25%
			Verona		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below the Delevan Pipeline Intake	63-77		All Years
			Below the Feather River Confluence	63-77		All Years
			Freeport	63-77		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:

cfs = cubic feet per second

Table 12B-39
Impact Indicators Evaluated for Striped Bass in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Spawning, Embryo Incubation, and Initial Rearing	April through June	Monthly mean flow (cfs)	Below the Delevan Pipeline Intake		10	All Years
					10	Lower 25%
			Verona		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below the Delevan Pipeline Intake	59-68*		All Years
			Below the Feather River Confluence	59-68		All Years
Larvae, Fry, and Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Below the Delevan Pipeline Intake		10	All Years
					10	Lower 25%
			Verona		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below the Delevan Pipeline Intake	61-71		All Years
			Below the Feather River Confluence	61-71		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:

cfs = cubic feet per second

Table 12B-40
Impact Indicators Evaluated for Largemouth Bass in the Sacramento River

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Adults and Other Life Stages	Year-round	Monthly mean flow (cfs)	Below Keswick Dam		10	All Years
					10	Lower 25%
			Below the Delevan Pipeline Intake		10	All Years
					10	Lower 25%
			Freeport		10	All Years
					10	Lower 25%
Spawning	March through June	Monthly mean water temperature (°F)	Below Keswick Dam	59-75*		All Years
			Below the Delevan Pipeline Intake	59-75		All Years
			Freeport	59-75		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:
cfs = cubic feet per second

12B.4.1.5 Feather River

Table 12B-41
Impact Indicators Evaluated for Spring-run Chinook Salmon in the Feather River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration and Holding	March through October	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	60		All Years
				64		All Years
				68		All Years
			Below the Thermalito Afterbay Outlet	60		All Years
				64		All Years
				68		All Years
			Mouth of the Lower Feather River	60		All Years
				64		All Years
				68		All Years
Adult Spawning and Embryo Incubation	September through February	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Below the Thermalito Afterbay Outlet	56		All Years
				58		All Years
				60		All Years
				62		All Years
	September through December	Scaled Composite Weighted Usable Area (WUA) (% of maximum)	Thermalito Afterbay Outlet to Honcut Creek		1	All Years

Table 12B-41
Impact Indicators Evaluated for Spring-run Chinook Salmon in the Feather River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Below the Thermalito Afterbay Outlet	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
Smolt Emigration	October through June	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Below the Thermalito Afterbay Outlet	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Table 12B-41
Impact Indicators Evaluated for Spring-run Chinook Salmon in the Feather River

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
			Mouth of the Lower Feather River	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Note:
cfs = cubic feet per second

Table 12B-42
Impact Indicators Evaluated for Fall-run Chinook Salmon in the Feather River

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Adult Immigration and Holding	July through December	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	60		All Years
				64		All Years
				68		All Years
			Below the Thermalito Afterbay Outlet	60		All Years
				64		All Years
				68		All Years
			Mouth of the Lower Feather River	60		All Years
				64		All Years
				68		All Years
Adult Spawning	October through December	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Below the Thermalito Afterbay Outlet	56		All Years
				58		All Years
				60		All Years
				62		All Years
		Scaled Composite Weighted Usable Area (WUA) (% of maximum)	Thermalito Afterbay Outlet to Honcut Creek		1	All Years

Table 12B-42
Impact Indicators Evaluated for Fall-run Chinook Salmon in the Feather River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Embryo Incubation	October through March	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	56		All Years
				58		All Years
				60		All Years
				62		All Years
			Below the Thermalito Afterbay Outlet	56		All Years
				58		All Years
				60		All Years
				62		All Years
Juvenile Rearing and Emigration	November through June	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Below the Thermalito Afterbay Outlet	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Mouth of the Lower Feather River	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Note:
cfs = cubic feet per second

Table 12B-43
Impact Indicators Evaluated for Steelhead in the Feather River

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	**Value**	**%**	
Adult Immigration and Holding	August through April	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	52		All Years
				56		All Years
				70		All Years
			Below the Thermalito Afterbay Outlet	52		All Years
				56		All Years
				70		All Years
			Mouth of the Lower Feather River	52		All Years
				56		All Years
				70		All Years
Adult Spawning and Embryo Incubation	December through May	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	52		All Years
				54		All Years
				57		All Years
				60		All Years
			Below the Thermalito Afterbay Outlet	52		All Years
				54		All Years
				57		All Years
				60		All Years
	December through April	Scaled composite weighted usable area (WUA) (% of maximum)	Thermalito Afterbay Outlet to Honcut Creek		10	All Years

Table 12B-43
Impact Indicators Evaluated for Steelhead in the Feather River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	65		All Years
				68		All Years
				72		All Years
				75		All Years
			Below the Thermalito Afterbay Outlet	65		All Years
				68		All Years
				72		All Years
				75		All Years
Smolt Emigration	October through May	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	Lower 25%
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	52		All Years
				55		All Years
				59		All Years
			Below the Thermalito Afterbay Outlet	52		All Years
				55		All Years
				59		All Years
			Mouth of the Lower Feather River	52		All Years
				55		All Years
				59		All Years

Note:
cfs = cubic feet per second

Table 12B-44
Impact Indicators Evaluated for Green Sturgeon in the Feather River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration and Holding	February through December	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Feather River at Shanghai Bend		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	61		All Years
				64		All Years
				68		All Years
			Below the Thermalito Afterbay Outlet	61		All Years
				64		All Years
				68		All Years
			Mouth of the Lower Feather River	61		All Years
				64		All Years
				68		All Years
Adult Spawning and Embryo Incubation	March through August	Monthly mean flow (cfs)	Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below the Thermalito Afterbay Outlet	68		All Years
Juvenile Rearing	Year-round	Monthly mean flow (cfs)	Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below the Thermalito Afterbay Outlet	66		All Years
			Mouth of the Lower Feather River	66		All Years
Juvenile Emigration	May through September	Monthly mean flow (cfs)	Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Feather River at Shanghai Bend		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below the Thermalito Afterbay Outlet	66		All Years
			Mouth of the Lower Feather River	66		All Years

Note:
cfs = cubic feet per second

Table 12B-45
Impact Indicators Evaluated for White Sturgeon in the Feather River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration and Holding	November through May	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Feather River at Shanghai Bend		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below the Fish Barrier Dam	77		All Years
			Below the Thermalito Afterbay Outlet	77		All Years
			Mouth of the Feather River	77		All Years
Spawning and Egg Incubation	February through May	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Feather River at Shanghai Bend*		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below the Fish Barrier Dam	61		All Years
			Below the Thermalito Afterbay Outlet	61		All Years
			Mouth of the Feather River	61		All Years
Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Feather River at Shanghai Bend		10	All Years
					10	Lower 25%
			Mouth of the Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below the Fish Barrier Dam	66		All Years
			Below the Thermalito Afterbay Outlet	66		All Years
			Mouth of the Feather River	66		All Years

Note:
cfs = cubic feet per second

Table 12B-46
Impact Indicators Evaluated for River Lamprey in the Feather River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration	September through June	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
Adult Spawning and Egg Incubation	February through July	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	50-64*		All Years
			Below the Thermalito Afterbay Outlet	50-64		All Years
			Mouth of the Lower Feather River	50-64		All Years
Ammocoete Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	72		All Years
			Below the Thermalito Afterbay Outlet	72		All Years
			Mouth of the Lower Feather River	72		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:

cfs = cubic feet per second

Table 12B-47
Impact Indicators Evaluated for Pacific Lamprey in the Feather River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration	January through June	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
Adult Spawning and Egg Incubation	January through August	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	50-64*		All Years
			Below the Thermalito Afterbay Outlet	50-64		All Years
			Mouth of the Lower Feather River	50-64		All Years
Ammocoete Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	72		All Years
			Below the Thermalito Afterbay Outlet	72		All Years
			Mouth of the Lower Feather River	72		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:
cfs = cubic feet per second

Table 12B-48
Impact Indicators Evaluated for Hardhead in the Feather River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adults and Juveniles	Year-round	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	65-82*		All Years
			Below the Thermalito Afterbay Outlet	65-82		All Years
			Mouth of the Lower Feather River	65-82		All Years
Adult Spawning	April through June	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	59-64		All Years
			Below the Thermalito Afterbay Outlet	59-64		All Years
			Mouth of the Lower Feather River	59-64		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:

cfs = cubic feet per second

Table 12B-49
Impact Indicators Evaluated for California Roach in the Feather River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adults and Other Life Stages	Year-round	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	86		All Years
			Below the Thermalito Afterbay Outlet	86		All Years
			Mouth of the Lower Feather River	86		All Years
Adult Spawning	March through June	Monthly mean flow (cfs)	Low Flow Channel below the Fish Barrier Dam		10	All Years
					10	Lower 25%
			Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Lower Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Low Flow Channel below the Fish Barrier Dam	60		All Years
			Below the Thermalito Afterbay Outlet	60		All Years
			Mouth of the Lower Feather River	60		All Years

Note:
cfs = cubic feet per second

Table 12B-50
Impact Indicators Evaluated for Sacramento Splittail in the Feather River

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Spawning	February through May	Monthly mean flow (cfs)	Mouth of the Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Mouth of the Feather River	45-75*		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:
cfs = cubic feet per second

Table 12B-51
Impact Indicators Evaluated for American Shad in the Feather River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Spawning, Embryo Incubation, and Initial Rearing	April through June	Monthly mean flow (cfs)	Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below the Thermalito Afterbay Outlet	60-70*		All Years
			Mouth of the Feather River	60-70		All Years
Larvae, Fry, and Juvenile Rearing and Emigration	July through November	Monthly mean flow (cfs)	Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below the Thermalito Afterbay Outlet	63-77		All Years
			Mouth of the Feather River	63-77		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:
cfs = cubic feet per second

Table 12B-52
Impact Indicators Evaluated for Striped Bass in the Feather River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Spawning, Embryo Incubation, and Initial Rearing	April through June	Monthly mean flow (cfs)	Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below the Thermalito Afterbay Outlet	59-68*		All Years
			Mouth of the Feather River	59-68		All Years
Larvae, Fry, and Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Feather River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Below the Thermalito Afterbay Outlet	61-71		All Years
			Mouth of the Feather River	61-71		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:
cfs = cubic feet per second

Table 12B-53
Impact Indicators Evaluated for Largemouth Bass in the Feather River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adults and Other Life Stages	Year-round	Monthly mean flow (cfs)	Below the Thermalito Afterbay Outlet		10	All Years
					10	Lower 25%
			Mouth of the Feather River		10	All Years
					10	Lower 25%
Spawning	March through June	Monthly mean water temperature (°F)	Below the Thermalito Afterbay Outlet	59-75*		All Years
			Mouth of the Feather River	59-75		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:
cfs = cubic feet per second

12B.4.1.6 American River

Table 12B-54
Impact Indicators Evaluated for Spring-run Chinook Salmon in the American River

Lifestage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value (°F)	%	
Non-Natal Juvenile Rearing	November through April	Monthly mean flow (cfs)	Mouth of the American River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Mouth of the American River	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Note:
cfs = cubic feet per second

Table 12B-55
Impact Indicators Evaluated for Fall-run Chinook Salmon in the American River

Lifestage	Evaluation Period	Impact Indicator	Location Description	Criteria Value (°F)	Criteria %	Range
Adult Immigration and Holding	September through December	Monthly mean flow (cfs)	American River at Watt Avenue		10	All Years
					10	Lower 25%
			Mouth of the American River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	American River at Watt Avenue	60		All Years
				64		All Years
				68		All Years
			Mouth of the American River	60		All Years
				64		All Years
				68		All Years
Adult Spawning	October through December	Monthly mean flow (cfs)	American River at Watt Avenue		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	American River at Watt Avenue	56		All Years
				58		All Years
				60		All Years
				62		All Years
		Scaled Composite Weighted Usable Area (WUA) (% of maximum)	Sailor Bar (RM 21.8) through Rossmoor (RM 17.3)		1	All Years
Embryo Incubation	October through March	Monthly mean flow (cfs)	American River at Watt Avenue		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	American River at Watt Avenue	56		All Years
				58		All Years
				60		All Years
				62		All Years
Juvenile Rearing and Emigration	January through June	Monthly mean flow (cfs)	Nimbus Dam Release		10	All Years
					10	Lower 25%
			American River at Watt Avenue		10	All Years
					10	Lower 25%
			Mouth of the American River		10	All Years
					10	Lower 25%

Table 12B-55
Impact Indicators Evaluated for Fall-run Chinook Salmon in the American River

Lifestage	Evaluation Period	Impact Indicator	Location Description	Criteria Value (°F)	Criteria %	Range
		Monthly mean water temperature (°F)	American River at Nimbus Dam	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			American River at Watt Avenue	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years
			Mouth of the American River	60		All Years
				63		All Years
				65		All Years
				68		All Years
				70		All Years
				75		All Years

Notes:

cfs = cubic feet per second
RM = river mile

Table 12B-56
Impact Indicators Evaluated for Steelhead in the American River

Lifestage	Evaluation Period	Impact Indicator	Location Description	Criteria Value (°F)	Criteria %	Range
Adult Immigration and Holding	November through April	Monthly mean flow (cfs)	American River at Watt Avenue		10	All Years
					10	Lower 25%
			Mouth of the American River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	American River at Watt Avenue	52		All Years
				56		All Years
				70		All Years
			Mouth of the American River	52		All Years
				56		All Years
				70		All Years
Adult Spawning	January through April	Monthly mean flow (cfs)	American River at Watt Avenue		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	American River at Watt Avenue	52		All Years
				54		All Years
				57		All Years
				60		All Years
		Scaled Composite Weighted Usable Area (WUA) (% of maximum)	Sailor Bar (RM 21.8) through Rossmoor (RM 17.3)		1	All Years
Embryo Incubation	January through May	Monthly mean flow (cfs)	American River at Watt Avenue		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	American River at Watt Avenue	52		All Years
				54		All Years
				57		All Years
				60		All Years
Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Nimbus Dam Release		10	All Years
					10	Lower 25%
			American River at Watt Avenue		10	All Years
					10	Lower 25%
			Mouth of the American River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	American River at Nimbus Dam	65		All Years
				68		All Years
				72		All Years
				75		All Years

Table 12B-56
Impact Indicators Evaluated for Steelhead in the American River

Lifestage	Evaluation Period	Impact Indicator	Location Description	Criteria Value (°F)	Criteria %	Range
			American River at Watt Avenue	65		All Years
				68		All Years
				72		All Years
				75		All Years
			Mouth of the American River	65		All Years
				68		All Years
				72		All Years
				75		All Years
Smolt Emigration	January through June	Monthly mean flow (cfs)	American River at Watt Avenue		10	All Years
					10	Lower 25%
			Mouth of the American River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	American River at Watt Avenue	52		All Years
				55		All Years
			Mouth of the American River	52		All Years
				55		All Years

Notes:
cfs = cubic feet per second
RM = river mile

Table 12B-57
Impact Indicators Evaluated for Green Sturgeon in the American River

Lifestage	Evaluation Period	Impact Indicator	Location	Criteria		
			Description	Value (°F)	%	Range
Adult Immigration and Holding	February through December	Monthly mean flow (cfs)	Mouth of the American River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Mouth of the American River	61		All Years
Adult Spawning and Egg Incubation	March through August	Monthly mean flow (cfs)	Mouth of the American River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Mouth of the American River	68		All Years
Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Mouth of the American River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Mouth of the American River	66		All Years

Notes:
cfs = cubic feet per second

Table 12B-58
Impact Indicators Evaluated for River Lamprey in the American River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration	September through June	Monthly mean flow (cfs)	Nimbus Dam Release		10	All Years
					10	Lower 25%
			American River at Watt Avenue		10	All Years
					10	Lower 25%
			Mouth of the American River		10	All Years
					10	Lower 25%
Adult Spawning and Egg Incubation	February through July	Monthly mean flow (cfs)	Nimbus Dam Release		10	All Years
					10	Lower 25%
			American River at Watt Avenue		10	All Years
					10	Lower 25%
			Mouth of the American River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Nimbus Dam Release	50-64*		All Years
			American River at Watt Avenue	50-64		All Years
			Mouth of the American River	50-64		All Years
Ammocoete Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Nimbus Dam Release		10	All Years
					10	Lower 25%
			American River at Watt Avenue		10	All Years
					10	Lower 25%
			Mouth of the American River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Nimbus Dam Release	72		All Years
			American River at Watt Avenue	72		All Years
			Mouth of the American River	72		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:

cfs = cubic feet per second

Table 12B-59
Impact Indicators Evaluated for Pacific Lamprey in the American River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Immigration	January through June	Monthly mean flow (cfs)	Nimbus Dam Release		10	All Years
					10	Lower 25%
			American River at Watt Avenue		10	All Years
					10	Lower 25%
			Mouth of the American River		10	All Years
					10	Lower 25%
Adult Spawning and Egg Incubation	January through August	Monthly mean flow (cfs)	Nimbus Dam Release		10	All Years
					10	Lower 25%
			American River at Watt Avenue		10	All Years
					10	Lower 25%
			Mouth of the American River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Nimbus Dam Release	50-64*		All Years
			American River at Watt Avenue	50-64		All Years
			Mouth of the American River	50-64		All Years
Ammocoete Rearing and Emigration	Year-round	Monthly mean flow (cfs)	Nimbus Dam Release		10	All Years
					10	Lower 25%
			American River at Watt Avenue		10	All Years
					10	Lower 25%
			Mouth of the American River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Nimbus Dam Release	72		All Years
			American River at Watt Avenue	72		All Years
			Mouth of the American River	72		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:
cfs = cubic feet per second

Table 12B-60
Impact Indicators Evaluated for Hardhead in the American River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adults and Other Life Stages	Year-round	Monthly mean flow (cfs)	American River at Watt Avenue		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	American River at Watt Avenue	65-82*		All Years
Adult Spawning	April through June	Monthly mean flow (cfs)	American River at Watt Avenue		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	American River at Watt Avenue	59-64		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:

cfs = cubic feet per second

Table 12B-61
Impact Indicators Evaluated for California Roach in the American River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adults and Other Life Stages	Year-round	Monthly mean flow (cfs)	American River at Watt Avenue		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	American River at Watt Avenue	86		All Years
Adult Spawning	March through June	Monthly mean flow (cfs)	American River at Watt Avenue		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	American River at Watt Avenue	60		All Years

Note:
cfs = cubic feet per second

Table 12B-62
Impact Indicators Evaluated for Sacramento Splittail in the American River

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Spawning	February through May	Monthly mean flow (cfs)	Mouth of the American River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	Mouth of the American River	45-75*		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:
cfs = cubic feet per second

Table 12B-63
Impact Indicators Evaluated for American Shad in the American River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Spawning, Embryo Incubation, and Initial Rearing	April through June	Monthly mean flow (cfs)	American River at Watt Avenue		10	All Years
					10	Lower 25%
			Mouth of the American River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	American River at Watt Avenue	60-70*		All Years
			Mouth of the American River	60-70		All Years
Larvae, Fry, and Juvenile Rearing and Emigration	July through November	Monthly mean flow (cfs)	American River at Watt Avenue		10	All Years
					10	Lower 25%
			Mouth of the American River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	American River at Watt Avenue	63-77		All Years
			Mouth of the American River	63-77		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:
cfs = cubic feet per second

Table 12B-64
Impact Indicators Evaluated for Striped Bass in the American River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult Spawning, Embryo Incubation, and Initial Rearing	April through June	Monthly mean flow (cfs)	American River at Watt Avenue		10	All Years
					10	Lower 25%
			Mouth of the American River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	American River at Watt Avenue	59-68*		All Years
			Mouth of the American River	59-68		All Years
Larvae, Fry, and Juvenile Rearing and Emigration	Year-round	Monthly mean flow (cfs)	American River at Watt Avenue		10	All Years
					10	Lower 25%
			Mouth of the American River		10	All Years
					10	Lower 25%
		Monthly mean water temperature (°F)	American River at Watt Avenue	61-71		All Years
			Mouth of the American River	61-71		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:
cfs = cubic feet per second

Table 12B-65
Impact Indicators Evaluated for Largemouth Bass in the American River

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adults and Other Life Stages	Year-round	Monthly mean flow (cfs)	American River at Watt Avenue		10	All Years
					10	Lower 25%
Spawning	March through June	Monthly mean water temperature (°F)	American River at Watt Avenue	59-75*		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:

cfs = cubic feet per second

12B.4.1.7 Sacramento-San Joaquin Delta

Table 12B-66
Impact Indicators Evaluated for Delta Smelt in the Delta

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Adult	December through May	Mean monthly water temperature (°F)	Sacramento River at Freeport	59-68*		All Years
	December through February	Mean monthly OMR flow (cfs)	Old and Middle Rivers	<-5000 cfs		All Years
	December through April	Mean monthly salvage	SWP and CVP Export Facilities		10	All Years
Egg and Embryo	February through May	Mean monthly water temperature (°F)	Sacramento River at Freeport	59-68		All Years
Larval	March through June	Mean monthly water temperature (°F)	Sacramento River at Freeport	59-68		All Years
		Mean monthly OMR flow (cfs)	Old and Middle Rivers	>-1,500 cfs		Dry and Critical Water Years
		Mean monthly Delta outflow (cfs)	Delta		10	All Years
Juvenile	May through July	Mean monthly water temperature (°F)	Sacramento River at Freeport	59-68		All Years
		Mean monthly salvage	SWP and CVP Export Facilities		10	All Years
		Mean monthly X2 location(RKm)	Changes in X2 location between RKm 65 and 80	0.5 RKm		All Years

*Water temperature ranges were evaluated by calculating the net change in the probability of water temperatures occurring within the specified range.

Note:

cfs = cubic feet per second

Table 12B-67
Impact Indicators Evaluated for Longfin Smelt in the Delta

Life Stage	Evaluation Period	Impact Indicator	Location Description	Criteria Value	Criteria %	Range
Adult	December through March	Mean monthly OMR flow (cfs)	Old and Middle Rivers	<-5000 cfs		All Years
Larval and Juvenile	December through March	Mean monthly OMR flow (cfs)	Old and Middle Rivers	<-5000 cfs		Dry and Critical Water Years
	Year-round	Mean monthly salvage	SWP and CVP Export Facilities		10	All Years
	January through June	Mean monthly X2 location (RKm)	Changes in X2 location	< 75 RKm		All Years

Notes:

cfs = cubic feet per second
CVP = Central Valley Project
RKm = river kilometer
SWP = State Water Project
X2 = the position of the two parts per thousand (ppt) salinity isopleths

Table 12B-68
Impact Indicators Evaluated for Winter-run Chinook Salmon in the Delta

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Juvenile	Year-round	Through-Delta survival	Delta Passage Model		10	All Years
	May through July	Mean monthly salvage	SWP and CVP Export Facilities		10	All Years

Notes:

CVP = Central Valley Project
SWP = State Water Project

Table 12B-69
Impact Indicators Evaluated for Spring-run Chinook Salmon in the Delta

Life Stage	Evaluation Period	Impact Indicator	Location		Criteria	
			Description	Value	%	Range
Juvenile	November through June	Mean monthly salvage	SWP and CVP Export Facilities		10	All Years

Notes:

CVP = Central Valley Project
SWP = State Water Project

Table 12B-70
Impact Indicators Evaluated for Fall- and Late Fall-run Chinook Salmon in the Delta

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
San Joaquin River Adult	December through February	Mean monthly OMR flow (cfs)	Old and Middle Rivers	<-5000 cfs		All Years
Juvenile	November through June	Mean monthly salvage	SWP and CVP Export Facilities		10	All Years

Notes:
cfs = cubic feet per second
CVP = Central Valley Project
SWP = State Water Project

Table 12B-71
Impact Indicators Evaluated for Steelhead in the Delta

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Juvenile Rearing and Emigration	October through July	Mean monthly flow (cfs)	Rio Vista		10	All Years
		Mean monthly flow (cfs)	Yolo Bypass		10	All Years
		Mean monthly Delta outflow (cfs)	Delta		10	All Years
		Mean monthly OMR flow (cfs)	Old and Middle Rivers		10	All Years
		Mean monthly salvage	SWP and CVP Export Facilities		10	All Years

Notes:
cfs = cubic feet per second
CVP = Central Valley Project
SWP = State Water Project

Table 12B-72
Impact Indicators Evaluated for Green Sturgeon in the Delta

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Juvenile Rearing and Emigration	Year-round	Mean monthly flow (cfs)	Yolo Bypass		10	All Years
		Mean monthly salvage	SWP and CVP Export Facilities		10	All Years

Notes:
cfs = cubic feet per second
CVP = Central Valley Project
SWP = State Water Project

Table 12B-73
Impact Indicators Evaluated for White Sturgeon in the Delta

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Juvenile Rearing and Emigration	April through June	Mean monthly flow (cfs)	Yolo Bypass		10	All Years
		Mean monthly salvage	SWP and CVP Export Facilities		10	All Years

Notes:
cfs = cubic feet per second
CVP = Central Valley Project
SWP = State Water Project

Table 12B-74
Impact Indicators Evaluated for River Lamprey and Pacific Lamprey in the Delta

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Macropthalmia Emigration	Year-round	Mean monthly salvage	SWP and CVP Export Facilities		10	All Years

Notes:
CVP = Central Valley Project
SWP = State Water Project

Table 12B-75
Impact Indicators Evaluated for Sacramento Splittail in the Delta

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Egg and Larval	February through May	Mean monthly flow (cfs)	Yolo Bypass		10	All Years
Juvenile Rearing and Emigration	April through July	Mean monthly flow (cfs)	Yolo Bypass		10	All Years
		Mean monthly salvage	SWP and CVP Export Facilities		10	All Years
Adult Spawning	February through May	Mean monthly flow (cfs)	Yolo Bypass		10	All Years
	December through March	Mean monthly salvage	SWP and CVP Export Facilities		10	All Years

Notes:
cfs = cubic feet per second
CVP = Central Valley Project
SWP = State Water Project

Table 12B-76
Impact Indicators Evaluated for American Shad in the Delta

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Egg and Larval	December through April	Mean monthly salvage	SWP and CVP Export Facilities		10	All Years
	April through June	Mean monthly X2 location (RKm)	Changes in X2 location less than or equal to 75 RKm	75 RKm		All Years

Notes:

CVP = Central Valley Project
RKm = river kilometer
SWP = State Water Project
X2 = the position of the two parts per thousand (ppt) salinity isopleth

Table 12B-77
Impact Indicators Evaluated for Striped Bass in the Delta

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
Egg and Larval	December through April	Mean monthly salvage	SWP and CVP Export Facilities		10	All Years
	April through June	Mean monthly X2 location (RKm)	Changes in X2 location	1 RKm		All Years

Notes:

CVP = Central Valley Project
RKm = river kilometer
SWP = State Water Project
X2 = the position of the two parts per thousand (ppt) salinity isopleth

Table 12B-78
Impact Indicators Evaluated for Largemouth Bass in the Delta

Life Stage	Evaluation Period	Impact Indicator	Location	Criteria		Range
			Description	Value	%	
All Life Stages	December through April	Mean monthly salvage	SWP and CVP Export Facilities		10	All Years
	April through June	Mean monthly X2 location (RKm)	Changes in X2 location	1 RKm		All Years

Notes:
CVP = Central Valley Project
RKm = river kilometer
SWP = State Water Project
X2 = the position of the two parts per thousand (ppt) salinity isopleth

12B.4.2 Primary Study Area

Impact indicators used to evaluate the potential effects of implementation of the NODOS Project alternatives on fish species of primary management concern in the Primary Study Area are provided in Table 12B-79.

12B.4.2.1 Construction-Related Impact Indicators

Table 12B-79
Construction-Related Impact Indicators

Impact Indicators	Indicator Value
Erosion, Sedimentation, and Turbidity	Increase in erosion, sedimentation, and turbidity resulting in habitat modification or degradation in the form of a reduction in physical habitat availability or habitat constituent element suitability for a species to substantially affect this species, relative to the basis of comparison.
Hydrostatic Pressure Waves, Noise, and Vibration	Hydrostatic pressure waves, noise, and vibration resulting in habitat modification or degradation in the form of a reduction in physical habitat availability or habitat constituent element suitability for a species to substantially affect this species, relative to the basis of comparison.
Potential Hazardous Materials and Chemical Spills	Potential hazardous materials and chemical spills resulting in habitat modification or degradation in the form of a reduction in physical habitat availability or habitat constituent element suitability for a species to substantially affect this species, relative to the basis of comparison.
Stranding Potential	Stranding of a species during construction activities to substantially affect this species, relative to the basis of comparison.
Predation Risk	Increase in predation of a species to substantially affect this species, relative to the basis of comparison.
SRA Habitat Quantity and Quality	Loss of existing shaded riverine aquatic habitat value, acreage and riverside length resulting in habitat modification or degradation in the form of a reduction in physical habitat availability or habitat constituent element suitability for a species to substantially affect this species, relative to the basis of comparison.
Fish Passage	Impedance with the movement of a species resulting in habitat modification or degradation to substantially affect this species, relative to the basis of comparison.
Impingement and Entrainment	Increase in impingement and entrainment of a species to substantially affect this species, relative to the basis of comparison.

12B.4.2.2 Operations-Related Impact Indicators

Operations-related impacts in the Primary Study Area include potential changes in flows and water temperatures in the Sacramento River associated with discharge and/or diversions at the proposed Delevan Pipeline Intake/Discharge Facilities. These potential impacts were included in CALSIM II and Reclamation Temperature modeling outputs (to the extent possible); therefore, impact indicators were included in the operations-related impact indicators for the Sacramento River within the Secondary Study Area.

12B.5 References

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Appendix 12C
Fisheries Impact Assessment

APPENDIX 12C
Fisheries Impact Assessment

12C.1 Evaluation Criteria and Significance Thresholds

For a description of the evaluation criteria and significance thresholds used in the fisheries and aquatic impact assessment, refer to the Environmental Consequences section of Chapter 12 Aquatic Biological Resources.

12C.2 Impact Assessment Assumptions

For a description of impact assessment assumptions used in the fisheries and aquatic impact assessment, refer to the Environmental Consequences section of Chapter 12 Aquatic Biological Resources.

12C.3 Impacts Associated with the No Project/No Action Alternative Relative to Existing Conditions

Proposed projects that would be implemented under the No Project/No Action Alternative are discussed in the Environmental Consequences section of Chapter 12 Aquatic Biological Resources. A summary of the potential impacts of the No Project/No Action Alternative, relative to Existing Conditions, to fish species of primary management concern that use reservoir habitat is provided in Table 12-13 of Chapter 12 Aquatic Biological Resources. A summary of the potential impacts of the No Project/No Action Alternative, relative to Existing Conditions, to fish species of primary management concern that use riverine, estuarine, and floodplain habitats is provided in Table 12-14 of Chapter 12 Aquatic Biological Resources.

12C.3.1 Extended Study Area – No Project/No Action Alternative Relative to Existing Conditions

12C.3.1.1 SWP and CVP Operations

Agricultural Water Use

Potential changes to fisheries and aquatic resources associated with any changes in agricultural water deliveries under the No Project/No Action Alternative were addressed by evaluating State Water Project (SWP) and Central Valley Project (CVP) CALSIM II water operations modeling in the Secondary and Extended study areas, below. Therefore, no further evaluation of potential effects on fisheries and aquatic resources associated with agricultural water use was conducted.

Municipal and Industrial Water Use

Potential changes to fisheries and aquatic resources associated with any changes in municipal and industrial water deliveries under the No Project/No Action Alternative were addressed by evaluating SWP and CVP CALSIM II water operations modeling in the Secondary and Extended study areas, below. Therefore, no further evaluation of potential effects on fisheries and aquatic resources associated with municipal and industrial water use was conducted.

Wildlife Refuge Water Use

Potential changes to fisheries and aquatic resources associated with any changes in wildlife refuge water deliveries under the No Project/No Action Alternative were addressed by evaluating SWP and CVP CALSIM II water operations modeling in the Secondary and Extended study areas, below. Because wildlife refuge water deliveries are not anticipated to be substantially affected, fisheries and aquatic resources within refuges are not anticipated to be substantially affected under the No Project/No Action Alternative.

San Luis Reservoir

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for San Luis Reservoir during April through November.

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar coldwater pool storage conditions, because of modeling results indicating: (1) lower long-term average monthly storage during most months of the evaluation period, and lower average monthly storage by water year type during most water year types of the evaluation period, but with higher average monthly storage during dry and critical water years; (2) lower monthly storage exceedance probabilities during most months of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance decrease during most months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in San Luis Reservoir, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for San Luis Reservoir during March through June. Relative to Existing Conditions, the No Project/No Action Alternative would be expected to provide:

- Similar warmwater fish spawning and early life stage conditions, because of modeling results indicating increased and decreased monthly water surface elevation reductions of six feet or more with similar frequency during the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in San Luis Reservoir, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Export Service Area Reservoirs

Changes in modeled total SWP and CVP Delta exports (Appendix 12H) under the No Project/No Action Alternative relative to Existing Conditions were analyzed to evaluate potential changes in storage and water surface elevations and associated impacts on fisheries in export service area reservoirs. These results are provided in the appendices.

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Slightly less suitable export service area reservoir fisheries habitat conditions, because of modeling results indicating: (1) long-term average Delta exports would be higher and lower with the same frequency during the evaluation period, average monthly by water year type Delta exports would be slightly lower during most water year types, and would be lower by 10 percent or more during August of dry and critical water years; (2) higher monthly export exceedance probabilities during March, June through September, and December, and lower export exceedance probabilities during January, February, April, May, October and November; and (3) a net 10 percent or more export probability of exceedance decrease during most months of the year.

In conclusion, in consideration of potential impacts to SWP and CVP export service area reservoir fisheries, the No Project/No Action Alternative would result in similar or potentially less suitable and less-than-significant impacts, relative to Existing Conditions.

12C.3.2 Secondary Study Area – No Project/No Action Alternative Relative to Existing Conditions

12C.3.2.1 SWP and CVP Operations

Trinity Lake

Reservoir storage model results (Appendix 12H) were examined for Trinity Lake during April through November for coldwater fish species, and during March through June for warmwater species.

Coldwater Fish Species

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar or slightly improved coldwater pool storage conditions, because of modeling results indicating: (1) slightly higher long-term average monthly storage during most of the evaluation period, and higher average monthly storage by water year type during most water years of the evaluation period; (2) equivalent or higher and lower monthly storage exceedance probabilities with the same frequency during the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during most months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Trinity Lake, the No Project/No Action Alternative would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar warmwater fish spawning and early life stage conditions, because of modeling results indicating similar frequencies of monthly water surface elevation reductions of six feet or more during the March through June evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Trinity Lake, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Trinity River

Flow and water temperature model results were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork for all species (Appendix 12E and 12F). Model results for early life stage mortality were also examined for fall-run Chinook salmon (Appendix 12J).

Coho Salmon

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Equivalent adult immigration and holding conditions, because of modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly lower average monthly flows during most water year types; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar, or slightly lower (particularly during September, October, and January) or slightly higher (particularly during November and December) average monthly probabilities of exceeding specified water temperature index values.
- Equivalent adult spawning and embryo incubation conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly lower average monthly flows during most water year types, except for February during above normal water years when average monthly flows would be slightly higher ; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values, although slightly lower probabilities of exceedance would occur during May, October, and January.
- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and equivalent or slightly lower average monthly flows during most water year types, except for February during above normal water years when average monthly flows would be slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year, with slightly lower probabilities during July and August, although higher probabilities of exceedance would occur during November through April.
- Equivalent smolt emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly lower average monthly flows during most water year types, except for February during above normal water years when average monthly flows would be slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions,

equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values, although slightly lower probabilities would occur during June.

In conclusion, in consideration of potential impacts to all life stages of Coho salmon in the Trinity River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Spring-Run Chinook Salmon

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Equivalent or slightly improved adult immigration and holding conditions, because of modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar, or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values, particularly during June through September.

- Equivalent adult spawning and egg incubation conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly lower average monthly flows during all water year types; (2) equivalent monthly flow exceedance probabilities during all months of evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, during August and September, although slightly higher probabilities of exceedance would occur during October.

- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and equivalent or slightly lower average monthly flows during most water year types, except for February during above normal water years when average monthly flows would be slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during July and August, although slightly higher probabilities would occur during September.

- Equivalent smolt emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and during February of above normal water years when average monthly flows slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during July.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Trinity River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Fall-Run Chinook Salmon

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Equivalent adult immigration and holding conditions, because of modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly lower average monthly flows during most water year types; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar monthly probabilities of exceeding specified water temperature index values.
- Equivalent adult spawning conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly lower average monthly flows during most water year types, except for February during above normal water years when average monthly flows would be slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during June, and slightly higher probabilities of exceedance during October and April.
- Equivalent embryo incubation conditions due to modeling results indicating slightly reduced, yet similar, total annual early life stage mortality, and equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during June, and slightly higher probabilities of exceedance during October and April.
- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and during February of above normal water years when average monthly flows would be slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the evaluation period, with lower probabilities of exceedance during July and August, although slightly higher probabilities of exceedance would occur during September.
- Equivalent smolt emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and during February of above normal water years when average monthly flows would be slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent or similar

probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during July.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Trinity River, the No Project/No Action Alternative would result in generally similar and less-than-significant impacts, relative to Existing Conditions.

Steelhead (Winter-run and Summer-run)

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Equivalent adult immigration and holding conditions for winter-run steelhead, because of modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly lower average monthly flows during most water year types, except for February during above normal water years when average monthly flows would be slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar, or slightly lower (particularly during August through October) average monthly probabilities of exceeding specified water temperature index values, although slightly higher probabilities of exceedance would occur during April.
- Equivalent or slightly improved adult immigration and holding conditions for summer-run steelhead due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during all water year types, with the exception of slightly lower flows during June of wet water years; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during June and August.
- Equivalent adult spawning and egg incubation conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and during February of above normal water years when average monthly flows would be slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values throughout the evaluation period.
- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and equivalent or slightly lower average monthly flows during most water year types, except for February during above normal water years when average monthly flows would be slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent or similar probabilities of exceeding specified water temperature index values throughout most of the year.

- Equivalent smolt emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and during February of above normal water years when average monthly flows would be slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during June and July, although slightly higher probabilities of exceedance would occur during April.

In conclusion, in consideration of potential impacts to all life stages of steelhead (winter-run and summer-run) in the Trinity River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Green Sturgeon

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Equivalent adult immigration and holding conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and during February of above normal water years when average monthly flows would be slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar average monthly probabilities of exceeding specified water temperature index values.
- Equivalent adult spawning conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be slightly lower more frequently; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values during the evaluation period.
- Equivalent or slightly improved juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and equivalent or slightly lower average monthly flows during most water year types, except for February during above normal water years when average monthly flows would be slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during July and September.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Trinity River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

White Sturgeon

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Equivalent adult immigration and holding conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.
- Equivalent adult spawning conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and during February of above normal water years when average monthly flows would be slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.
- Equivalent or slightly improved juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and equivalent or slightly lower average monthly flows during most water year types, except for February during above normal water years when average monthly flows would be slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during July and September.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Trinity River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Pacific Lamprey

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Equivalent adult immigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and during February of above normal water years when average monthly flows would be slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; and (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period.
- Equivalent adult spawning and egg incubation conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and

equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and during February of above normal water years when average monthly flows would be slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of remaining within the specified water temperature range.

- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and equivalent or slightly lower average monthly flows during most water year types, except for February during above normal water years when average monthly flows would be slightly higher; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Trinity River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Klamath River downstream of the Trinity River

Because potential changes to the flow regime of the Trinity River under the No Project/No Action Alternative would have a less-than-significant impact on aquatic biological resources, it is expected that any potential changes to the Klamath River downstream of the Trinity River also would be less than significant.

Lewiston Lake, Whiskeytown Lake, Keswick Reservoir, Lake Natoma, and the Thermalito Complex

Modeling was not conducted for Lewiston Lake, Keswick Reservoir, Lake Natoma, or the Thermalito Complex. However, modeling conducted on the reservoirs upstream of these regulating reservoirs indicates that the No Project/No Action Alternative, when compared to Existing Conditions, would result in less than significant changes to storage and water surface elevation fluctuations. Because these reservoirs would continue to operate as regulating reservoirs, it is assumed that there would not be substantial changes in storage or water surface elevations, resulting in less-than-significant impacts to fish species of primary management concern.

Because flows released from Whiskeytown Lake would not experience significant changes, storage and water surface elevations would not be expected to substantially change under the No Project/No Action Alternative. Therefore, potential changes in storage and water surface elevations in Whiskeytown Lake are anticipated to result in less than significant impacts to coldwater and warmwater fish species, respectively.

Spring Creek

Operational modeling was not performed for Spring Creek. However, with implementation of the No Project/No Action Alternative, operation of Whiskeytown Lake and Keswick Reservoir are not expected to significantly change, and therefore would not be expected to affect the released flows that dilute Spring Creek runoff. Because no change in the dilution of Spring Creek runoff is expected, there would be no impact on aquatic biological resources.

Shasta Lake

Reservoir storage model results (Appendix 12H) were examined for Shasta Lake during April through November for coldwater fish species, and during March through June for warmwater species.

Coldwater Fish Species

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Equivalent or slightly less suitable coldwater pool storage conditions, because of modeling results indicating: (1) slightly lower long-term average monthly storage during most of the evaluation period, and slightly lower average monthly storage by water year type during most water years of the evaluation period; (2) equivalent or slightly lower monthly storage exceedance probabilities would occur more often during the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during most months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Shasta Lake, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar warmwater fish spawning and early life stage conditions, because of modeling results indicating slightly decreased frequencies of monthly water surface elevation reductions of six feet or more would occur more often during the March through June evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Shasta Lake, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Sacramento River

For salmonid species, flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam Ball’s Ferry, Jelly’s Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport, and Rio Vista, in addition to model results for spawning habitat availability (WUA) (Appendix 12N), early life stage mortality (SacSalMort) (Appendix 12J), overall population mortality and production potential (SALMOD) (Appendix 12K), and lifecycle modeling (IOS) (Appendix 12L). Modeling results for other fish species are described separately.

Winter-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball’s Ferry, Jelly’s Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for spawning habitat availability (WUA) (Appendix 12N), early life stage mortality (SacSalMort) (Appendix 12J), overall population mortality and production potential (SALMOD) (Appendix 12K), and lifecycle modeling (IOS) (Appendix 12L).

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average and average by water year type monthly flows; (2) similar monthly flow exceedance probabilities; (3) during low flow conditions, generally similar monthly flow exceedance probabilities; (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.
- Similar or less suitable spawning conditions due to decreased spawning habitat availability during June through August, and similar probabilities of exceeding specified water temperature index values.
- Similar or less suitable embryo incubation conditions due to reduced mean total annual early life stage mortality, but with increased average annual mortality during wet and dry water years, reduced annual early life stage mortality over approximately 40 percent of the entire cumulative frequency distribution, and similar probabilities of exceeding specified water temperature index values.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar long-term average monthly flows and average monthly flows by water year type; (2) similar monthly flow exceedance probabilities, but with lower flow exceedance probabilities during July and August, and slightly higher flow exceedance probabilities during September through November; (3) under low flow conditions, similar monthly flow exceedance probabilities, but with lower flow exceedance probabilities during July and August and higher flow exceedance probabilities during October and November; and (4) similar monthly probabilities of exceeding specified water temperature index values.
- Similar conditions pertaining to population mortality and production potential (SALMOD) because of: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced by less than one percent, and average annual mortality by water year type would be reduced by one percent during below normal water years, by seven percent during dry water years and by four percent during critical water years, and would be increased by three percent during wet water years and by five percent during above normal water years; (2) an increase in total annual mortality exceedance probabilities over approximately 50 percent of the distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction, with 10 percent or more exceedance probability reductions over approximately four percent of the entire distribution; and (4) long-term average total annual winter-run Chinook salmon production would increase by less than one percent, while average total annual production would increase during below normal water years by less than one percent and during dry and critical water years by one percent, and decreases during wet water years by less than one percent and during above normal water years by two percent.
- Similar conditions pertaining to early life stage survival and abundance of spawners (IOS) because of: (1) over the 81-year evaluation period, long-term average annual egg to fry survival would be decreased by less than one percent, and average annual egg to fry survival by water year type would be decreased during wet water years by less than one percent and during dry water years by two percent, and would be increased during above normal water years by one percent, during below normal water years by less than one percent and during critical water years by four percent; (2) long-term average annual fry to smolt survival would be decreased by one percent, and average annual fry to smolt survival by water year type would be decreased during wet water years by

two percent, during above normal water years by one percent, during below normal water years by two percent, and during dry water years by one percent, and would be increased during critical water years by one percent; (3) long-term average annual female spawner abundance would increase by two percent, and average annual female spawner abundance by water year type would increase during wet water years by one percent, during above normal and below normal water years by four percent, during dry water years by two percent and during critical water years by four percent; (4) similar annual egg to fry survival exceedance probabilities over approximately 60 percent of the entire distribution; (5) a decrease in annual fry to smolt survival exceedance probabilities over approximately 60 percent of the entire distribution; and (6) an increase in annual female spawner abundance exceedance probabilities over approximately 70 percent of the entire distribution.

In conclusion, in consideration of potential impacts to all life stages of winter-run Chinook salmon in the Sacramento River, the No Project/No Action Alternative would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Spring-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J), and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar average monthly and average monthly flows by water year type; (2) similar monthly flow exceedance probabilities; (3) during low flow conditions, similar monthly flow exceedance probabilities, but with lower flow exceedance probabilities during July and August in the lower Sacramento River; (4) similar monthly probabilities of exceeding specified water temperature index values.

- Similar spawning conditions due to similar monthly flows and flow exceedance probabilities, and similar or slightly lower probabilities of exceeding specified water temperature index values.

- Similar embryo incubation conditions due to similar average total annual early life stage mortality and increased early life stage mortality over approximately 50 percent of the cumulative frequency distribution, and similar or slightly lower probabilities of exceeding specified water temperature index values.

- Similar juvenile rearing conditions due to modeling results indicating: (1) similar long-term average monthly flows; (2) similar monthly flow exceedance probabilities; (3) under low flow conditions, similar monthly flow exceedance probabilities; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

- Similar smolt emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows and average monthly flows by water year type; (2) similar monthly flow exceedance probabilities; (3) under low flow conditions, similar monthly flow exceedance probabilities; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

- Similar conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by four percent), and average annual mortality by water year type would be reduced during below normal water years by two percent, during dry water years by 10 percent, and during critical water years by five percent, and would be increased during wet water years by five percent and during above normal water years by less than one percent; (2) an increase in total annual mortality exceedance probabilities over approximately 70 percent the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability increase, with increases of 10 percent or more over 45 percent of the distribution; and (4) long-term average total annual spring-run Chinook salmon production would increase by one percent, while average total annual production would decrease during wet water years by less than one percent, and increases during above normal and below normal water years by less than one percent, during dry water years by two percent and during critical water years by three percent.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Sacramento River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J), spawning habitat availability (WUA) (Appendix 12N), and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type; (2) similar monthly flow exceedance probabilities, but with lower flow exceedance probabilities during July and August, and higher flow exceedance probabilities during September; (3) during low flow conditions, similar monthly flow exceedance probabilities, with lower flow exceedance probabilities during July and August; (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.
- More suitable spawning conditions due to increased spawning habitat availability during October through December, and lower or equivalent probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, specifically during October.
- Similar or less suitable embryo incubation conditions due to similar or increased mean total annual early life stage mortality and increased annual early life stage mortality over more than 50 percent of the entire cumulative frequency distribution, and lower or equivalent probabilities of exceeding specified water temperature index values during October, and therefore more suitable water temperatures.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar long-term average monthly flows; (2) equivalent or similar monthly flow exceedance probabilities;

(3) under low flow conditions, similar monthly flow exceedance probabilities; and (4) similar monthly probabilities of exceeding specified water temperature index values.

- Similar conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by of two percent), average annual mortality by water year type would be decreased during wet and above normal water years by less than one percent, during below normal and dry water years by one percent, and during critical water years by eight percent; (2) a decrease in total annual mortality exceedance probabilities over approximately 60 percent of the entire distribution; (3) an equivalent net 10 percent or more total annual mortality exceedance probability difference; and (4) long-term average total annual fall-run Chinook salmon production would increase by one percent, while average total annual production would increase during wet, above normal, below normal and dry water years by less than one percent and during critical water years by four percent.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Sacramento River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Late Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball’s Ferry, Jelly’s Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J) and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to Existing Conditions, The No Project/No Action Alternative would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type; (2) similar monthly flow exceedance probabilities; (3) during low flow conditions, similar monthly flow exceedance probabilities; and (4) similar monthly probabilities of exceeding specified water temperature index values.
- Similar spawning conditions due to similar or slightly higher average monthly flows and flow exceedance probabilities, and similar probabilities of exceeding specified water temperature index values.
- Similar or less suitable embryo incubation conditions due to modeling results indicating: (1) slightly higher average total annual early life stage mortality, and higher annual mortality over more than 60 percent of the cumulative frequency distribution; and (2) similar probabilities of exceeding specified water temperature index values.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar long-term average monthly flows; (2) similar monthly flow exceedance probabilities; (3) under low flow conditions, similar monthly flow exceedance probabilities, but with lower flow exceedance probabilities during July and August in the lower Sacramento River; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values.

- Similar conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be increased by less than one percent, average annual mortality by water year type would be increased during wet and above normal water years by less than one percent, and during below normal and critical water years by one percent, and would decreased during dry water years of three percent; (2) similar or slightly higher and lower total annual mortality exceedance probabilities; (3) an equivalent net 10 percent or more total annual mortality exceedance probability difference; (4) equivalent or similar long-term average and average by water year type total annual late fall-run Chinook salmon production during all water year types.

In conclusion, in consideration of potential impacts to all life stages of late fall-run Chinook salmon in the Sacramento River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Steelhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, and results from the SacEFT (Appendix 8B) were examined for steelhead egg mortality, spawning habitat availability, redd dewatering, redd scouring, juvenile rearing habitat availability and juvenile stranding.

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly by water year type flows; (2) similar monthly flow exceedance probabilities; (3) during low flow conditions, similar monthly flow exceedance probabilities, but with lower flow exceedance probabilities during August and slightly higher flow exceedance probabilities during December and January; (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values.

- Similar spawning conditions due to modeling results indicating: (1) similar mean monthly flows and flow exceedance probabilities; (2) equivalent or similar flow exceedance probabilities during low flow conditions; (3) similar probabilities of exceeding specified water temperature index values; and (4) SacEFT results indicate that spawning habitat availability conditions would be generally similar.

- Similar embryo incubation conditions due to modeling results indicating: (1) similar probabilities of exceeding specified water temperature index values; (2) SacEFT results indicate that egg mortality associated with modeled water temperatures would be generally equivalent; (3) SacEFT results indicate that redd dewatering conditions may be improved slightly more often; and (4) SacEFT results indicate that redd scouring conditions would be generally equivalent.

- Similar juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly by water year type flows; (2) equivalent or similar monthly flow exceedance probabilities; (3) under low flow conditions, equivalent or similar monthly flow exceedance probabilities; (4) equivalent monthly probabilities of exceeding specified water temperature index values, but with slightly lower probabilities of exceeding 65°F during September;

and (5) SacEFT results indicate that juvenile rearing habitat availability may be increased slightly more often while juvenile stranding potential may be increased more often.

- Similar smolt emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows and average monthly flows by water year type; (2) similar monthly flow exceedance probabilities; (3) under low flow conditions, similar monthly flow exceedance probabilities; and (4) similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the Sacramento River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Green Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities, at Wilkins Slough, at Freeport and at Rio Vista, and egg survival results from the SacEFT (Appendix 8B) were examined. Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type; (2) similar or slightly lower monthly flow exceedance probabilities more often; (3) during low flow conditions, similar monthly flow exceedance probabilities; and (4) similar monthly probabilities of exceeding specified water temperature index values.
- Similar spawning conditions because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type; (2) similar or equivalent monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or similar monthly flow exceedance probabilities; and (4) equivalent monthly probabilities of exceeding the specified water temperature index value.
- Similar egg incubation conditions because of equivalent probabilities of exceeding the specified water temperature index value below Keswick Dam and Red Bluff Diversion Dam, while the SacEFT results indicate reduced water temperatures more often near Hamilton City and potentially increased survival.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar long-term average monthly flows and average monthly flows by water year type; (2) similar or slightly lower monthly flow exceedance probabilities; (3) under low flow conditions, similar monthly flow exceedance probabilities; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Sacramento River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

White Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River at Hamilton City, below the proposed Delevan Pipeline Intake Facilities, Wilkins Slough, Knights

Landing, below the Feather River confluence, Freeport and Rio Vista. Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type during most of the evaluation period; (2) similar or equivalent monthly flow exceedance probabilities; (3) during low flow conditions, similar flow exceedance probabilities; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.
- Similar spawning and egg incubation conditions, because of modeling results indicating: (1) similar long-term average and average by water year type monthly flows; (2) similar monthly flow exceedance probabilities; (3) during low flow conditions, similar flow exceedance probabilities; and (4) equivalent or slightly higher probabilities of exceeding specified water temperature index values.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar long-term average monthly and average by water year type monthly flows; (2) similar monthly flow exceedance probabilities; (3) under low flow conditions, similar monthly flow exceedance probabilities; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Sacramento River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

River Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport. Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type; (2) similar or equivalent monthly flow exceedance probabilities; and (3) during low flow conditions, similar flow exceedance probabilities.
- Similar spawning and egg incubation conditions, because of modeling results indicating: (1) similar long-term average and average by water year type monthly flows; (2) similar monthly flow exceedance probabilities; (3) during low flow conditions, similar monthly flow exceedance probabilities; and (4) similar probabilities of occurring within specified water temperature ranges during most month.
- Similar ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly and average by water year type monthly flows; (2) similar monthly flow exceedance probabilities; (3) under low flow conditions, similar monthly flow exceedance probabilities; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the Sacramento River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport. Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) similar long-term average and average monthly by water year type flows; (2) similar or slightly higher monthly flow exceedance probabilities more often; and (3) during low flow conditions, similar or slightly higher flow exceedance probabilities.
- Similar spawning and egg incubation conditions, because of modeling results indicating: (1) similar long-term average and average monthly by water year type flows; (2) similar monthly flow exceedance probabilities, with slightly higher flow exceedance probabilities below Keswick Dam; (3) during low flow conditions, similar flow exceedance probabilities; and (4) similar probabilities of water temperatures occurring within the specified water temperature range during most months.
- Similar ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly and average by water year type monthly flows; (2) similar monthly flow exceedance probabilities; (3) under low flow conditions, similar monthly flow exceedance probabilities, but with lower flow exceedance probabilities at Freeport; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Sacramento River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Hardhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) similar long-term average monthly and average by water year type monthly flows; (2) similar monthly flow exceedance probabilities; (3) under low flow conditions, similar monthly flow exceedance probabilities, but with lower flow exceedance probabilities at Freeport during July and August; and (4) similar probabilities of water temperatures occurring within the specified range.
- Similar spawning conditions, because of modeling results indicating: (1) similar long-term average and average by water year type monthly flows; (2) similar or slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or slightly higher monthly flow exceedance probabilities; and (4) similar probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the Sacramento River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

California Roach

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport. Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) similar long-term average monthly and average by water year type monthly flows; (2) similar monthly flow exceedance probabilities; (3) under low flow conditions, similar monthly flow exceedance probabilities, but with lower flow exceedance probabilities at Freeport during July and August; and (4) equivalent probabilities of water temperatures occurring within the specified range.
- Similar spawning conditions, because of modeling results indicating: (1) similar long-term average and average by water year type monthly flows; (2) similar or slightly higher monthly flow exceedance probabilities more often; (3) during low flow conditions, similar or slightly higher monthly flow exceedance probabilities; and (4) similar probabilities of exceeding the specified water temperature index value.

In conclusion, in consideration of potential impacts to all life stages of California roach in the Sacramento River, the NODOS Project No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to the Existing Condition.

Sacramento Splittail

Evaluation of water temperatures for splittail in the Sacramento River (i.e., 45-75° F) indicate that water temperature conditions would be essentially equivalent or similar under the No Project/No Action Alternative relative to Existing Conditions, resulting in a less than significant impact.

American Shad

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities, below the Feather River Confluence (Verona) and at Freeport.

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult spawning and other life stage conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type; (2) equivalent monthly flow exceedance probabilities; (3) during low flow conditions, equivalent flow exceedance probabilities; and (4) similar but slightly higher probabilities of water temperatures occurring within the specified water temperature range below the Feather River Confluence, and slightly lower probabilities of water temperatures occurring within the specified range at Freeport.
- Similar larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) similar long-term average and average by water year type monthly flows; (2) similar or slightly

lower monthly flow exceedance probabilities more often; (3) during low flow conditions, similar monthly flow exceedance probabilities, but with lower flow exceedance probabilities at Freeport during July and August; and (4) similar probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of American shad in the Sacramento River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Striped Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below the proposed Delevan Pipeline Intake Facilities and below the Feather River Confluence (Verona). Relative to Existing Conditions, The No Project/No Action Alternative would generally be expected to provide:

- Similar adult spawning and other life stage conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type; (2) equivalent or similar monthly flow exceedance probabilities; (3) during low flow conditions, equivalent flow exceedance probabilities; and (4) similar probabilities of water temperatures occurring within the specified water temperature range.
- Similar larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) similar long-term average and average by water year type monthly flows; (2) similar monthly flow exceedance probabilities; (3) during low flow conditions, similar monthly flow exceedance probabilities; and (4) similar probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the Sacramento River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Largemouth Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and Freeport. Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) similar long-term average and average by water year type monthly flows; (2) similar monthly flow exceedance probabilities; and (3) during low flow conditions, similar monthly flow exceedance probabilities.
- Similar spawning conditions, because of modeling results indicating similar monthly probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the Sacramento River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Clear Creek

Flow and water temperature model results (Appendix 12E and 12F) were examined for Clear Creek below Whiskeytown Dam, Clear Creek at Igo, and at the mouth of Clear Creek.

Spring-run Chinook Salmon

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities during most of the evaluation period; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period; and (4) similar monthly probabilities of exceeding specified water temperature index values.
- Similar or improved spawning and embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities during most of the evaluation period; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities during most of the evaluation period; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile emigration conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities during most of the evaluation period; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values at Igo and generally similar or slightly lower probabilities of exceeding specified water temperatures at the mouth of Clear Creek.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in Clear Creek, the No Project/No Action Alternative would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Fall-run Chinook Salmon

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar or improved spawning and embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile emigration conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in Clear Creek, the No Project/No Action Alternative would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Late Fall-run Chinook Salmon

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.

- Similar or improved spawning and embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile emigration conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) equivalent or slightly lower monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of late fall-run Chinook salmon in Clear Creek, the No Project/No Action Alternative would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Steelhead

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar monthly probabilities of exceeding specified water temperature index values.
- Similar or improved spawning and embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, generally higher monthly

flow exceedance probabilities; and (4) equivalent or slightly lower monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of steelhead in Clear Creek, the No Project/No Action Alternative would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

River Lamprey

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; and (3) during low flow conditions, higher monthly flow exceedance probabilities.
- Similar or improved spawning and embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, generally higher monthly flow exceedance probabilities; and (4) similar monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in Clear Creek, the No Project/No Action Alternative would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Pacific Lamprey

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; and (3) during low flow conditions, higher monthly flow exceedance probabilities.
- Similar or improved spawning and embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, generally higher monthly

flow exceedance probabilities; and (4) similar monthly probabilities of water temperatures occurring within the specified water temperature range.

- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in Clear Creek, the No Project/No Action Alternative would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Hardhead

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, generally higher monthly flow exceedance probabilities; and (4) similar or slightly lower monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar or improved spawning and embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar monthly probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of hardhead in Clear Creek, the No Project/No Action Alternative would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

California Roach

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, generally higher monthly flow exceedance probabilities; and (4) equivalent monthly probabilities of water temperatures exceeding the specified water temperature index value.
- Similar or improved spawning conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly

flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar monthly probabilities of water temperatures exceeding the specified water temperature index value.

In conclusion, in consideration of potential impacts to all life stages of California roach in Clear Creek, the No Project/No Action Alternative would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Lake Oroville

Reservoir hydrologic model results (Appendix 12H) were examined for Lake Oroville during April through November for coldwater fish species, and during March through June for warmwater species.

Coldwater Fish Species

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar or less suitable coldwater pool storage conditions, because of modeling results indicating: (1) slightly lower long-term average monthly storage during most of the evaluation period, and slightly lower average monthly storage by water year type during most water years of the evaluation period; (2) equivalent or lower monthly storage exceedance probabilities would occur more often during the evaluation period; and (3) a net 10 percent or more monthly storage exceedance reduction more often during the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Lake Oroville, the No Project/No Action Alternative would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar warmwater fish spawning and early life stage conditions, because of modeling results indicating similar frequencies of monthly water surface elevation reductions of six feet or more during the March through June evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Lake Oroville, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Feather River

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River below the Thermalito Afterbay outlet and at the mouth of the Feather River for American shad, striped bass and largemouth bass. Only model results for flow and temperature at the mouth of the Feather River were examined for splittail.

For all other species, flow and water temperature model results were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River. Flow model results for the Feather River at Shanghai Bend were also examined for sturgeon species.

In addition to flow and water temperature modeling, model results for spawning habitat availability (WUA) (Appendix 12N) and early life stage mortality (Appendix 12J) were examined for salmonid species, and usable flooded area (Appendix 12G) was evaluated for splittail.

Flows in the Low Flow Channel below the Fish Barrier Dam were modeled consistent with the terms of the FERC settlement agreement. As shown in the modeling results, long-term average flows, average flows by water year type, and flow exceedance probabilities of 10 percent or more during all years and during low flow conditions were equivalent for the No Project/No Action Alternative, relative to Existing Conditions. Although these results are not repeated for the discussions below, the model results for the Low Flow Channel below the Fish Barrier Dam were considered along with the information presented below, and were incorporated into the impact determinations for the following species: spring-run Chinook salmon, fall-run Chinook salmon, steelhead, green sturgeon, white sturgeon, river lamprey, Pacific lamprey, hardhead, and California roach.

Spring-run Chinook Salmon

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or slightly higher average monthly flows by water year type would occur more often during most water year types, although lower average monthly flows would occur during dry and critical water year types more often; (2) similar or slightly higher monthly flow exceedance probabilities during most months below the Thermalito Afterbay outlet and at the mouth of the Feather River, although lower probabilities of exceedance would occur throughout the evaluation period; (3) during low flow conditions, similar probabilities of exceedance during most of the evaluation period, although significantly higher monthly flow exceedance probabilities would occur during June, August, and September; and (4) similar monthly probabilities of exceeding specified water temperature index values.
- Similar or improved spawning conditions due to modeling results indicating higher spawning habitat availability during half of the adult spawning period, and similar or slightly lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, during September through October.
- Similar or less suitable embryo incubation conditions due to modeling results indicating slightly increased total annual long-term average early life stage mortality, and similar or lower probabilities of exceeding specified water temperature index values
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows, and higher and lower average monthly flows by water year type with similar monthly frequencies; (2) similar or slightly lower monthly flow exceedance probabilities more often below the Thermalito Afterbay outlet, although higher probabilities of exceedance generally would occur during June, August, and September; (3) under low flow conditions, similar or slightly higher monthly flow exceedance probabilities more often below

the Thermalito Afterbay outlet, although slightly lower flows would occur during the evaluation period; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

- Similar smolt emigration conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows during most of the evaluation period, and similar or slightly lower average monthly flows by water year type during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities, although higher probabilities of exceedance generally would occur during June; (3) during low flow conditions, similar or slightly higher monthly flow exceedance probabilities; and (4) similar monthly probabilities of exceeding specified water temperature index values during the evaluation period.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Feather River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Fall-run Chinook Salmon

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) higher and lower long-term average monthly flows would occur with similar monthly frequency during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type would occur with similar monthly frequency during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) similar or slightly lower monthly flow exceedance probabilities during October, November, and July, with higher probabilities of exceedance during the remainder of the evaluation period; (3) during low flow conditions, similar or slightly higher monthly flow exceedance probabilities during most months of the evaluation period, although lower probabilities of exceedance would occur during July; and (4) similar monthly probabilities of exceeding specified water temperature index values.
- Improved spawning conditions due to modeling results indicating higher spawning habitat availability during the entire adult spawning period, and similar or slightly lower probabilities of exceeding specified water temperature index values during most of the evaluation period.
- Similar or less suitable embryo incubation conditions due to modeling results indicating slightly increased total annual long-term average early life stage mortality, and similar or lower probabilities of exceeding specified water temperature index values.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar average monthly flows by water year type during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities during most months, although higher probabilities of exceedance generally would occur during June; (3) under low flow conditions, similar or slightly higher monthly flow exceedance probabilities would occur more often than lower monthly flow exceedance probabilities; and (4) similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Feather River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Steelhead

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly flows below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or slightly lower average monthly flows by water year type during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities would occur more often, although higher probabilities of exceedance would occur during August and September; (3) during low flow conditions, similar or slightly higher monthly flow exceedance probabilities would occur more often; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values.
- Similar or slightly improved spawning conditions due to modeling results indicating higher spawning habitat availability during most of the adult spawning period, and similar or slightly higher probabilities of exceeding specified water temperature index values.
- Similar embryo incubation conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows below the Thermalito Afterbay outlet, and similar or slightly lower average monthly flows by water year type; (2) similar or slightly lower monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet; (3) during low flow conditions, similar monthly flow exceedance probabilities below the Thermalito Afterbay outlet; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows, and higher and lower average monthly flows by water year type would occur with similar monthly frequency during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet, although higher probabilities of exceedance generally would occur during June, August, and September; (3) under low flow conditions, similar or slightly higher monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet, although slightly lower flows would occur during the evaluation period; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar smolt emigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or slightly lower average monthly flows by water year type would occur during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) similar or slightly lower monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) under low flow conditions, higher and lower monthly flow exceedance probabilities would occur with similar monthly frequency below the Thermalito Afterbay outlet and at the mouth of the Feather River; and

(4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values during the evaluation period.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the Feather River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Green Sturgeon

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows, and higher and lower average monthly flows by water year type would occur with similar frequency during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet, although higher probabilities of exceedance generally would occur during June, August, and September; (3) under low flow conditions, similar or slightly higher monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet, although slightly lower flows would occur during the evaluation period; and (4) similar monthly probabilities of exceeding specified water temperature index values during the evaluation period.
- Similar adult spawning and embryo incubation conditions because of modeling results indicating: (1) similar long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet, and similar or slightly higher average monthly flows by water year type during most water year types below the Thermalito Afterbay outlet; (2) higher and lower monthly flow exceedance probabilities would occur with similar frequency below the Thermalito Afterbay outlet; (3) during low flow conditions, similar or higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values.
- Similar juvenile rearing conditions due to modeling results indicating: (1) similar long-term average monthly flows, and higher and lower average monthly flows by water year type would occur with similar monthly frequency during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance generally would occur during June, August, and September; (3) under low flow conditions, similar or slightly higher monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although slightly lower flows would occur during the evaluation period; and (4) similar monthly probabilities of exceeding specified water temperature index values.
- Improved juvenile emigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows below the Thermalito Afterbay outlet, at Shanghai Bend, and at the mouth of the Feather River, and similar or slightly higher average monthly flows by water year type during all water year types below the Thermalito Afterbay outlet, at Shanghai Bend, and at the mouth of the Feather River; (2) higher monthly flow exceedance probabilities during most months below the Thermalito Afterbay outlet, at Shanghai Bend, and at the mouth of the Feather River, except during July when flows would be slightly lower; (3) under low flow conditions, higher monthly flow exceedance probabilities during most months below the Thermalito Afterbay outlet, at

Shanghai Bend, and at the mouth of the Feather River, except during July when flows would be slightly lower; and (4) similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Feather River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

White Sturgeon

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows and average monthly flows by water year type during the evaluation period at Shanghai Bend and at the mouth of the Feather River; (2) similar or slightly lower monthly flow exceedance probabilities during the evaluation period at all locations evaluated; (3) during low flow conditions, similar flow exceedance probabilities during the evaluation period at all locations evaluated; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.
- Similar adult spawning and egg incubation conditions because of modeling results indicating: (1) similar long-term average monthly flows during the evaluation period at Shanghai Bend and at the mouth of the Feather River, and higher and lower average monthly flows by water year type would occur with similar monthly frequency during most water year types at Shanghai Bend and at the mouth of the Feather River, except during dry and critical water year types when generally lower average monthly flows would occur more frequently; (2) similar or slightly lower monthly flow exceedance probabilities during most of the evaluation period at Shanghai Bend and at the mouth of the Feather River; (3) during low flow conditions, similar monthly flow exceedance probabilities during the evaluation period at Shanghai Bend and at the mouth of the Feather River; and (4) equivalent monthly probabilities of exceeding specified water temperature index values during the evaluation period at all locations evaluated.
- Similar juvenile rearing and outmigration conditions due to: (1) similar long-term average monthly flows during the evaluation period at Shanghai Bend and at the mouth of the Feather River, and higher and lower average monthly flows by water year type would occur with similar frequency during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities would occur more often at Shanghai Bend and at the mouth of the Feather River, although higher probabilities of exceedance generally would occur during June, August, and September; (3) under low flow conditions, similar or slightly higher monthly flow exceedance probabilities would occur more often at Shanghai Bend and at the mouth of the Feather River; and (4) similar monthly probabilities of exceeding specified water temperature index values during most months.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Sacramento River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

River Lamprey

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows and average monthly flows by water year type during most of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) similar or slightly lower monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance generally would occur during June and September; and (3) under low flow conditions, similar or slightly higher monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although slightly lower flows would occur during the evaluation period.
- Similar spawning and egg incubation conditions, because of modeling results indicating: (1) similar long-term average monthly flows occur below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type would occur with similar monthly frequency during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher monthly flow exceedance probabilities generally would occur during June; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities would occur with similar monthly frequency below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar or slightly lower probabilities of water temperatures occurring within the specified water temperature range.
- Similar ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type would occur with similar monthly frequency during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance generally would occur during June, August, and September; (3) under low flow conditions, similar or slightly higher monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although slightly lower flows would occur during the evaluation period; and (4) similar or slightly lower probabilities of exceeding specified water temperatures at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the Feather River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Pacific Lamprey

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) similar long-term average monthly flows below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type would occur with similar frequency during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher monthly flow exceedance probabilities generally would occur during June; and (3) during low flow conditions, higher and lower monthly flow exceedance probabilities would occur with similar frequency below the Thermalito Afterbay outlet and at the mouth of the Feather River.

- Similar spawning and egg incubation conditions, because of modeling results indicating: (1) similar long-term average monthly flows below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type would occur with similar frequency during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher monthly flow exceedance probabilities generally would occur during June and August; (3) during low flow conditions, similar or slightly higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar or slightly lower probabilities of water temperatures occurring within the specified water temperature range at all Feather River locations evaluated.
- Similar ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type would occur with similar frequency during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance generally would occur during June, August, and September; (3) under low flow conditions, similar or slightly higher monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although slightly lower flows would occur during the evaluation period; and (4) similar or slightly lower probabilities of exceeding specified water temperatures at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Feather River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Hardhead

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult and juvenile life stage conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type would occur with similar monthly frequency during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance generally would occur during June, August, and September; (3) under low flow conditions, similar or slightly higher monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although slightly lower flows would occur during the evaluation period; and (4) similar probabilities of water temperatures remaining within the specified water temperature range.

- Similar adult spawning conditions, because of modeling results indicating: (1) similar or slightly higher long-term average monthly flows at all Feather River locations evaluated, and similar or slightly higher average monthly flows by water year type during most water year types; (2) similar or slightly higher monthly flow exceedance probabilities flows during most of the evaluation period; (3) during low flow conditions, similar or higher monthly flow exceedance probabilities during the entire evaluation period; and (4) equivalent probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the Feather River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

California Roach

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult and other life stage conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type would occur with similar frequency during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance generally would occur during June, August, and September; (3) under low flow conditions, similar or slightly higher monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although slightly lower flows would occur during the evaluation period; and (4) equivalent probabilities of exceeding specified water temperatures during all months of the evaluation period.
- Similar adult spawning conditions, because of modeling results indicating: (1) similar long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type would occur with similar frequency during most water year types; (2) similar monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although lower probabilities of exceedance would occur during March and higher probabilities of exceedance generally would occur during June; (3) under low flow conditions, similar monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although lower probabilities of exceedance would occur during March and higher probabilities of exceedance generally would occur during June; and (4) equivalent probabilities of exceeding specified water temperatures during the evaluation period at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of roach in the Feather River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Splittail

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar spawning conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows, and higher and lower average monthly flows by water year type would occur with similar frequency during most water year types at the mouth of the Feather River; (2) similar monthly flow exceedance probabilities during most of the evaluation period; (3) during low flow conditions, similar monthly flow exceedance probabilities during most of the evaluation period; (4) similar changes in usable flooded area (UFA) exceedance probabilities of 10 percent or more; and (5) equivalent monthly probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of splittail in the Feather River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Striped Bass

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult spawning and other life stage conditions, because of modeling results indicating: (1) similar or slightly higher long-term average monthly flows, and similar or slightly higher average monthly flows by water year type during most water year types; (2) similar or slightly higher monthly flow exceedance probabilities flows during most of the evaluation period; (3) during low flow conditions, similar or higher monthly flow exceedance probabilities during the entire evaluation period; and (4) similar or slightly lower monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar larvae, fry, and juvenile rearing emigration conditions, because of modeling results indicating: (1) similar long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type would occur with similar monthly frequency during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance generally would occur during June, August, and September; (3) under low flow conditions, similar or slightly higher monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar probability of water temperatures occurring within the specified water temperature range below the Thermalito Afterbay outlet and at the mouth of the Feather River.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the Feather River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

American Shad

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult spawning and other life stage conditions, because of modeling results indicating: (1) similar or slightly higher long-term average monthly flows, and similar or slightly higher average monthly flows by water year type during most water year types; (2) similar or slightly higher monthly flow exceedance probabilities flows during most of the evaluation period; (3) during low flow conditions, similar or higher monthly flow exceedance probabilities during the entire evaluation period; and (4) similar or slightly higher monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) similar long-term average and average monthly flows by water year type, with higher and lower flows occurring with similar monthly frequency during most water year types during the evaluation period at all Feather River locations evaluated; (2) higher monthly flow exceedance probabilities during August and September at all Feather River locations evaluated and similar or lower monthly flow exceedance probabilities during October, November, and July at all Feather River locations evaluated; (3) during low flow conditions, higher monthly flow exceedance probabilities during August and September at all Feather River locations evaluated and similar or lower monthly flow exceedance probabilities during October, November, and July at all Feather River locations evaluated; and (4) similar probabilities of water temperatures occurring within the specified water temperature range at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of American shad in the Feather River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Largemouth Bass

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) similar long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type would occur with similar monthly frequency during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance generally would occur during June, August, and September; and (3) under low flow conditions, similar or slightly higher monthly flow exceedance probabilities would occur more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although slightly lower flows would occur during some months of the evaluation period.
- Similar spawning conditions because of modeling results indicating generally similar monthly probabilities of water temperatures occurring within the specified water temperature range for all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the Feather River, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Sutter Bypass

The Sutter Bypass has been reported to be an important nursery area for anadromous salmonids of Butte Creek and the upper Sacramento River and its tributaries, particularly during wetter water years (USFWS, 2000). Flooded lands of the Sutter Bypass are also reported to be an important spawning and nursery area for Sacramento splittail (USFWS, 2000). Fish species of primary management concern, including Chinook salmon, lamprey, splittail, and largemouth bass are known to utilize the Sutter Bypass (Feyrer et al., 2006), and could potentially be affected by changes in spills from the Sacramento River into the Sutter Bypass. Other anadromous fish species also may potentially utilize the bypass for rearing (i.e., steelhead and sturgeon).

During wet water years, the Sacramento River spills water at the Colusa and Moulton weirs with flows that reach the Butte Sink; the Sacramento River also spills at the Tisdale Weir through the Tisdale Bypass, and into the Sutter Bypass below the Sutter National Wildlife Refuge (USFWS, 2000). The Moulton and Colusa weirs begin operation automatically, sending excess flows from the Sacramento River into the Butte Basin when flows in the Sacramento River at the weirs exceed 60,000 cfs and 30,000 cfs, respectively (USACE, 1999). The Tisdale Weir operates automatically to send excess flows from the Sacramento River to the Sutter Bypass when Sacramento River flows exceed 23,000 cfs (USACE, 1999). Sacramento River flows above 90,000 cfs at Ord Ferry overtop the east bank of the Sacramento River at several locations upstream from the State Plan of Flood Control left-bank levees (DWR, 2010).

Modeling results (Appendix 6C) for Ord Ferry spills and spills at the Moulton, Colusa and Tisdale weirs for the No Project/No Action Alternative, relative to Existing Conditions, indicate the following:

Ord Ferry Spill

Ord Ferry spill exceedance probabilities would be equivalent over the entire monthly distributions during May through November and would be equivalent over most of the distributions during December through April, but would be lower by 10 percent or more slightly more often during December and January, and would be generally similar or equivalent during March and April.

Moulton Weir Spill

Moulton Weir spill exceedance probabilities would be equivalent over the entire monthly distributions during May through November and would be equivalent over most of the distributions during December through April, but would be higher and lower with similar monthly frequencies over a portion of the distribution during December, January, and February, decrease slightly more often during March, and increase slightly more often during April.

Colusa Weir Spill

Colusa Weir spill exceedance probabilities would be equivalent over almost the entire monthly distributions during May through November and would be equivalent or similar over most of the distributions during December through April, with slight increases and decreases occurring with similar frequencies over portions of the distributions during December through April.

Tisdale Weir Spill

Tisdale Weir spill exceedance probabilities would be equivalent over almost the entire monthly distributions during May through October and would be equivalent or similar over most of the distributions during November through April, with slight increases and decreases occurring with similar frequencies over portions of the distributions during November through April.

Fish Species of Primary Management Concern

There are no available modeling products to simulate flow magnitudes or flooded area in the Sutter Bypass. The relationships and interactions of the various hydrologic inputs into the Sutter Bypass and the resulting flow and flooded area in the Sutter Bypass are not quantifiable. Because spills into the Sutter Bypass from the Sacramento River only represent some of the hydrologic inputs to the lower Sutter Bypass and because the proportions of each input are not known, potential changes to fisheries habitat conditions in the Sutter Bypass associated with simulated changes in spills from the Sacramento River are not known. Moreover, it is not anticipated that the changes in spill exceedance probabilities discussed above would have a substantial impact on fisheries and aquatic resources in the Sutter Bypass.

Folsom Lake

Reservoir model results (Appendix 12H) were examined for Folsom Lake during April through November for coldwater fish species, and during March through June for warmwater species.

Coldwater Fish Species

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar or less suitable coldwater pool storage conditions, because of modeling results indicating: (1) slightly lower long-term average monthly storage during most of the evaluation period, and slightly lower average monthly storage by water year type during most water years of the evaluation period; (2) equivalent or lower monthly storage exceedance probabilities would occur more often during the evaluation period; and (3) a slight net 10 percent or more monthly storage exceedance decrease during all months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Folsom Lake, the No Project/No Action Alternative would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar warmwater fish spawning and early life stage conditions, because of modeling results indicating similar frequencies of monthly water surface elevation reductions of six feet or more during the March through June evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Folsom Lake, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

American River

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and the mouth of the American River for salmonid and lamprey species. In addition, model results for spawning habitat availability (WUA) (Appendix 12N) at Sailor Bar through Rossmoor and early life stage mortality (Appendix 12J) were examined for salmonids.

In addition, flow and water temperature model results at the mouth of the American River were examined for green sturgeon, splittail, striped bass, and American shad; model results for the American River at Watt Avenue were examined for hardhead, roach, largemouth bass, and American shad; model results for the American River at Nimbus Dam were examined for striped bass.

Fall-run Chinook Salmon

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Less suitable adult immigration and holding conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River, with particularly lower flows during September and October during drier water year conditions; (2) substantially lower monthly flow exceedance probabilities during the evaluation period at all locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated; and (4) equivalent or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Less suitable adult spawning conditions due to modeling results indicating lower spawning habitat availability during the October through December evaluation period, and similar or slightly higher monthly probabilities of exceeding specified water temperature index values.
- Less suitable embryo incubation conditions due to slightly higher total annual early life stage mortality, and generally similar or slightly higher monthly probabilities of exceeding specified water temperature index values.
- Generally less suitable juvenile rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River, with particularly lower flows during August, September and October during drier water year conditions; (2) lower monthly flow exceedance probabilities during the entire evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during May at the mouth of the American River, and during June at all evaluated locations; and (4) similar probabilities of exceeding specified water temperature index values, although higher probabilities of exceedance would occur during May and June.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the American River, the No Project/No Action Alternative would result in potentially adverse and potentially significant impacts, relative to Existing Conditions.

Spring-run Chinook Salmon

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar non-natal juvenile rearing conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type; (2) lower monthly flow exceedance probabilities during the entire evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout the evaluation period.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the American River, the No Project/No Action Alternative would result in generally similar and less-than-significant impacts, relative to Existing Conditions.

Steelhead

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar or less suitable adult immigration and holding conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during all months of the evaluation period at all locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during November at all locations evaluated, although slightly higher probabilities of exceedance would occur during January and February; and (4) similar probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during December and February, and slightly higher probabilities of exceedance during November and March.
- Similar spawning conditions due to modeling results indicating improved spawning habitat availability during January, February, and April, and similar monthly probabilities of exceeding specified water temperature index values, although slightly higher probabilities of exceedance would occur during March.
- Similar embryo incubation conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities during all months of the evaluation period; (3) during low flow conditions, equivalent or lower monthly flow exceedance probabilities, although slightly higher probabilities of exceedance would occur during January and February; and (4) similar monthly probabilities of exceeding specified water temperature index values, although slightly higher probabilities of exceedance would occur during March.
- Less suitable juvenile rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River, with particularly lower flows during August, September and October during drier water year conditions; (2) lower monthly flow exceedance probabilities during the entire evaluation period; (3) during low

flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during May at the mouth of the American River, and during June at all evaluated locations; and (4) similar probabilities of exceeding specified water temperature index values during November through April, with higher probabilities of exceedance during May through October.

- Less suitable smolt emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during the entire evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during May at the mouth of the American River and June at all locations evaluated, although slightly higher probabilities of exceedance would occur during January and February; and (4) similar probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during February, and slightly higher probabilities of exceedance during March.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the American River, the No Project/No Action Alternative would result in potentially adverse and potentially significant impacts, relative to Existing Conditions.

Green Sturgeon

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Less suitable adult immigration and holding conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types, with particularly lower flows during August, September and October during drier water year conditions; (2) lower monthly flow exceedance probabilities occurring during the entire evaluation period, with substantially lower flows during May through November; (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during most months; and (4) similar probabilities of exceeding specified water temperature index values, with slightly higher probabilities of exceedance during May and October.

- Less suitable spawning and egg incubation conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types, with particularly lower flows during August during drier water year conditions; (2) lower monthly flow exceedance probabilities occurring during the entire evaluation period, with substantially lower flows during May through August; (3) during low flow conditions, lower monthly flow exceedance probabilities occurring during all months of the evaluation period, with substantially lower probabilities of exceedance during most months; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values, particularly during May through August.

- Less suitable juvenile rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities occurring during the entire evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during May through

November; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the American River, the No Project/No Action Alternative would result in potentially adverse and potentially significant impacts, relative to Existing Conditions.

River Lamprey

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Less suitable adult immigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River, with particularly lower flows during September and October during drier water year conditions; (2) lower monthly flow exceedance probabilities during the evaluation period at all locations evaluated; and (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated, with substantially lower flows during September through November, and during June.
- Less suitable spawning and egg incubation conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during the evaluation period at all locations, although slight increases would occur during February and April at some locations; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated, with substantially lower probabilities of exceedance during May at the mouth of the American River and during June at all evaluated locations; and (4) similar or slightly lower monthly probabilities of water temperatures occurring within the specified water temperature range, although slightly higher probabilities of remaining within the temperature range would occur during April.
- Less suitable ammocoete rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during the entire evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during June through November; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in American River, the No Project/No Action Alternative would result in potentially adverse and potentially significant impacts, relative to Existing Conditions.

Pacific Lamprey

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Less suitable adult immigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during the evaluation period at all locations, although slight increases would occur during January, February and April at some locations; and (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated, with substantially lower probabilities of exceedance during May at the mouth of the American River and during June at all evaluated locations.
- Less suitable spawning and egg incubation conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during the evaluation period at all locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated, with substantially lower probabilities of exceedance during May at the mouth of the American River and during June through August at all evaluated locations; and (4) similar or slightly lower probabilities of occurring within specified water temperature ranges, although, slightly higher probabilities of remaining within the temperature range would occur during April.
- Less suitable ammocoete rearing and emigration conditions due to modeling results indicating: lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during the entire evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during June through November; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values, particularly during May through August.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the American River, the No Project/No Action Alternative would result in potentially adverse and potentially significant impacts, relative to Existing Conditions.

Hardhead

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Less suitable adult and other life stage conditions due to modeling results indicating: (1) lower long-term average monthly flows the evaluation period, and lower average monthly flows by water year type during most water year types, with substantially lower flows during drier water year types during August through October; (2) lower monthly flow exceedance probabilities during the evaluation period, with substantially lower probabilities of exceedance during August through October; (3) during low flow conditions, lower monthly flow exceedance probabilities during all months of the evaluation period, although slightly higher probabilities would occur during January and February; and (4) similar or slightly higher probabilities of remaining within specified water temperature ranges.

- Similar spawning conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities during the entire evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period; and (4) similar probabilities of remaining within specified water temperature ranges.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the American River, the No Project/No Action Alternative would result in generally similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

California Roach

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Less suitable adult and other life stage conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities during the evaluation period, with substantially lower probabilities of exceedance during August through October; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, although slightly higher probabilities of occurrence during January and February; and (4) equivalent probabilities of exceeding specified water temperature index values.
- Similar spawning conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities during the entire evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period; and (4) equivalent or slightly lower probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of California roach in the American River, the No Project/No Action Alternative would result in generally similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Splittail

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Less suitable spawning conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities during all months of the evaluation period; (4) slightly lower usable flooded area (UFA) exceedance probabilities of 10 percent or more; and (5) equivalent probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of splittail in the American River, the No Project/No Action Alternative would result in generally less suitable and potentially significant impacts, relative to Existing Conditions.

Striped Bass

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Less suitable adult spawning, embryo incubation, and initial rearing conditions due to modeling results indicating: (1) lower long-term average monthly flows during most of the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during most the evaluation period at the locations evaluated, with significantly lower probabilities of exceedance during June; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated, with substantially lower probabilities of exceedance during May at the mouth of the American River and during June at all evaluated locations; and (4) similar probabilities of remaining within the specified water temperature range during the evaluation period.
- Less suitable larvae, fry, and juvenile rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities during the entire evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during May through November; and (4) similar probabilities of remaining within the specified water temperature range throughout the year, with a slightly higher probability of the temperatures occurring within the specified range during October and May, and slightly lower probabilities during June through September.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the American River, the No Project/No Action Alternative would result in potentially adverse and potentially significant impacts, relative to Existing Conditions.

American Shad

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar or less suitable adult spawning, embryo incubation, and initial rearing conditions due to modeling results indicating: (1) lower long-term average monthly flows during most of the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during most the evaluation period at the locations evaluated, with substantially lower probabilities of exceedance during June; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated, with substantially lower probabilities of exceedance during May at the mouth of the American River and during June at all evaluated locations; and (4) similar probabilities of remaining within the specified water temperature range during the evaluation period, although slightly higher probabilities of remaining within the temperature range would occur during April and May, and slightly lower probabilities would occur during June.

- Less suitable larvae, fry, and juvenile rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during most of the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River with particularly lower flows during August, September, and October during drier water year conditions; (2) substantially lower monthly flow exceedance probabilities during the evaluation period at all locations evaluated; (3) during low flow conditions, substantially lower monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated; and (4) similar monthly probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of American shad in the American River, the No Project/No Action Alternative would result in potentially adverse and potentially significant impacts, relative to Existing Conditions.

Largemouth Bass

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar or less suitable adult and other life stage conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types, with particularly lower flows during August, September and October during drier water year conditions; (2) lower monthly flow exceedance probabilities during the evaluation period; and (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated, with substantially lower flows during June through August and October through December, although equivalent or slightly higher flows would occur during January, February, April, and September.
- Similar or improved spawning conditions due to modeling results indicating equivalent or slightly higher probabilities of remaining within specified water temperature ranges.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the American River, the No Project/No Action Alternative would result in generally similar and less-than-significant impacts, relative to Existing Conditions.

Sacramento-San Joaquin Delta and Yolo Bypass

Model results were examined for OMR flows (Appendix 12E), salvage at the SWP and CVP export facilities (Appendix 12I), and X2 location (Appendix 12E) for delta smelt and longfin smelt; water temperatures (Appendix 12E) in the Sacramento River at Freeport were also examined for delta smelt.

Model results were examined for through-Delta juvenile survival (Appendix 12M) for all runs of Chinook salmon; OMR flows (Appendix 12E) were also examined for San Joaquin River fall- and late fall-run Chinook salmon.

Model results were examined for Sacramento River flows (Appendix 12F) at Rio Vista, Yolo Bypass outflow (Appendix 12E), Delta outflow (Appendix 12E), OMR flows (Appendix 12E), and salvage at the SWP and CVP export facilities (Appendix 12I) for steelhead.

Model results were examined for salvage at the SWP and CVP export facilities for all other species. In addition, Yolo Bypass outflow was examined for delta smelt, splittail, green sturgeon, and white sturgeon; and X2 location was examined for American shad, striped bass and largemouth bass.

Delta Smelt in the Delta Region

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult conditions, because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range (December through May); (2) similar overall normalized mean monthly salvage at the SWP and CVP export facilities (December through April); and (3) similar or slightly higher monthly probabilities of OMR flows being more negative than -5,000 cfs (December through February)
- Similar or more suitable spawning conditions in the Yolo Bypass (December through May), because of modeling results indicating: (1) similar long-term average Yolo Bypass flows; (2) similar or slightly increased Yolo Bypass flow exceedance probabilities; and (3) during low flow conditions, lower flow exceedance probabilities during December and January, albeit similar simulated flows, and higher flow exceedance probabilities during March and April
- Similar egg and embryo conditions (February through May), because of modeling results indicating similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range
- Similar larvae conditions (March through June), because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range; (2) during March through June of dry and critical water years, slightly higher (less negative) mean monthly OMR flows during dry water years when flows would be equal to or more negative than -1,500 cfs, but lower mean monthly OMR flows during critical water years; and (3) during the latter portion of the larval delta smelt downstream migration period (i.e., May and June), long-term average and average by water year type monthly Delta outflow would be similar or slightly lower during most water years, while monthly Delta outflow exceedance probabilities (of 10 percent or more) would be generally equivalent during May and June.
- Similar juvenile conditions (May through July), because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range; (2) slightly higher normalized mean monthly salvage at the SWP export facility and similar overall normalized mean monthly salvage at the CVP export facility; (3) between river kilometer (RKm) 65 and 80, long-term average and average by water year type X2 location would move slightly upstream during May (by less than 0.5 RKm) and move slightly downstream during June and July (by less than 0.5 RKm); and (4) similar Yolo Bypass flows and associated productivity in the Delta

In conclusion, in consideration of potential impacts to all life stages of delta smelt in the Delta, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Longfin Smelt in the Delta Region

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar adult conditions because of slightly higher (during December) and equivalent (during January through March) monthly probabilities of OMR flows being more negative than -5,000 cfs during December through March
- Similar larvae and juvenile conditions because of modeling results indicating: (1) slightly higher (during December) and equivalent (during January through March) monthly probabilities of OMR flows being more negative than -5,000 cfs during December through March; (2) during April and May of dry and critical water years, higher mean monthly OMR flows during March and June of dry water years (by 1.3 and 1.7 percent, respectively) and during April and May of critical water years (by 2.3 and 12.5 percent, respectively), and lower during April and May of dry water years (by 11.3 and 4.4 percent, respectively) and during March and June of critical water years (by 12.8 and 0.5 percent, respectively); (3) similar overall mean monthly salvage at the SWP and CVP export facilities; (4) equivalent (during January through April), slightly lower (during May) and slightly higher (during June) monthly exceedance probabilities of X2 location occurring at or downstream of 75 RKm during January through June; and (5) similar Yolo Bypass flows and associated productivity in the Delta

In conclusion, in consideration of potential impacts to all life stages of longfin smelt in the Delta, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Splittail in the Delta Region

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar egg and larval conditions (February through May) because of modeling results indicating: (1) similar mean monthly Yolo Bypass outflow during most months of most water year types; and (2) similar or slightly higher flow exceedance probabilities (of 10 percent or more)
- Similar juvenile rearing and emigration conditions (April through July) because of modeling results indicating: (1) similar mean monthly Yolo Bypass outflow during all water year types; (2) similar flow exceedance probabilities (of 10 percent or more); (3) slightly higher overall simulated mean monthly salvage at the SWP export facility and similar overall mean monthly salvage at the CVP export facility; and (4) similar Yolo Bypass flows and associated productivity in the Delta
- Similar adult spawning and upstream migration conditions, because of modeling results indicating: (1) similar mean monthly Yolo Bypass outflow and similar or slightly higher flow exceedance probabilities; and (2) similar overall simulated mean monthly salvage at the SWP and CVP export facilities during December through March

In conclusion, in consideration of potential impacts to all life stages of splittail in the Delta Region including the Yolo Bypass, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Winter-run Chinook Salmon in the Delta Region

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar juvenile conditions, because of modeling results indicating: (1) slightly higher monthly Delta survival exceedance probabilities over most of the distribution; and (2) similar Yolo Bypass flows and associated productivity in the Delta

In conclusion, in consideration of potential impacts juvenile winter-run Chinook salmon in the Delta, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Spring-run Chinook Salmon in the Delta Region

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar juvenile conditions, because of modeling results indicating: (1) slightly higher monthly Delta survival exceedance probabilities over most of the distribution; and (2) similar Yolo Bypass flows and associated productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile spring-run Chinook salmon in the Delta, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Fall-run and Late Fall-run Chinook Salmon in the Delta Region

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar San Joaquin River adult straying conditions because of modeling results indicating similar or slightly higher monthly probabilities of OMR flows being more negative than -5,000 cfs during December through February
- Similar juvenile conditions because of modeling results indicating: (1) slightly higher monthly Delta survival exceedance probabilities over most of the distribution; and (2) similar Yolo Bypass flows and associated productivity in the Delta

In conclusion, in consideration of potential impacts juvenile and San Joaquin River adult fall and late fall-run Chinook salmon in the Delta, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Steelhead in the Delta Region

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar juvenile rearing and emigration conditions in the Delta (October through July) because of modeling results indicating: (1) similar long-term average and average by water year type monthly flows at Rio Vista during most months of all water year types; (2) similar monthly flow exceedance probabilities at Rio Vista during most months, including during low flow conditions, but with lower flow exceedance probabilities during August; (3) similar mean monthly Yolo Bypass outflow during most months, but substantially lower mean monthly flows during October of below normal water years and during November of dry water years, and substantially higher mean monthly flows during November of below normal and critical water years, and similar or slightly higher flow exceedance probabilities; (4) similar Yolo Bypass flows and associated productivity in the Delta; (5) similar or slightly lower long-term average and average by water year type monthly Delta outflow during most months of most water year types; (6) similar or lower long-term average and average by water year type monthly OMR flows; and (7) slightly higher overall simulated mean monthly salvage at the SWP export facility and slightly lower mean monthly salvage at the CVP export facility, particularly during below normal and critical water years

In conclusion, in consideration of potential impacts to all life stages of Central Valley steelhead in the Delta, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Green Sturgeon in the Delta Region

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar juvenile rearing and emigration conditions (year-round) because of modeling results indicating: (1) similar mean monthly Yolo Bypass outflow and similar or slightly higher flow exceedance probabilities; (2) similar Yolo Bypass flows and associated productivity in the Delta; and (3) similar simulated mean monthly salvage at the SWP and CVP export facilities

In conclusion, in consideration of potential impacts to green sturgeon in the Delta, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

White Sturgeon in the Delta Region

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar juvenile rearing and emigration conditions (year-round) because of modeling results indicating: (1) generally similar mean monthly Yolo Bypass outflow during most months, but with substantially higher mean monthly flows during November of below normal and critical water years and substantially lower mean monthly flows during October of below normal water years and during November of dry water years, in addition to similar or slightly higher flow exceedance probabilities; (2) similar Yolo Bypass flows and associated productivity in the Delta and (3) similar simulated mean monthly salvage at the SWP and CVP export facilities

In conclusion, in consideration of potential impacts to white sturgeon in the Delta, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Pacific and River Lamprey in the Delta Region

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar macropthalmia emigration conditions (year-round) because of modeling results indicating similar simulated mean monthly salvage at the SWP and CVP export facilities, but with lower mean monthly salvage at the CVP export facility during critical water years

In conclusion, in consideration of potential impacts to Pacific and river lamprey in the Delta, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

American Shad in the Delta Region

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar egg and larval conditions in the Delta because of modeling results indicating: (1) equivalent (during April), slightly lower (during May) and slightly higher (during June) exceedance probabilities of X2 location being located at or downstream of 75 RKm during April through June; (2) similar overall mean monthly salvage at the SWP and CVP export facilities; and (3) similar Yolo Bypass flows and associated productivity in the Delta

In conclusion, in consideration of potential impacts to American shad in the Delta, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Striped Bass in the Delta Region

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar egg and larval conditions in the Delta because of modeling results indicating: (1) slight upstream mean monthly movements in X2 location during April and May of all water year types and equivalent X2 locations during June of most water year types during April through June; (2) slightly higher or similar overall normalized mean monthly salvage at the SWP and CVP export facilities; and (3) similar Yolo Bypass flows and associated productivity in the Delta

In conclusion, in consideration of potential impacts to striped bass in the Delta, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Largemouth Bass in the Delta Region

Relative to Existing Conditions, the No Project/No Action Alternative would generally be expected to provide:

- Similar juvenile rearing conditions in the Yolo Bypass because of modeling results indicating: (1) similar mean monthly Yolo Bypass outflow during most months, in addition to similar or slightly higher flow exceedance probabilities; and (2) similar Yolo Bypass flows and associated productivity in the Delta

- Similar juvenile and adult conditions in the Delta because modeling results indicating: (1) upstream mean monthly movements in X2 location of 0.5 RKm or more would not occur during any month of any water year type, while downstream mean monthly movements in X2 location of 0.5 RKm or more would occur during January and July of below normal water years and during January, February, August and September of critical water years; and (2) slightly higher overall simulated mean monthly salvage at the SWP export facility and similar overall mean monthly salvage at the CVP export facility

In conclusion, in consideration of potential impacts to largemouth bass in the Delta, the No Project/No Action Alternative would result in similar and less-than-significant impacts, relative to Existing Conditions.

Suisun, San Pablo, and San Francisco Bays

Fish species of primary management concern, including Chinook salmon, steelhead, river lamprey, Pacific lamprey, green sturgeon, white sturgeon, and splittail utilize the bays as a migration corridor and/or for juvenile rearing. Insubstantial changes in Delta outflow would not result in substantial changes to migration or rearing habitat for these fish species in the bays. Striped bass and American shad also utilize the bays for migration and rearing, however, changes in X2 location were evaluated during the striped bass and American shad spawning and initial rearing period to evaluate potential changes in larval transport and rearing habitat in the Bay-Delta (see the Delta Region, above). Potential effects on delta smelt and longfin smelt migration and rearing in the Bay-Delta also were analyzed through evaluation of changes in X2 location (see the Delta Region, above).

12C.3.3 Primary Study Area – No Project/No Action Alternative Relative to Existing Conditions

For a discussion of potential impacts to fisheries and aquatic resources under the No Project/No Action Alternative in the Primary Study Area, refer to the Environmental Consequences section of Chapter 12 Aquatic Biological Resources.

12C.4 Impacts Associated with Alternative A Relative to Existing Conditions

12C.4.1 Extended Study Area – Alternative A Relative to Existing Conditions

A summary of the potential impacts of Alternative A, relative to Existing Conditions, to fish species of primary management concern that use reservoir habitat is provided in Table 12-15 of Chapter 12 Aquatic Biological Resources. A summary of the potential impacts of the No Project/No Action Alternative, relative to Existing Conditions, to fish species of primary management concern that use riverine, estuarine, and floodplain habitats is provided in Table 12-16 of Chapter 12 Aquatic Biological Resources.

12C.4.1.1 SWP and CVP Operations

Agricultural Water Use

Potential changes to fisheries and aquatic resources associated with any changes in agricultural water deliveries under Alternative A were addressed by evaluating SWP and CVP CALSIM II water operations modeling in the Secondary and Extended study areas, below. Therefore, no further evaluation of potential effects on fisheries and aquatic resources associated with agricultural water use was conducted.

Municipal and Industrial Water Use

Potential changes to fisheries and aquatic resources associated with any changes in municipal and industrial water deliveries under Alternative A were addressed by evaluating SWP and CVP CALSIM II water operations modeling in the Secondary and Extended study areas, below. Therefore, no further evaluation of potential effects on fisheries and aquatic resources associated with municipal and industrial water use was conducted.

Wildlife Refuge Water Use

Potential changes to fisheries and aquatic resources associated with any changes in wildlife refuge water deliveries under Alternative A were addressed by evaluating SWP and CVP CALSIM II water operations modeling in the Secondary and Extended study areas, below. National Wildlife Refuges (NWR) and Wildlife Areas (WA) in the Extended Study Area that receive Level 4 water deliveries from the CVP[1] are anticipated to have more reliable water deliveries, particularly during drier water years, with NODOS Project implementation.

Fish species known to occur within the Sacramento River NWRs and associated canals are generally expected to be non-native warmwater resident fish species, but may include fish species such as California roach. The NWRs and WAs within the San Joaquin River and Tulare Lake basins that receive Level 4 water deliveries reportedly support warmwater resident fish species in the waterways that supply the refuges. While fish species of primary management concern are generally not known to occur within the San Joaquin River and Tulare Lake basin NWRs and Wildlife Areas, during infrequent flooding events Sacramento splittail may utilize the San Joaquin River Basin NWRs for spawning. Because wildlife refuge water deliveries may be more reliable during drier water years, fisheries and aquatic habitat conditions may be more suitable during some years in the refuges. However, because deliveries to the refuges are not anticipated to be substantially affected, fisheries and aquatic resources within the refuges are not anticipated to be substantially affected under Alternative A, relative to Existing Conditions.

San Luis Reservoir

Coldwater Fish Species

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Less suitable coldwater pool storage conditions, because of modeling results indicating: (1) slightly lower long-term average monthly storage occurring more often; (2) lower monthly storage exceedance probabilities during most months of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance decrease during most months (June through October) of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in San Luis Reservoir, Alternative A would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

[1] The Level 4 water deliveries that could be affected by project operations are contracted to the Sacramento and Delevan NWRs within the Sacramento River Basin, the West Bear Creek unit of the San Luis NWR Complex and the Merced unit of the Merced NWR, as well as the Los Banos, Volta, and Mendota WAs, the China Island and Salt Slough units of the North Grasslands WA, private wetlands of the Grassland Resource Conservation District within the San Joaquin River Basin, and the Kern and Pixley NWRs within the Tulare Lake Basin.

Warmwater Fish Species

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or slightly less suitable warmwater fish spawning and early life stage conditions, because of modeling results indicating slightly increased frequencies of monthly water surface elevation reductions of six feet or more during most months of the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in San Luis Reservoir, Alternative A would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Export Service Area Reservoirs

Export Service Area Reservoir Fisheries

Changes in modeled total SWP and CVP Delta exports (Appendix 12H) under Alternative A relative to Existing Conditions were analyzed to evaluate potential changes in storage and water surface elevations and associated impacts on fisheries in export service area reservoirs.

Relative to Existing Conditions, NODOS Alternative A would generally be expected to provide:

- Equivalent or improved export service area reservoir fisheries habitat conditions, because of modeling results indicating: (1) slightly higher long-term average and average monthly by water year type Delta exports during most months of all water year types, and 10 percent higher or more during September and October of wet water years, during November of above normal water years, and during August, September and November of critical water years, and lower by 10 percent or more during December of critical water years; (2) higher monthly export exceedance probabilities during June through January, and lower export exceedance probabilities during February through May; and (3) a net 10 percent or more export probability of exceedance increase during most months of the year.

In conclusion, in consideration of potential impacts to SWP and CVP export service area reservoir fisheries, Alternative A would result in potentially more suitable and less-than-significant impacts, relative to Existing Conditions.

12C.4.2 Secondary Study Area – Alternative A Relative to Existing Conditions

12C.4.2.1 Construction, Operation, and Maintenance Impacts

Pump Installation at the Red Bluff Pumping Plant

The installation of an additional pump within one of the existing concrete bays, and ongoing operations and maintenance activities associated with the T-C Canal and GCID Canal intakes, have the potential to contribute sediment and increase turbidity in the Sacramento River downstream of the canal intakes. Activities associated with access, staging, storage, and disposal areas during installation also have the potential to increase turbidity in the Sacramento River. Additionally, due to the movement of traffic between construction staging areas, and storage and disposal areas, as well as from general construction activities, the potential exists for dust to accumulate on access roads and enter waterways as sediment. Accumulated debris and sediment at the intake structures would also require periodic removal.

Although many fish species are migratory and capable of moving freely, a sudden localized increase in turbidity may potentially affect some juvenile fishes by temporarily disrupting normal behaviors that are essential to growth and survival such as feeding, sheltering, and migrating (NMFS, 2003). Additional turbidity-related effects associated with behavioral alteration include disruption of feeding behaviors, which increases the likelihood that individual fish would face increased competition for food and space, and experience reduced growth rates, or possibly weight loss (NMFS, 2003). Potential turbidity increases also may affect the sheltering abilities of some juvenile fishes and may decrease their likelihood of survival by increasing their susceptibility to predation (NMFS, 2003).

Downstream effects on fishes from introduced sediment associated with construction-, operation-, and maintenance-related activities are dependent on the life stages present, the particle size distribution of introduced sediment, the concentration of suspended solids, and on the magnitude of instream flows (Cordone and Kelley, 1961; Redding *et al.*, 1987; Reid and Anderson, 1999). Exposure duration is reportedly a critical determinant of the occurrence and magnitude of potential physical or behavioral effects on fishes associated with increased turbidity (Newcombe and MacDonald, 1991). While native fish species such as salmonids reportedly appear to be little affected by the high concentrations of suspended sediments that occur during storm and snowmelt runoff episodes (Bjornn and Reiser, 1991), chronic exposure to increased turbidity can cause physiological stress responses that can increase maintenance energy use and reduce feeding and growth (Lloyd, 1987; Redding *et al.*, 1987; Servizi and Martens, 1991). However, some studies have reported that increased instream sediment loads do not substantially affect some fish species (Cordone and Kelley, 1961; Redding *et al.*, 1987; Reid and Anderson, 1999). Gregory and Levings (1998) reported that turbidity provides refuge and cover to fishes from piscivorous fishes and birds. In rivers with intense predation pressure, the benefit of increased turbidity (i.e., enhanced survival) may balance with the cost of potentially detrimental physical effects (i.e., reduced growth). Turbidity levels of about 23 nephelometric turbidity units (NTUs) have been reported to minimize predation risk of juvenile Chinook salmon (Gregory, 1993).

Hazardous materials and chemicals in the form of gasoline, engine oil, lubricants, or other fluids used during construction, operation, and maintenance activities could potentially enter the Sacramento River near the T-C Canal and GCID Canal intakes as a result of seepage or accidental spills. During operation and maintenance activities at the intake structures, such as debris and sediment removal, biofouling prevention, corrosion prevention, equipment maintenance, and repairs, there is the potential for chemical or hazardous spills or leakage in the Sacramento River. Accidental discharge of hazardous materials and chemicals could potentially affect fishes that may be present in the immediate vicinity and downstream of the facilities by increasing physiological stress, reducing reproductive success, causing direct mortality, and altering primary and secondary production. However, the potential for hazardous materials and chemicals to enter the Sacramento River during construction activities is expected to be minimized because activities would be limited to installing a pump into an existing bay at the T-C Canal intake facility, in addition to ongoing maintenance activities at the T-C Canal and GCID Canal intakes.

Adult, juvenile, and early life stages of fish species of primary management concern could be present within and downstream of canal intake areas year-round. Therefore, fish species could potentially be affected by construction, operation, and maintenance activities in the Sacramento River. These activities would result in a potentially significant impact to fish species of primary management concern. However, implementation of water quality impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources*)* to minimize the potential for increases in erosion, sedimentation and turbidity and in-water hazardous spills, in addition to the limited installation and operation and maintenance activities, is anticipated to minimize potentially significant impacts on all life stages of fish species of primary management concern, resulting in a less than significant impact.

12C.4.2.2 SWP and CVP Operations

Model results examined for Alternative A were the same as those described for the No Project Alternative for each waterway and facility included in the Secondary Study Area.

Trinity Lake

Coldwater Fish Species

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Equivalent or improved coldwater pool storage conditions, because of slightly higher: (1) higher long-term average monthly storage, and higher average monthly storage by water year type occurring more often during most months of the evaluation period; (2) equivalent or higher monthly storage exceedance probabilities during all months of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during all months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Trinity Lake, Alternative A would result in more suitable and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or improved warmwater fish spawning and early life stage conditions, because of modeling results indicating slightly reduced frequencies of monthly water surface elevation reductions of six feet or more during most months of the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Trinity Lake, Alternative A would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

Trinity River

Coho Salmon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Equivalent adult immigration and holding conditions, because of modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar, or slightly lower (particularly during September and October) or slightly higher (particularly during January) average monthly probabilities of exceeding specified water temperature index values.
- Equivalent adult spawning and embryo incubation conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March

and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values, with slightly lower monthly probabilities of exceedance during May, October, and November.

- Equivalent or slightly improved juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently and particularly during above normal and below normal water years when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year, and slightly lower probabilities during July through October.
- Equivalent smolt emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) generally equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of Coho salmon in the Trinity River, Alternative A would result in generally similar and less-than-significant impacts, relative to Existing Conditions.

Spring-Run Chinook Salmon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Equivalent or slightly improved adult immigration and holding conditions, because of modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar, or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values, particularly during July through September.
- Improved adult spawning and egg incubation conditions due to modeling results indicating: (1) equivalent or slightly higher long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during all water year types; (2) equivalent monthly flow exceedance probabilities during all months of evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and

(4) lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, at most water temperature indices.

- Equivalent or slightly improved juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during July through September.
- Equivalent smolt emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during June and July.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Trinity River, Alternative A would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

Fall-Run Chinook Salmon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions, because of modeling results indicating: (1) equivalent or slightly higher long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar, or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values, particularly during August and September.
- Equivalent or slightly improved adult spawning conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding

specified water temperature index values throughout most of the year, with generally lower probabilities of exceedance during June and October.

- Improved embryo incubation conditions due to modeling results indicating reduced total annual early life stage mortality, and equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during June and October.

- Equivalent or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the evaluation period, with lower probabilities of exceedance during June through September.

- Equivalent smolt emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during June and July.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Trinity River, Alternative A would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

Steelhead (Winter-run and Summer-run)

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Equivalent adult immigration and holding conditions for winter-run steelhead, because of modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar, or slightly lower (particularly during September and October) average monthly probabilities of exceeding specified water temperature index values.

- Equivalent or slightly improved adult immigration and holding conditions for summer-run steelhead due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during all water year types; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year, with generally lower probabilities of exceedance during July and August.

- Equivalent adult spawning and egg incubation conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout the evaluation period.

- Equivalent or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and generally equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during July through September.

- Equivalent smolt emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or lower average monthly flows, particularly during wet water years when average monthly flows would be lower more frequently, and during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of steelhead (winter-run and summer-run) in the Trinity River, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Green Sturgeon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar, or slightly lower (particularly during June, July and September) average monthly probabilities of exceeding specified water temperature index values.

- Equivalent or improved adult spawning conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperature conditions, during the evaluation period.
- Equivalent or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during June, July, and September.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Trinity River, Alternative A would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

White Sturgeon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Equivalent adult immigration and holding conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.
- Equivalent adult spawning conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when

flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.

- Equivalent or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during June, July, and September.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Trinity River, Alternative A would result in generally similar and less-than-significant impacts, relative to Existing Conditions.

Pacific Lamprey

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Equivalent adult immigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; and (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period.
- Equivalent adult spawning and egg incubation conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of remaining within the specified water temperature range.
- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire

year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Trinity River, Alternative A would result in generally similar and less-than-significant impacts, relative to Existing Conditions.

Klamath River downstream of the Trinity River

Because potential changes within the Trinity River were considered to be less than significant under Alternative A, it is expected that any potential changes in the Klamath River downstream of the Trinity River also would be less than significant.

Lewiston Lake, Whiskeytown Lake, Keswick Reservoir, Lake Natoma, and the Thermalito Complex

Modeling was not conducted for Lewiston Lake, Keswick Reservoir, Lake Natoma, or the Thermalito Complex. However, modeling conducted on the reservoirs upstream of these regulating reservoirs indicates that Alternative A, when compared to Existing Conditions, would result in either no change or insignificant changes to storage and water surface elevation fluctuations. Because these reservoirs would continue to operate as regulating reservoirs, it is assumed that there would not be substantial changes in storage or water surface elevations, resulting in less-than-significant impacts to fish species of primary management concern.

Because flows released from Whiskeytown Lake would not experience significant changes, storage and water surface elevations would not be expected to substantially change under Alternative A. Therefore, potential changes in storage and water surface elevation in Whiskeytown Lake are anticipated to result in less than significant impacts to coldwater and warmwater fish species, respectively.

Spring Creek

It is not anticipated that operations of Spring Creek Reservoir or flows in Spring Creek would be substantially affected under implementation of Alternative A. It is anticipated that Spring Creek Reservoir would continue to operate for flood control purposes, and to manage the release of contaminated water from Iron Mountain Mine.

Shasta Lake

Coldwater Fish Species

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage, and higher average monthly storage by water year type during all months of the evaluation period; (2) equivalent or higher monthly storage exceedance probabilities during all months of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during all months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Shasta Lake, Alternative A would result in more suitable and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or improved warmwater fish spawning and early life stage conditions, because of modeling results indicating similar or slightly reduced frequencies of monthly water surface elevation reductions of six feet or more during the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Shasta Lake, Alternative A would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

Sacramento River

Winter-run Chinook Salmon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly flows during most of the evaluation period, and lower average monthly flows by water year type would occur more often than higher average monthly flows during most water year types at all Sacramento River locations evaluated, except for below Keswick Dam when average monthly flows would be higher more often during wet and above normal water year types, and would be higher and lower with the same monthly frequency during dry water year types; (2) lower monthly flow exceedance probabilities during more than half of the evaluation period at all locations evaluated; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated; (4) similar, or slightly higher (particularly during April) or slightly lower (particularly during May through July) average monthly probabilities of exceeding specified water temperature index values.
- Improved spawning conditions due to modeling results indicating greater spawning habitat availability during the entire April through August adult spawning period, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during the months with the warmest water temperature conditions (i.e., May through August) and during the periods when warmest water temperatures occur.
- Improved embryo incubation conditions due to modeling results indicating reduced total annual early life stage mortality, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during the months with the warmest water temperature conditions (May through August) and during the periods when warmest water temperatures occur.
- Improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during more than half of the evaluation period in the upper Sacramento River (below Keswick and Red Bluff Diversion Dam), and higher and lower long-term average flows would occur with the same monthly frequency in the lower Sacramento River (Verona, Freeport and Rio Vista); (2) lower average monthly flow exceedance probabilities more often in the upper Sacramento River, and higher average monthly flow exceedance probabilities slightly more often in the lower Sacramento River; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at all locations evaluated; and (4) lower, and therefore more suitable,

monthly probabilities of exceeding specified water temperature index values, particularly at the warmest water temperature index values (70°F and 75°F).

- Improved conditions pertaining to population mortality and production potential (SALMOD) because modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by 16 percent), and average annual mortality by water year type would be reduced during all water year types (by six percent during wet water years, 17 percent during above normal water years, 9 percent during below normal water years, 25 percent during dry water years, and 23 percent during critical water years); (2) a decrease in total annual mortality exceedance probabilities over the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction, with a 10 percent or more exceedance probability reductions over nearly 25 percent of the entire distribution; and (4) long-term average total annual winter-run Chinook salmon production would increase by two percent, while average total annual production would decrease by less than one percent during wet water years, would increase during above normal water years by five percent, during below normal water years by one percent, and during dry and critical water years by four percent.
- Improved conditions pertaining to population survival and abundance of spawners (IOS) because modeling results indicating: (1) over the 81-year evaluation period, long-term average annual egg to fry survival would increase by three percent, and average annual egg to fry survival by water year type would decrease during wet water years by one percent and during above normal water years by less than one percent, and would increase during below normal water years by three percent, during dry water years by three percent and during critical water years by 32 percent; (2) long-term average annual fry to smolt survival would increase by two percent, and average annual fry to smolt survival by water year type would increase during wet water years by one percent, during above normal water years by three percent, and during critical water years by 18 percent, and would decrease during below normal water years by two percent and during dry water years by one percent; (3) long-term average annual female spawner abundance would increase by 10 percent, and average annual female spawner abundance by water year type would increase during wet water years by 10 percent, during above normal water years by 17 percent, during below normal water years by five percent, during dry water years by nine percent and during critical water years by 14 percent; (4) an increase in annual egg to fry survival exceedance probabilities over approximately 50 percent of the entire distribution, particularly at lower survival rates; (5) an increase in annual fry to smolt survival exceedance probabilities over approximately 60 percent of the entire distribution, particularly at lower survival rates; and (6) an increase in annual female spawner abundance exceedance probabilities over nearly the entire distribution.

In conclusion, in consideration of potential impacts to all life stages of winter-run Chinook salmon in the Sacramento River, Alternative A would result in beneficial and less-than-significant impacts, relative to Existing Conditions.

Spring-run Chinook Salmon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type during most of the evaluation period in the upper Sacramento River, and lower and higher long-term average monthly and average monthly flows by water year type occurring with similar monthly frequency in the lower Sacramento River; (2) lower monthly flow exceedance probabilities during more than half of the evaluation period in the upper Sacramento River, and lower and higher monthly flow exceedance probabilities occurring with similar monthly frequencies in the lower Sacramento River; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated; (4) similar, or slightly higher (particularly during April) and slightly lower (particularly during May through September) average monthly probabilities of exceeding specified water temperature index values (i.e., similar or improved water temperature conditions during May through September).

- Potentially improved spawning conditions because of modeling results indicating lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during months with warm water temperature conditions (i.e., September and October).
- Improved embryo incubation conditions due to modeling results indicating reduced total annual early life stage mortality, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures.
- Similar or improved juvenile rearing conditions due to modeling results indicating: (1) lower long-term average monthly flows during more than half of the evaluation period in the upper Sacramento River; (2) lower monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values.
- Similar or improved smolt emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type during more than half of the evaluation period, except for during critical water years when flows would be higher more often; (2) lower monthly flow exceedance probabilities more often at all locations evaluated; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at all locations evaluated; and (4) lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values below Red Bluff Diversion Dam and below the Feather River confluence, but higher monthly probabilities of exceeding specified water temperature index values at Freeport.
- Improved conditions pertaining to population mortality and production potential (SALMOD) because modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by 24 percent), and average annual mortality by water year type would be reduced during all water year types (by 40 percent during wet water years, two percent during above normal water years, six percent during below normal water years, 45 percent during dry water years, and 16 percent during critical water years); (2) a decrease in total annual mortality exceedance probabilities over more than 90 percent of the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction; and (4) long-term average total annual spring-run Chinook salmon production would increase by four percent, while average total annual production would increase during wet water years by two percent, during above normal and below normal water years by one percent, during dry water years by 11 percent, and during critical water years by seven percent.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Sacramento River, Alternative A would result in beneficial and less-than-significant impacts, relative to Existing Conditions.

Fall-run Chinook Salmon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions, because of modeling results indicating: (1) lower or similar long-term average monthly and average monthly flows by water year type during most of the evaluation period in the upper Sacramento River, and higher long-term average monthly and average monthly flows by water year type in the lower Sacramento River; (2) lower monthly flow exceedance probabilities during more than half of the evaluation period in the upper Sacramento River, and higher monthly flow exceedance probabilities during all months evaluated in the lower Sacramento River; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring during most months of the evaluation period at all locations evaluated; (4) lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values.
- Generally similar spawning conditions because of modeling results indicating higher spawning habitat availability during October and November, lower spawning habitat availability during December and January, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, specifically during October.
- Improved embryo incubation conditions due to reduced total annual early life stage mortality, and lower or equivalent probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures.
- Generally similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during more than half of the evaluation period at all locations evaluated; (2) lower monthly flow exceedance probabilities more often at all locations evaluated; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at all locations evaluated, particularly in the lower Sacramento River; and (4) similar monthly probabilities of exceeding specified water temperature index values, with less suitable water temperatures during April, and more suitable water temperatures during May.
- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by six percent), average annual mortality by water year type would increase during wet water years by five percent, and would decrease during above normal water years by 13 percent, during below normal water years by less than one percent, during dry water years by 16 percent, and during critical water years by 26 percent; (2) a decrease in total annual mortality exceedance probabilities over approximately 75 percent of the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction; and (4) long-term average total annual fall-run Chinook salmon production would increase by three percent, while average total annual production would decrease during wet water years by eight percent, and would increase during above normal water years by 11 percent, during below normal water years by less than one percent, during dry water years by six percent, and during critical water years by 14 percent.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Sacramento River, Alternative A would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

Late fall-run Chinook Salmon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Equivalent adult immigration and holding conditions, because of modeling results indicating: (1) higher long-term average monthly and average monthly flows by water year type below Keswick Dam, and lower long-term average monthly and average monthly flows by water year type below Red Bluff Diversion Dam and in the lower Sacramento River; (2) higher and lower monthly flow exceedance probabilities with similar monthly frequency below Keswick Dam, and lower monthly flow exceedance probabilities at all other locations evaluated; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring during most months of the evaluation period at all locations evaluated; (4) similar monthly probabilities of exceeding specified water temperature index values, but with more suitable water temperatures during October and less suitable water temperatures during April.
- Similar spawning conditions because of modeling results indicating similar probabilities of exceeding specified water temperature index values, with more suitable water temperatures during May and less suitable water temperatures during April.
- Similar or less suitable embryo incubation conditions due to modeling results indicating similar or increased total annual early life stage mortality, and similar probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows more often in the upper Sacramento River, and higher average monthly flows more often in the lower Sacramento River; (2) lower monthly flow exceedance probabilities more often in the upper Sacramento River, and higher monthly flow exceedance probabilities in the lower Sacramento River; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at all locations evaluated, particularly in the lower Sacramento River; and (4) similar or lower monthly probabilities of exceeding specified water temperature index values more often, and therefore more suitable water temperature conditions.
- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by three percent), average annual mortality by water year type is increased during wet water years by one percent, and is decreased during above normal water years by two percent, during below normal waters by 10 percent, during dry water years by four percent, and during critical water years by 11 percent; (2) a decrease in total annual mortality exceedance probabilities over approximately 56 percent of the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction; and (4) long-term average total annual late fall-run Chinook salmon production would increase by two percent, while average total annual production by water year type would decrease during wet water years by less than one percent, and would increase during above normal water years by two percent, during below normal water years by two percent, during dry water years by one percent, and during critical water years by eight percent.

In conclusion, in consideration of potential impacts to all life stages of late fall-run Chinook salmon in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Steelhead

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Equivalent adult immigration and holding conditions, because of modeling results indicating: (1) higher and lower long-term average monthly flows occurring with similar monthly probabilities at all locations evaluated except for below Red Bluff Diversion Dam, where long-term average monthly flows would be lower more often, while average monthly flows by water year type would be higher or similar more often below Keswick Dam, lower more often below Red Bluff Diversion Dam, and similar or higher more often in the lower Sacramento River; (2) higher and lower monthly flow exceedance probabilities with similar monthly frequencies at all locations evaluated; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring during most months of the evaluation period at all locations evaluated; (4) lower monthly probabilities of exceeding specified water temperature index values during September and October, and higher monthly probabilities of exceeding specified water temperature index values during November and March.
- Similar spawning conditions due to modeling results indicating: (1) higher mean monthly flows and flow exceedance probabilities during December through February, and lower flows during March and April; (2) higher flow exceedance probabilities during low flow conditions; (3) similar probabilities of exceeding specified water temperature index values, but with less suitable water temperatures during April; and (4) SacEFT results indicate that spawning habitat availability conditions would be generally similar.
- Similar embryo incubation conditions due to modeling results indicating: (1) similar probabilities of exceeding specified water temperature index values, but with less suitable water temperatures during April; (2) SacEFT results indicate that egg mortality associated with modeled water temperatures would be generally equivalent; (3) SacEFT results indicate that redd dewatering conditions may be improved slightly more often; and (4) SacEFT results indicate that redd scouring conditions would be generally equivalent.
- Generally similar juvenile rearing conditions due to modeling results indicating: (1) lower or similar long-term average monthly and average monthly by water year type flows; (2) lower monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; (4) lower monthly probabilities of exceeding specified water temperature index values more often, and therefore more suitable water temperature conditions; and (5) SacEFT results indicate that juvenile rearing habitat availability may be increased slightly more often while juvenile stranding potential may be increased more often.
- Similar or less suitable smolt emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type more often, except for during critical water years in the lower Sacramento River, when flows would be generally similar or higher; (2) lower monthly flow exceedance probabilities more often; (3) under low flow conditions, lower monthly flow exceedance probabilities below Red Bluff Diversion Dam, and higher monthly flow exceedance probabilities more often at all other locations evaluated; and (4) similar or

higher monthly probabilities of exceeding specified water temperature index values, and therefore less suitable water temperature conditions.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Green Sturgeon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type below Keswick Dam, and generally higher long-term average monthly and average monthly flows by water year type below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; (2) lower monthly flow exceedance probabilities more often below Keswick Dam, but higher monthly flow exceedance probabilities below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring more often at all locations evaluated; and (4) lower, and therefore more suitable, average monthly probabilities of exceeding specified water temperature index values.
- Similar spawning conditions because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type below Keswick Dam and Red Bluff Diversion Dam, and higher long-term average monthly and average monthly flows by water year type at Wilkins Slough; (2) lower monthly flow exceedance probabilities more often below Keswick Dam and Red Bluff Diversion Dam, but higher monthly flow exceedance probabilities at Wilkins Slough; and (3) during low flow conditions, higher monthly flow exceedance probabilities occurring more often at all locations evaluated.
- Similar egg incubation conditions because of modeling results indicating equivalent probabilities of exceeding the specified water temperature index value below Keswick Dam and Red Bluff Diversion Dam, while the SacEFT results indicate reduced water temperatures more often near Hamilton City and potentially increased survival.
- Similar or improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type more often below Red Bluff Diversion Dam, and higher average monthly flows and average monthly flows by water year type during June through November, and lower average monthly flows during December through May below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; (2) lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam, higher monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities, and higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies at Rio Vista; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at all locations evaluated; and (4) lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values at all locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Sacramento River, Alternative A would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

White Sturgeon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) lower or similar long-term average monthly and average monthly flows by water year type during most of the evaluation period; (2) lower monthly flow exceedance probabilities during more than half of the evaluation period at all locations evaluated; (3) during low flow conditions, lower flow exceedance probabilities occurring more often at Hamilton City and higher monthly flow exceedance probabilities occurring more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.
- Less suitable spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows; (2) lower monthly flow exceedance probabilities, including during low flow conditions; and (3) higher or similar probabilities of exceeding specified water temperature index values, and therefore less suitable water temperatures.
- More suitable juvenile rearing and outmigration conditions due to: (1) higher and lower long-term average monthly and average by water year type monthly flows with similar frequency; (2) higher monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) lower monthly probabilities of exceeding specified water temperature index values, and therefore more suitable water temperature conditions.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Sacramento River, Alternative A would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

River Lamprey

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly flows by water year type occurring with similar monthly frequencies at all locations evaluated; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies at all locations evaluated; and (3) during low flow conditions, higher flow exceedance probabilities occurring more often at all locations evaluated.
- Similar spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows more often below Keswick Dam and below Red Bluff Diversion Dam, and higher and lower average monthly flows occurring with similar monthly frequencies below the proposed Delevan Pipeline Intake Facilities; (2) lower monthly flow exceedance probabilities more often at all locations evaluated; (3) during low flow conditions, higher or similar monthly flow exceedance probabilities below Keswick Dam, lower monthly flow exceedance probabilities below Red Bluff Diversion Dam, and higher and lower flow exceedance probabilities occurring with similar monthly frequencies below the proposed Delevan Pipeline Intake Facilities; and (4) higher probabilities of occurring within specified water temperature ranges, and therefore more suitable water temperatures.

- Similar ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher and lower monthly flow exceedance probabilities occurring with similar frequencies (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Pacific Lamprey

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly flows by water year type occurring with similar monthly frequencies at all locations evaluated; (2) lower monthly flow exceedance probabilities more often; and (3) during low flow conditions, higher or similar flow exceedance probabilities.
- Similar spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows more often below Keswick Dam and Red Bluff Diversion Dam, and higher and lower mean monthly flows occurring with similar monthly frequencies below the proposed Delevan Pipeline Intake Facilities; (2) lower monthly flow exceedance probabilities more often at all locations evaluated; (3) during low flow conditions, higher or similar monthly flow exceedance probabilities below Keswick Dam and below the proposed Delevan Pipeline Intake Facilities, and lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam; and (4) higher probabilities of occurring within specified water temperature ranges, and therefore more suitable water temperatures.
- Similar ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Hardhead

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly flows by water year type occurring with similar monthly frequencies; (2) higher monthly flow exceedance probabilities more often; (3) during low flow conditions, higher or similar flow exceedance probabilities more often; and (4) lower probabilities of water temperatures occurring within the specified range slightly more often, and therefore, potentially less suitable water temperatures.

- Similar spawning conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows more often below Keswick Dam and at Freeport, and higher and lower mean monthly flows occurring with similar monthly frequencies below the proposed Delevan Pipeline Intake Facilities; (2) lower monthly flow exceedance probabilities more often below Keswick Dam and below the proposed Delevan Pipeline Intake Facilities; (3) during low flow conditions, higher or similar monthly flow exceedance probabilities; and (4) higher probabilities of occurring within specified water temperature ranges, and therefore more suitable water temperatures.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

California Roach

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly flows by water year type occurring with similar monthly frequencies; (2) generally higher monthly flow exceedance probabilities more often; (3) during low flow conditions, higher or similar flow exceedance probabilities more often; and (4) equivalent probabilities of water temperatures exceeding the specified water temperature index value.
- Similar spawning conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows more often; (2) lower or similar monthly flow exceedance probabilities more often; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities below Keswick Dam, higher and lower probabilities with the same monthly frequency below the proposed Delevan Pipeline Intake Facilities, and equivalent or lower flow exceedance probabilities at Freeport; and (4) similar probabilities of exceeding the specified water temperature index value, but a higher probability of exceedance during April below the proposed Delevan Pipeline Intake Facilities, and therefore slightly more suitable water temperatures.

In conclusion, in consideration of potential impacts to all life stages of California roach in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Sacramento Splittail

Evaluation of water temperatures for splittail in the Sacramento River (i.e., 45-75° F) indicate that water temperature conditions would be essentially equivalent or similar under Alternative A relative to Existing Conditions, resulting in a less than significant impact.

American Shad

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar adult spawning and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type more often below Red Bluff Diversion Dam, and higher and lower average monthly flows occurring with similar monthly frequencies at Verona and Freeport; (2) lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam, equivalent or higher exceedance probabilities at Verona, and equivalent exceedance probabilities at Freeport; (3) during low flow conditions, lower flow exceedance probabilities below Red Bluff Diversion Dam, equivalent or higher exceedance probabilities at Verona, and equivalent exceedance probabilities at Freeport; and (4) higher probabilities of water temperatures occurring within the specified water temperature range below the Feather River confluence, and generally lower probabilities of water temperatures occurring within the specified range below Red Bluff Diversion Dam and at Freeport.

- Similar or improved larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) higher long-term average and average by water year type monthly flows more often; (2) higher monthly flow exceedance probabilities more often; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) lower probabilities of water temperatures occurring within the specified water temperature range below the proposed Delevan Pipeline Intake Facilities and below the Feather River confluence, and higher probabilities of water temperatures occurring within the range at Freeport.

In conclusion, in consideration of potential impacts to all life stages of American shad in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Striped Bass

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Generally similar or improved adult spawning and other life stage conditions, because of: (1) higher and lower long-term average monthly and average monthly flows by water year type with similar monthly frequencies; (2) lower monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities and equivalent or higher flow exceedance probabilities at Verona; (3) during low flow conditions, equivalent or higher flow exceedance probabilities; and (4) higher probabilities of water temperatures occurring within the specified water temperature range.
- Generally similar larvae, fry, and juvenile emigration conditions, because of: (1) higher and lower long-term average and average by water year type monthly flows with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities with similar monthly frequencies below the proposed Delevan Pipeline Intake Facilities and higher exceedance probabilities more often at Verona; (3) during low flow conditions, higher monthly flow exceedance probabilities more often; and (4) higher and lower probabilities of water temperatures occurring within the specified water temperature range with similar monthly frequencies.

In conclusion, in consideration of potential impacts to all life stages of American shad in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Largemouth Bass

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) higher and lower long-term average monthly flows and average monthly flows by water year type occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; and (3) during low flow conditions, higher monthly flow exceedance probabilities more often.

- Similar or improved spawning conditions, because of modeling results indicating similar monthly probabilities of water temperatures occurring within the specified water temperature range during March through June, but with a slightly higher probability of water temperatures occurring within the specified range during April.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Clear Creek

Spring-run Chinook Salmon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for substantially higher mean monthly flows during July of all water year types and during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities during most of the evaluation period; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar or improved spawning and embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities during most of the evaluation period; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities during most of the evaluation period; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile emigration conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for substantially higher mean monthly flows during July of all water year types and higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities during most of the evaluation period; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in Clear Creek, Alternative A would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Fall-run Chinook Salmon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar or improved spawning and embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile emigration conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in Clear Creek, Alternative A would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Late Fall-run Chinook Salmon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.

- Similar or improved spawning and embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile emigration conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of late fall-run Chinook salmon in Clear Creek, Alternative A would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Steelhead

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar or improved spawning and embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for substantially higher mean monthly flows during July of all water year types and higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and

(4) equivalent or slightly lower monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of steelhead in Clear Creek, Alternative A would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

River Lamprey

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; and (3) during low flow conditions, higher monthly flow exceedance probabilities.
- Similar or improved spawning and embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for substantially higher mean monthly flows during July of all water year types and higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, generally higher monthly flow exceedance probabilities; and (4) similar monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for substantially higher mean monthly flows during July of all water year types and higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in Clear Creek, Alternative A would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Pacific Lamprey

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; and (3) during low flow conditions, higher monthly flow exceedance probabilities.
- Similar or improved spawning and embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for substantially higher mean monthly flows during July of all water year types and higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and

(4) similar monthly probabilities of water temperatures occurring within the specified water temperature range.

- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for substantially higher mean monthly flows during July of all water year types and higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in Clear Creek, Alternative A would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Hardhead

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for substantially higher mean monthly flows during July of all water year types and higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar or slightly lower monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar or improved spawning and embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar monthly probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of hardhead in Clear Creek, Alternative A would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

California Roach

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for substantially higher mean monthly flows during July of all water year types and higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) equivalent monthly probabilities of water temperatures exceeding the specified water temperature index value.
- Similar or improved spawning conditions due to modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type, except for higher mean monthly flows during most months of critical water year types; (2) slightly higher monthly flow exceedance

probabilities; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar monthly probabilities of water temperatures exceeding the specified water temperature index value.

In conclusion, in consideration of potential impacts to all life stages of California roach in Clear Creek, Alternative A would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Lake Oroville

Coldwater Fish Species

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage during most of the evaluation period, higher average monthly storage by water year type occurring during below normal, dry and critical water years, and slightly lower average monthly storage occurring during wet and above normal water years; (2) equivalent or slightly higher and lower monthly storage exceedance probabilities occurring with similar monthly frequencies during the evaluation period; and (3) similar or slightly higher probabilities of storage exceedances of 10 percent or more.

In conclusion, in consideration of potential impacts to coldwater fish species in Lake Oroville, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar warmwater fish spawning and early life stage conditions, because of slightly increased and decreased frequencies of monthly water surface elevation reductions of six feet or more occurring with similar frequencies.

In conclusion, in consideration of potential impacts to warmwater fish species in Lake Oroville, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Feather River

Flows in the Low Flow Channel below the Fish Barrier Dam were modeled consistent with the terms of the FERC Settlement Agreement. As shown in Appendix 12F, modeled results for long-term average flows, average flows by water year type, and flow exceedance probabilities of 10 percent or more during all years and during low flow conditions were equivalent for Alternative A, relative to Existing Conditions. Although these results are not repeated for the discussions below, the model results for the Low Flow Channel below the Fish Barrier Dam were considered along with the information presented below and were incorporated into the impact determinations for the following species: spring-run Chinook salmon, fall-run Chinook salmon, steelhead, green sturgeon, white sturgeon, river lamprey, Pacific lamprey, hardhead, and California roach.

Spring-run Chinook Salmon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) higher and lower long-term average monthly flows occurring with similar monthly frequency during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or slightly higher average monthly flows by water year type occurring more often than lower average monthly flows during wet, above normal, and below normal water year types, lower average monthly flows during dry water year types, and higher and lower average monthly flows by water year type occurring with similar frequency during critical water year types the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) higher monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although significantly lower probabilities of exceedance occur during October; (3) during low flow conditions, significantly higher monthly flow exceedance probabilities during June through September, and higher and lower monthly flow exceedance probabilities occurring with similar frequencies during the remainder of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values at all Feather River locations evaluated.
- Improved spawning conditions due to modeling results indicating greater spawning habitat availability during most of the adult spawning period, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures during most of the evaluation period.
- Improved embryo incubation conditions due to modeling results indicating reduced total annual long-term average early life stage mortality, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures during most of the evaluation period.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet, and similar or higher average monthly flows by water year type occurring more often than lower average monthly flows during wet, above normal, and below normal water year types below the Thermalito Afterbay outlet, and equivalent or lower average monthly flows during dry and critical water year types below the Thermalito Afterbay outlet; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet, although higher probabilities of exceedance occur during June through September; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet, although significantly higher flows occur during June through September; and (4) equivalent or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values occurring during most of the evaluation period at all Feather River locations evaluated.
- Similar or less suitable smolt emigration conditions, because of modeling results indicating: (1) lower long-term average monthly flows occurring during most of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and lower average monthly flows by water year type occurring more often than higher average monthly flows during all water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except for below

normal water year types when average monthly flows would be higher; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although significantly higher probabilities of exceedance would occur during June; (3) during low flow conditions, similar or lower monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although significantly higher probabilities of exceedance would occur during June; and (4) equivalent, or slightly lower monthly probabilities of exceeding specified water temperature index values during most of the evaluation period at the mouth of the Feather River, and equivalent or slightly higher monthly probabilities of exceeding specified water temperature index values during most of the evaluation period at the mouth of the Feather River.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Feather River, Alternative A would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

Fall-run Chinook Salmon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) higher and lower long-term average monthly flows occurring with similar monthly frequency during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type occurring with similar monthly frequency during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except for below normal water year types when average monthly flows would be lower more often than higher at the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) lower monthly flow exceedance probabilities occurring during October through December below the Thermalito Afterbay outlet and at the mouth of the Feather River, with higher probabilities of exceedance during July through September; (3) during low flow conditions, lower monthly flow exceedance probabilities during October through December and higher monthly flow exceedance probabilities during July through September below the Thermalito Afterbay outlet, and similar or higher monthly flow exceedance probabilities occurring more often at the mouth of the Feather River; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values, with slightly lower monthly probabilities of exceedance during August and September, and slightly higher probabilities during July and October.

- Improved spawning conditions due to modeling results indicating higher spawning habitat availability during the entire adult spawning period, and equivalent or slightly lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, during most of the evaluation period.

- Similar or improved embryo incubation conditions due to modeling results indicating reduced total annual long-term average early life stage mortality, and equivalent or slightly lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures during most of the evaluation period.

- Similar or less suitable juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows occurring during most months of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and equivalent or higher average monthly flows by water year type occurring more often than lower average monthly flows during wet, above normal, dry and critical water year types below the Thermalito Afterbay outlet, lower average monthly flows during below normal water year types below the Thermalito Afterbay outlet, equivalent or higher average monthly flows by water year type occurring more often than lower average monthly flows during above normal, below normal and critical water year types at the mouth of the Feather River, higher average monthly flows during wet and dry water year types at the mouth of the Feather River; (2) lower monthly flow exceedance probabilities during most months below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance would occur during June; (3) under low flow conditions, lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance generally would occur during June; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Feather River, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Steelhead

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and lower average monthly flows by water year type occurring during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance would occur during August and September; (3) during low flow conditions, lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) equivalent or lower monthly probabilities of exceeding specified water temperature index values during most of the evaluation period at all Feather River locations evaluated.

- Improved spawning conditions due to modeling results indicating higher spawning habitat availability during the entire adult spawning period, and equivalent or slightly lower probabilities of exceeding specified water temperature index values during most of the evaluation period at all Feather River locations evaluated.

- Similar or improved embryo incubation conditions due to modeling results indicating: (1) lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet, and lower average monthly flows by water year type occurring during most water year types below the Thermalito Afterbay outlet; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet; (3) during low flow conditions, lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet; and (4) equivalent or slightly lower monthly probabilities of exceeding specified water temperature index values occurring more often during most of the evaluation period at all Feather River locations evaluated.

- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet, and higher average monthly flows by water year type occurring during most water year types below the Thermalito Afterbay outlet, except for dry and critical water year types when average monthly flows would be generally lower more often below the Thermalito Afterbay outlet; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet, although higher flows generally would occur during June through September; (3) under low flow conditions, generally lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet, although higher flows occur during June through September; and (4) generally equivalent or similar monthly probabilities of exceeding specified water temperature index values at all Feather River locations evaluated.
- Generally similar smolt emigration conditions due to: (1) generally lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and generally lower average monthly flows by water year type occurring during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except for below normal water year types when average monthly flows would be higher more often; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) under low flow conditions, lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) equivalent or lower monthly probabilities of exceeding specified water temperature index values occurring more often during the evaluation period at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the Feather River, Alternative A would result in similar or less-than-significant impacts, relative to Existing Conditions.

Green Sturgeon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or less suitable adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly flows occurring more often during the evaluation period at Shanghai Bend and at the mouth of the Feather River, and higher average monthly flows by water year type occurring during most water year types at Shanghai Bend and at the mouth of the Feather River, except for dry and critical water year types when average monthly flows would be lower more often; (2) similar or lower monthly flow exceedance probabilities occurring more often at Shanghai Bend and at the mouth of the Feather River, except during the June through September period when monthly flows would be higher at all locations; (3) during low flow conditions, similar or slightly lower monthly flow exceedance probabilities at Shanghai Bend and at the mouth of the Feather River, except during the June through September period when monthly flows would be higher at all locations; and (4) similar or equivalent monthly probabilities of exceeding specified water temperature index values during most of the evaluation period at all Feather River Locations evaluated.
- Similar adult spawning and embryo incubation conditions because of modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period below the

Thermalito Afterbay outlet, and higher average monthly flows by water year type during most water year types below the Thermalito Afterbay outlet, except during dry and critical water year types when lower average monthly flows would occur; (2) higher monthly flow exceedance probabilities more often below the Thermalito Afterbay outlet; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet; and (4) similar or slightly higher and lower monthly probabilities of exceeding specified water temperature index values below the Thermalito Afterbay.

- Similar or less suitable juvenile rearing conditions due to modeling results indicating: (1) lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher average monthly flows by water year type occurring during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except for dry and critical water year types when average monthly flows would be lower more often below the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during the June through September period when monthly flows would be higher; (3) under low flow conditions, lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during the June through September period when monthly flows would be higher; and (4) similar monthly probabilities of exceeding specified water temperature index values below the Thermalito Afterbay outlet and at the mouth of the Feather River.
- Improved juvenile emigration conditions due to modeling results indicating: (1) higher long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet, at Shanghai Bend, and at the mouth of the Feather River, and higher average monthly flows by water year type occurring during all water year types below the Thermalito Afterbay outlet, at Shanghai Bend, and at the mouth of the Feather River; (2) higher monthly flow exceedance probabilities during most months below the Thermalito Afterbay outlet, at Shanghai Bend, and at the mouth of the Feather River, except during May when flows would be lower; (3) under low flow conditions, higher monthly flow exceedance probabilities occurring nearly all months below the Thermalito Afterbay outlet, at Shanghai Bend, and at the mouth of the Feather River, except during May when flows would be lower; and (4) similar monthly probabilities of exceeding specified water temperature index values occurring below the Thermalito Afterbay outlet and at the mouth of the Feather River.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Feather River, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

White Sturgeon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or less suitable adult immigration and holding conditions, because of: (1) lower long-term average monthly flows and average monthly flows by water year type during the evaluation period at Shanghai Bend and at the mouth of the Feather River, except during below normal water years when flows would be slightly higher; (2) lower monthly flow exceedance probabilities during most of the evaluation period at all locations evaluated; (3) during low flow conditions, similar or lower flow exceedance probabilities during the evaluation period at all locations evaluated; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.

- Similar or slightly less suitable adult spawning and egg incubation conditions because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period at Shanghai Bend and at the mouth of the Feather River, and higher and lower average monthly flows by water year type occurring with similar frequency during most water year types at Shanghai Bend and at the mouth of the Feather River, except during below normal water year types when higher average monthly flows would occur during all months, and during dry water year types when lower average monthly flows would occur during all months; (2) similar or slightly lower monthly flow exceedance probabilities during most of the evaluation period at Shanghai Bend and at the mouth of the Feather River; (3) during low flow conditions, similar or slightly lower monthly flow exceedance probabilities during most of the evaluation period at Shanghai Bend and at the mouth of the Feather River; and (4) similar monthly probabilities of exceeding specified water temperature index values during the evaluation period at all locations evaluated.
- Similar or less suitable juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period at Shanghai Bend and at the mouth of the Feather River, and similar or lower average monthly flows by water year type occurring with similar frequency during most water year types at Shanghai Bend and at the mouth of the Feather River, except during below normal water year types when higher average monthly flows would occur more often than lower average monthly flows; (2) lower monthly flow exceedance probabilities during October through May at Shanghai Bend and at the mouth of the Feather River, and higher monthly flow exceedance probabilities during June through September both locations; (3) during low flow conditions, lower monthly flow exceedance probabilities during October through May at Shanghai Bend and at the mouth of the Feather River, and higher monthly flow exceedance probabilities during June through September; and (4) similar monthly probabilities of exceeding specified water temperature index values during most months at all locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Feather River, Alternative A would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

River Lamprey

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or less suitable adult immigration conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly flows by water year type during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during below normal water year types when higher average monthly flows would occur; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during June and September when higher monthly flow exceedance probabilities would occur; and (3) during low flow conditions, lower monthly flow exceedance probabilities occurring with similar monthly frequencies at all locations evaluated, except during June and September months when higher monthly flow exceedance probabilities would occur.

- Similar or less suitable spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average monthly flows below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher average monthly flows by water year type during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during dry and critical water year types when lower monthly flows would occur; (2) lower monthly flow exceedance probabilities occurring with similar monthly frequencies below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during June and July when higher monthly flow exceedance probabilities would occur; (3) during low flow conditions, lower monthly flow exceedance probabilities occurring with similar frequency below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during June and July when higher monthly flow exceedance probabilities would occur; and (4) equivalent and lower probabilities of water temperatures occurring within the specified water temperature range at all Feather River locations evaluated.
- Similar ammocoete rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows occurring during the evaluation period at all Feather River locations evaluated, and similar or higher average monthly flows by water year type occurring with similar frequency during most water year types at all Feather River locations evaluated, except during dry and critical water year types when lower average monthly flows would occur more often than higher average monthly flows; (2) lower monthly flow exceedance probabilities occurring during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September at all Feather River locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September at all Feather River locations evaluated; and (4) similar probabilities of exceeding specified water temperatures at all Feather River locations evaluated, except during June through September when probabilities of exceeding specified water temperatures would be slightly lower.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the Feather River, Alternative A would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Pacific Lamprey

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or less suitable adult immigration conditions, because of modeling results indicating: (1) lower long-term average monthly flows occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher average monthly flows by water year type during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during dry water year types when higher average monthly flows would occur; (2) lower monthly flow exceedance probabilities during most of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during June when higher monthly flow exceedance probabilities would occur; and (3) during low flow conditions, lower monthly flow exceedance probabilities during most of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during June when higher monthly flow exceedance probabilities would occur.

- Similar or less suitable spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average monthly flows below the Thermalito Afterbay outlet, and at the mouth of the Feather River, and higher average monthly flows by water year type monthly flows during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during dry and critical water year types when lower monthly flows would occur; (2) lower monthly flow exceedance probabilities during most of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during June through August when higher monthly flow exceedance probabilities would occur; and (3) during low flow conditions, equivalent monthly flow exceedance probabilities during most of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during June through August when higher monthly flow exceedance probabilities would occur; and (4) equivalent or lower probabilities of water temperatures occurring within the specified water temperature range at all Feather River locations evaluated.
- Similar ammocoete rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period at all Feather River locations evaluated, and similar or higher average monthly flows by water year type occurring with similar frequency during most water year types at all Feather River locations evaluated, except during dry and critical water year types when lower average monthly flows would occur more often than higher average monthly flows; (2) lower monthly flow exceedance probabilities occurring during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September at all Feather River locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September; and (4) equivalent or slightly lower probabilities of exceeding specified water temperatures at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Feather River, Alternative A would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Hardhead

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or less suitable adult and juvenile life stage conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period at all Feather River locations evaluated, and similar or higher average monthly flows by water year type occurring with similar frequency during most water year types at all Feather River locations evaluated, except during dry and critical water year types when lower average monthly flows would occur more often than higher average monthly flows; (2) lower monthly flow exceedance probabilities during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September; (3) lower monthly flow exceedance probabilities during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September at all Feather River locations evaluated; and (4) equivalent or slightly lower probabilities of water temperatures remaining within the specified water temperature range during the evaluation period at all Feather River locations evaluated.

- Similar or less suitable adult spawning conditions, because of modeling results indicating: (1) lower long-term average monthly flows during April and May and higher long-term monthly flows during June at all Feather River locations evaluated, and higher average monthly flows by water year type during most water year types, except during dry and critical water year types; (2) lower monthly flow exceedance probabilities flows during April and May and higher monthly flow exceedance probabilities during June at all Feather River locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities flows during April and May, and higher monthly flow exceedance probabilities during June at all Feather River locations evaluated; and (4) similar or slightly lower probabilities of water temperatures occurring within the specified water temperature range at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the Feather River, Alternative A would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

California Roach

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar adult and other life stage conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period at all Feather River locations evaluated, and similar or higher average monthly flows by water year type occurring with similar frequency during most water year types at all Feather River locations evaluated, except during dry and critical water year types when lower average monthly flows would occur more often than higher average monthly flows; (2) lower monthly flow exceedance probabilities during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September; (3) during low flow conditions, lower monthly flow exceedance probabilities during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September; and (4) equivalent probabilities of exceeding specified water temperatures during all months of the evaluation period at all Feather River locations evaluated.
- Similar adult spawning conditions, because of modeling results indicating: (1) lower long-term average monthly flows during March through May, with higher long-term average monthly flows during June at all Feather River locations evaluated, and higher average monthly flows by water year type during most water year types, except during dry and critical water year types; (2) similar or slightly lower monthly flow exceedance probabilities flows during March through May, and higher monthly flow exceedance probabilities during June at all Feather River locations evaluated; (3) during low flow conditions, similar or slightly lower monthly flow exceedance probabilities flows during March through May, and higher monthly flow exceedance probabilities during June at all Feather River locations evaluated; and (4) similar probabilities of exceeding specified water temperatures during the evaluation period at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of California roach in the Feather River, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Splittail

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or less suitable spawning conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows, and higher and lower average monthly flows by water year type occurring with similar frequency during most water year types at the mouth of the Feather River, except during dry water year types when lower average monthly flows would occur during all months; (2) lower monthly flow exceedance probabilities during most of the evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities during February through May at the mouth of the Feather River; (4) lower usable flooded area (UFA) exceedance probabilities of 10 percent or more; and (5) equivalent monthly probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of splittail in the Feather River, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Striped Bass

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Less suitable adult spawning and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly flows during April and May months and higher long-term monthly flows during June at all Feather River locations evaluated, and higher average monthly flows by water year type during most water year types, except during dry and critical water year types; (2) lower monthly flow exceedance probabilities flows during April and May and higher monthly flow exceedance probabilities during June at all Feather River locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities flows during April and May and higher monthly flow exceedance probabilities during June at all Feather River locations evaluated; and (4) lower monthly probabilities of water temperatures occurring within the specified water temperature range at all Feather River locations evaluated.
- Similar or less suitable larvae, fry, and juvenile rearing emigration conditions, because of modeling results indicating: (1) lower long-term average monthly flows during the evaluation period at all Feather River locations evaluated, and similar or higher average monthly flows by water year type occurring with similar frequency during most water year types at all Feather River locations evaluated, except during dry and critical water year types when lower average monthly flows would occur more often than higher average monthly flows; (2) lower monthly flow exceedance probabilities during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September at all Feather River locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September at all Feather River locations evaluated; and (4) similar or slightly higher probability of water temperatures occurring within the specified water temperature range with similar frequencies below the Thermalito Afterbay outlet and at the mouth of the Feather River.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the Feather River, Alternative A would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

American Shad

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or less suitable adult spawning and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly flows during April and May months and higher long-term monthly flows during June at all Feather River locations evaluated, and higher average monthly flows by water year type during most months and water year types, except during dry and critical water year types; (2) higher monthly flow exceedance probabilities during June at all Feather River locations evaluated and lower monthly flow exceedance probabilities flows during April and May; (3) during low flow conditions, higher monthly flow exceedance probabilities during June and lower monthly flow exceedance probabilities flows during April and May at all Feather River locations evaluated; and (4) higher probability of water temperatures occurring within the specified water temperature range more often at all Feather River locations evaluated.
- Similar or slightly improved larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) similar or higher long-term average and average monthly flows by water year type occurring with similar frequency during most water year types during the evaluation period at all Feather River locations evaluated, except during below normal and critical water year types when similar and slightly lower average monthly flows by water year type would occur more often than higher average monthly flows; (2) higher monthly flow exceedance probabilities during June through September at all Feather River locations evaluated and lower monthly flow exceedance probabilities during October and November at all Feather River locations evaluated; (3) during low flow conditions, higher monthly flow exceedance probabilities during June through September at all Feather River locations evaluated and lower monthly flow exceedance probabilities during October and November at all Feather River locations evaluated; and (4) similar probabilities of water temperatures occurring within the specified water temperature range at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of American shad in the Feather River, Alternative A would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Largemouth Bass

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly flows occurring during the evaluation period at all Feather River locations evaluated, and generally similar or higher average monthly flows by water year type occurring with similar frequency during most water year types at all Feather River locations evaluated, except during dry and critical water year types when lower average monthly flows would occur more often than higher average monthly flows; (2) lower monthly flow exceedance probabilities during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September; and (3) during low flow conditions, lower monthly flow exceedance probabilities during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September.
- Similar spawning conditions, because of similar monthly probabilities of water temperatures occurring within the specified water temperature range for all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the Feather River, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Sutter Bypass

Modeling results for spills at Ord Ferry and Moulton, Colusa and Tisdale weirs for Alternative A relative to Existing Conditions indicate the following:

Ord Ferry Spill

Ord Ferry spill exceedance probabilities would be equivalent over the entire monthly distributions during May through November and would be equivalent over most of the distributions during December through April, but would be higher by 10 percent or more slightly more often during December, would be lower by 10 percent or more during January through March more often.

Moulton Weir Spill

Moulton Weir spill exceedance probabilities would be equivalent over the entire monthly distributions during May through November and would be equivalent over most of the distributions during December through April, but would be higher by 10 percent or more during December more often, would be lower by 10 percent or more during January through March more often and would be generally similar or lower slightly more often during April.

Colusa Weir Spill

Colusa Weir spill exceedance probabilities would be equivalent over almost the entire monthly distributions during May through November and would be equivalent or similar over most of the distributions during December through April, but would be generally higher and lower by 10 percent or more with similar frequencies during December and would be lower by 10 percent or more during January through April more often.

Tisdale Weir Spill

Tisdale Weir spill exceedance probabilities would be equivalent over almost the entire monthly distributions during May through October and would be equivalent or similar over most of the distributions during November through April, but would be generally higher and lower by 10 percent or more with similar monthly frequencies or would be lower more often during November, would be lower by 10 percent or more during January through March more often, and would be higher and lower by 10 percent or more with similar frequencies or would be higher more often during December.

Fish Species of Primary Management Concern

There are no modeling products available to simulate flow magnitudes or flooded area in the Sutter Bypass. The relationships and interactions of the various hydrologic inputs into the Sutter Bypass and the resulting flow and flooded area in the Sutter Bypass are not quantifiable. Because spills into the Sutter Bypass from the Sacramento River only represent some of the hydrologic inputs to the lower Sutter Bypass and because the proportions of each input are not known, potential changes to fisheries habitat conditions in the Sutter Bypass associated with simulated changes in spills from the Sacramento River are not known. Moreover, it is not anticipated that the changes in spill exceedance probabilities discussed above would have a substantial impact on fisheries and aquatic resources in the Sutter Bypass.

Folsom Lake

Coldwater Fish Species

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Equivalent or improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage, and higher average monthly storage by water year type occurring more often during most months of the evaluation period; (2) equivalent or higher monthly storage exceedance probabilities during more than half of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during most months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Folsom Lake, Alternative A would result in beneficial and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Relative to Existing Conditions, Alternative A would be expected to provide:

- Slightly less suitable warmwater fish spawning and early life stage conditions, because of modeling results indicating slightly increased frequencies of monthly water surface elevation reductions of six feet or more during half of the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Folsom Lake, Alternative A would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

American River

Fall-run Chinook Salmon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Less suitable adult immigration and holding conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during all months of the evaluation period at all locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated, although significantly higher probabilities of exceedance occur during September; and (4) equivalent or higher monthly probabilities of exceeding specified water temperature index values.
- Less suitable spawning conditions due to modeling results indicating lower spawning habitat availability during October and December, and higher monthly probabilities of exceeding specified water temperature index values.
- Less suitable embryo incubation conditions due to modeling results indicating higher total annual early life stage mortality, and similar or slightly higher monthly probabilities of exceeding specified water temperature index values.
- Similar or less suitable juvenile rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows, and lower average monthly flows by water year type

during the evaluation period at all locations evaluated; (2) equivalent or similar monthly flow exceedance probabilities during most months of the evaluation period; (3) during low flow conditions, similar monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values, particularly during May and June.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the American River, Alternative A would result in potentially adverse and potentially significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative A (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative A would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative A.

Spring-run Chinook Salmon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or less suitable non-natal juvenile rearing conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types; (2) equivalent or lower monthly flow exceedance probabilities during all months of the evaluation period; (3) during low flow conditions, equivalent or lower monthly flow exceedance probabilities during the evaluation period, with significantly lower probabilities of exceedance during November, December, and March; and (4) similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the American River, Alternative A would result in similar or less suitable but less-than-significant impacts, relative to Existing Conditions.

Steelhead

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Less suitable adult immigration and holding conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all evaluated locations; (2) lower monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated, with the exception of April, when probabilities of exceedance would be equivalent or higher; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, although higher flows would occur during February at Watt Avenue, and equivalent or higher flows would occur during April at all evaluated locations; and (4) similar monthly probabilities of exceeding specified water temperature index values.
- Similar spawning conditions due to similar spawning habitat availability and similar monthly probabilities of exceeding specified water temperature index values.
- Similar embryo incubation conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type

during most water year types; (2) lower monthly flow exceedance probabilities during most months of the evaluation period, although slightly higher probabilities of exceedance would occur during April and May; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period, with substantially higher flows during May, although substantially lower flows would occur during January and March; and (4) similar monthly probabilities of exceeding specified water temperature index values.

- Less suitable juvenile rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during April and May; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during some months at the evaluated locations, particularly during April, May, and September; and (4) similar or higher monthly probabilities of exceeding specified water temperature index values.
- Similar or less suitable smolt emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probabilities during most of the evaluation period, although slightly higher probabilities of exceedance would occur during April and May; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, with higher probabilities of exceedance during April and May; and (4) similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the American River, Alternative A would result in potentially adverse and potentially significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative A (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative A would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative A.

Green Sturgeon

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Less suitable adult immigration and holding conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) equivalent or lower monthly flow exceedance probabilities, with significantly lower flows during most of the evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, although significantly higher probabilities of exceedance would occur during May and September; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values.

- Less suitable spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) equivalent or lower monthly flow exceedance probabilities; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during May; and (4) higher monthly probabilities of exceeding specified water temperature index values.
- Less suitable juvenile rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probabilities during most of the evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, although significantly higher probabilities of exceedance would occur during May and September; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values at all locations evaluated more often.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in American River, Alternative A would result in potentially adverse and potentially significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative A (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative A would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative A.

River Lamprey

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Less suitable adult immigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during April and May; and (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during some months at the evaluated locations, particularly during April, May, and September.
- Similar or less suitable spawning and egg incubation conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during April and May; (3) during low flow conditions, substantially lower monthly flow exceedance probabilities during approximately half of the evaluation period and higher probabilities of exceedance during approximately half of the evaluation period; and (4) similar or slightly lower probabilities of remaining within specified water temperature ranges.

- Less suitable ammocoete rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during April and May; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during some months at the evaluated locations, particularly during April, May, and September; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the American River, Alternative A would result in potentially adverse and potentially significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative A (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative A would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative A.

Pacific Lamprey

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Less suitable adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during April and May; and (3) during low flow conditions, substantially lower monthly flow exceedance probabilities during most months of the evaluation period, although slightly higher probabilities of exceedance would occur during April and May.
- Less suitable spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during April and May; (3) during low flow conditions, substantially lower monthly flow exceedance probabilities during most months of the evaluation period, although slightly higher probabilities of exceedance would occur during April and May; and (4) similar or slightly lower probabilities of occurring within specified water temperature ranges.
- Less suitable ammocoete rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during April and May; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during some months at the evaluated locations, particularly

during April, May, and September; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the American River, Alternative A would result in potentially adverse and potentially significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative A (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative A would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative A.

Hardhead

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or less suitable adult and other life stage conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during April and May; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during February, April, May, and September; and (4) similar or slightly higher probabilities of occurring within specified water temperature ranges.
- Similar or improved spawning conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) higher monthly flow exceedance probabilities during April and May, with significantly lower probabilities of exceedance during June; (3) during low flow conditions, lower monthly flow exceedance probabilities during April and May, with lower probabilities of exceedance during June; and (4) similar or slightly higher probabilities of occurring within specified water temperature ranges.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the American River, Alternative A would result in generally similar and less-than-significant impacts, relative to Existing Conditions.

California Roach

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or less suitable adult and other life stage conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during April and May; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during February, April, May, and September; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.

- Similar or improved spawning conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, similar monthly flow exceedance probabilities during the evaluation period; and (4) lower monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of California roach in the American River, Alternative A would result in generally similar and less-than-significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative A (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative A would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative A.

Splittail

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or less suitable spawning conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) equivalent or lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities during February and March, and equivalent or higher monthly flow exceedance probabilities during April and May; (4) lower usable flooded area (UFA) exceedance probabilities of 10 percent or more; and (5) equivalent probabilities of remaining within specified water temperature ranges.

In conclusion, in consideration of potential impacts to all life stages of splittail in the American River, Alternative A would result in generally similar or less suitable and less-than-significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative A (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative A would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative A.

Striped Bass

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar adult spawning, embryo incubation, and initial rearing conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) similar monthly flow exceedance probabilities during April and May, although substantially lower monthly flow exceedance probabilities would occur during June; (3) during low flow conditions, higher monthly flow exceedance probabilities during April and May, although substantially lower flows would occur during June at the evaluated locations; and (4) similar probabilities of remaining within the specified water temperature range during the evaluation period.

- Less suitable larvae, fry, and juvenile rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities during the entire evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during June through August and October through January; and (4) similar probabilities of remaining within the specified water temperature range throughout the year, with a slightly higher probability of the temperatures occurring within the specified range during September, October, and May, and slightly lower probabilities during April, and June through August.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the American River, Alternative A would result in potentially adverse and potentially significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative A (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative A would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative A.

American Shad

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar adult spawning, embryo incubation, and initial rearing conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) similar monthly flow exceedance probabilities during April and May, although substantially lower monthly flow exceedance probabilities would occur during June; (3) during low flow conditions, higher monthly flow exceedance probabilities during April and May, although substantially lower flows would occur during June at the evaluated locations; and (4) similar probabilities of remaining within the specified water temperature range during the evaluation period.
- Less suitable larvae, fry, and juvenile rearing and emigration conditions due to: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probability during all months of the evaluation period at all locations; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, although substantially higher probabilities of exceedance would occur during September; and (4) similar or slightly higher probabilities of remaining within the specified water temperature range during the evaluation period.

In conclusion, in consideration of potential impacts to all life stages of American shad in the American River, Alternative A would result in potentially adverse and potentially significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative A (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative A would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative A.

Largemouth Bass

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Less suitable adult and other life stage conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during April and May; and (3) during low flow conditions, substantially lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during February, April, May, and September.
- Similar spawning conditions due to equivalent or slightly higher probabilities of remaining within specified water temperature ranges.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the American River, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Sacramento-San Joaquin Delta and Yolo Bypass

Delta Smelt in the Delta Region

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar adult conditions, because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range (December through May); (2) similar normalized mean monthly salvage at the SWP and CVP export facilities (December through April); and (3) similar or slightly higher monthly probabilities of OMR flows being more negative than -5,000 cfs (December through February)
- Less suitable spawning conditions in the Yolo Bypass (December through May), because of modeling results indicating: (1) lower long-term average Yolo Bypass flows; (2) similar or lower Yolo Bypass flow exceedance probabilities; and (3) during low flow conditions, lower flow exceedance probabilities (of 10 percent or more) during December and higher flow exceedance probabilities during February and March, albeit similar simulated flows throughout the period
- Similar egg and embryo conditions (February through May), because of modeling results indicating similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range
- Similar larvae conditions (March through June), because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range; (2) during March through June of dry and critical water years, slightly higher (less negative) mean monthly OMR flows when flows would be equal to or more negative than -1,500 cfs; and (3) during the latter portion of the larval delta smelt downstream migration period (i.e., May and June), long-term average and average by water year type monthly Delta outflow is slightly decreased

during May but is slightly increased during June, while monthly Delta outflow exceedance probabilities would be lower more often during May, but would be higher more often during June.

- Similar or improved juvenile conditions (May through July), because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range; (2) slightly higher overall normalized mean monthly salvage at the SWP export facility and similar normalized mean monthly salvage at the CVP export facility; (3) between RKm 65 and 80, long-term average and average by water year type X2 location would move slightly upstream during May (by less than 0.5 RKm), move slightly downstream during June (by less than 0.5 RKm), and move downstream during July (by 1.1, 1.6 and 1.9 RKm during wet, above normal, and below normal water years, respectively); and (4) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to all life stages of delta smelt in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Longfin Smelt in the Delta Region

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar adult conditions because of modeling results indicating slightly higher (during December through February) and slightly lower (during March) monthly probabilities of OMR flows being more negative than -5,000 cfs during December through March
- Similar larvae and juvenile conditions because of modeling results indicating: (1) slightly higher (during December) and equivalent (during January through March) monthly probabilities of OMR flows being more negative than -5,000 cfs during December through March; (2) during April and May of dry and critical water years, mean monthly OMR flows would be lower during April of dry and critical water years (by 14.2 and 2.5 percent, respectively) and would be higher during May of dry and critical water years (by 2.4 and 1.5 percent, respectively); (3) similar overall mean monthly salvage at the SWP and CVP export facilities; (4) slightly lower (during January through May) and higher (during June) monthly exceedance probabilities of X2 location occurring at or downstream of 75 RKm during January through June; and (5) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to all life stages of longfin smelt in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Splittail in the Delta Region

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Less suitable egg and larval conditions (February through May) because of modeling results indicating: (1) slightly reduced mean monthly Yolo Bypass outflow during most months of wet water years and reduced mean monthly flows during February through April of above normal and below normal water years, during February and March of dry water years and during March of critical water years, with mean monthly reductions of 10 percent or more during March of above normal water years, February and March of below normal water years, and during March of dry and critical water years; and (2) lower flow exceedance probabilities (of 10 percent or more) more often during February and March, and similar flow exceedance probabilities during April and May

- Similar juvenile rearing and emigration conditions (April through July) because of modeling results indicating: (1) similar mean monthly Yolo Bypass outflow during all water year types; (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; (3) similar flow exceedance probabilities (of 10 percent or more); and (4) slightly higher overall simulated mean monthly salvage at the SWP and CVP export facilities during April through July
- Less suitable adult spawning and upstream migration conditions, because of modeling results indicating: (1) reduced mean monthly Yolo Bypass outflow during February and March, as discussed above for egg and larval conditions; and (2) similar overall simulated mean monthly salvage at the SWP and CVP export facilities during December through March

In conclusion, in consideration of potential impacts to all life stages of splittail in the Delta Region including the Yolo Bypass, Alternative A would result in less suitable and potentially significant impacts, relative to Existing Conditions. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources*)* is anticipated to reduce these impacts to less than significant levels.

Winter-run Chinook Salmon in the Delta Region

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or improved juvenile conditions, because of modeling results indicating: (1) higher monthly Delta survival exceedance probabilities more often; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile winter-run Chinook salmon in the Delta, Alternative A would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Spring-run Chinook Salmon in the Delta Region

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or improved juvenile conditions, because of modeling results indicating: (1) higher monthly Delta survival exceedance probabilities more often; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile spring-run Chinook salmon in the Delta, Alternative A would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Fall-run and Late Fall-run Chinook Salmon in the Delta Region

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar San Joaquin River adult straying conditions because of modeling results indicating similar or slightly higher monthly probabilities of OMR flows being more negative than -5,000 cfs during December through February
- Similar or improved juvenile conditions because of modeling results indicating: (1) higher monthly Delta survival exceedance probabilities more often; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile and San Joaquin River adult fall and late fall-run Chinook salmon in the Delta, Alternative A would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Steelhead in the Delta Region

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar juvenile rearing and emigration conditions in the Delta (October through July) because of modeling results indicating: (1) higher long-term average and average by water year type monthly flows at Rio Vista during October, November, June and July, and lower average monthly flows during December through May; (2) lower mean monthly Yolo Bypass outflow and lower or similar flow exceedance probabilities; (3) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; (4) higher monthly flow exceedance probabilities at Rio Vista during October through December, June and July, and lower flow exceedance probabilities during January through May, with higher flow exceedance probabilities during all months except for during March during low flow conditions; (5) generally lower long-term average and average by water year type monthly Delta outflow during most months of most water year types, but with higher Delta outflow during June and July of all water year types, during October and November of below normal water years, during October of dry water years and during October and December of critical water years; (6) lower or similar long-term average and average by water year type monthly OMR flows; and (7) similar overall simulated mean monthly salvage at the SWP and CVP export facilities, but with higher mean monthly salvage during critical water years at the SWP export facility

In conclusion, in consideration of potential impacts to all life stages of Central Valley steelhead in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions. Alternative A impacts on steelhead in the Yolo Bypass are considered potentially significant, relative to Existing Conditions. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Green Sturgeon in the Delta Region

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar or less suitable juvenile rearing and emigration conditions (year-round) because of modeling results indicating: (1) lower mean monthly Yolo Bypass outflow and lower flow exceedance probabilities; (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; and (3) similar simulated mean monthly salvage at the SWP and CVP export facilities

In conclusion, in consideration of potential impacts to green sturgeon in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions. Alternative A impacts on green sturgeon in the Yolo Bypass are considered potentially significant, relative to Existing Conditions. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

White Sturgeon in the Delta Region

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar juvenile rearing and emigration conditions (year-round) because of modeling results indicating: (1) lower mean monthly Yolo Bypass outflow and lower flow exceedance probabilities; (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; and (3) similar simulated mean monthly salvage at the SWP and CVP export facilities

In conclusion, in consideration of potential impacts to white sturgeon in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions. Alternative A impacts on white sturgeon in the Yolo Bypass are considered potentially significant, relative to Existing Conditions. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Pacific and River Lamprey in the Delta Region

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar macropthalmia emigration conditions (year-round) because of modeling results indicating generally similar simulated mean monthly salvage at the SWP and CVP export facilities, but with slightly higher mean monthly salvage during critical water years at both facilities

In conclusion, in consideration of potential impacts to Pacific and river lamprey in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

American Shad in the Delta Region

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar egg and larval conditions in the Delta because of modeling results indicating: (1) slightly lower (during April and May) and slightly higher (during June) exceedance probabilities of X2 location being located at or downstream of 75 RKm during April through June; (2) slightly higher overall mean monthly salvage at the SWP and CVP export facilities; and (3) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to American shad in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Striped Bass in the Delta Region

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Similar egg and larval conditions in the Delta because of modeling results indicating: (1) slight upstream mean monthly movements in X2 location during April and May of all water year types and slight downstream mean monthly movements in X2 location during June of all water year types during April through June; (2) slightly higher normalized mean monthly salvage at the SWP export facility and similar normalized mean monthly salvage at the CVP export facility; and (3) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to striped bass in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to Existing Conditions.

Largemouth Bass in the Delta Region

Relative to Existing Conditions, Alternative A would generally be expected to provide:

- Less suitable juvenile rearing conditions in the Yolo Bypass because of modeling results indicating: (1) lower mean monthly Yolo Bypass outflow during most months, in addition to similar or lower flow exceedance probabilities (of 10 percent or more); and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta
- Similar juvenile and adult conditions in the Delta because of modeling results indicating: (1) upstream mean monthly movements in X2 location of 0.5 RKm or more during December and January of wet water years, during December through March of above normal water years, during January through April of below normal water years, during February through April of dry water years, and during February and March of critical water years, and downstream mean monthly movements in X2 location of 0.5 RKm or more during July and August of wet water years, during July through September of above normal water years, during June through December of below normal water years, during June through October of dry water years, and during July through October, December and January of critical water years; and (2) slightly higher simulated mean monthly salvage at the SWP export facility, and similar mean monthly salvage at the CVP export facility

In conclusion, in consideration of potential impacts to largemouth bass in the Delta, Alternative A would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions. Alternative A impacts on largemouth bass in the Yolo Bypass are considered potentially significant, relative to Existing Conditions. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

12C.4.3 Primary Study Area – Alternative A Relative to Existing Conditions

12C.4.3.1 Construction, Operation, and Maintenance Impacts

For a discussion of impacts to fisheries and aquatic resources under Alternative A relative to Existing Conditions in the Primary Study Area, refer to the Environmental Consequences section of Chapter 12 Aquatic Biological Resources.

12C.4.3.2 Ecosystem Enhancement Account – Operational Actions (Project-level Analysis – Alternatives A, B and C)

Potential impacts to fisheries and aquatic resources associated with the Operational Actions of the Ecosystem Enhancement Account are discussed in the Environmental Consequences section of Chapter 12 Aquatic Biological Resources.

12C.4.3.3 Ecosystem Enhancement Fund – Non-Operational Actions (Programmatic-level Analysis – Alternatives A, B and C)

Potential impacts to fisheries and aquatic resources associated with the Non-Operational Actions of the Ecosystem Enhancement Account are discussed in the Environmental Consequences section of Chapter 12 Aquatic Biological Resources.

12C.5 Impacts Associated with Alternative A Relative to the No Project/No Action Alternative

12C.5.1 Extended Study Area – Alternative A Relative to the No Project/No Action Alternative

12C.5.1.1 SWP and CVP Operations

Agricultural Water Use

Potential impacts to fisheries and aquatic resources associated with agricultural water use are discussed under Alternative A relative to Existing Conditions, above, and are applicable to Alternative A relative to the No Project/No Action Alternative.

Municipal and Industrial Water Use

Potential impacts to fisheries and aquatic resources associated with municipal and industrial water use are discussed under Alternative A relative to Existing Conditions, above, and are applicable to Alternative A relative to the No Project/No Action Alternative.

Wildlife Refuge Water Use

Potential impacts to fisheries and aquatic resources associated with wildlife refuge water use are discussed under Alternative A relative to Existing Conditions, above, and are applicable to Alternative A relative to the No Project/No Action Alternative.

San Luis Reservoir

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for San Luis Reservoir during April through November.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly and higher average monthly storage by water year type more often during October and November, and lower storage during June through August; (2) lower monthly storage exceedance probabilities occurring more often during the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during most months of the evaluation period, but lower storage exceedances (by 10 percent or more) during June and July.

In conclusion, in consideration of potential impacts to coldwater fish species in San Luis Reservoir, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for San Luis Reservoir during March through June.

Relative to the No Project/No Action Alternative, Alternative A would be expected to provide:

- Similar or less suitable warmwater fish spawning and early life stage conditions, because of modeling results indicating similar frequencies of monthly water surface elevation reductions of six feet or more during April through June and a higher frequency of water surface elevation reductions during March.

In conclusion, in consideration of potential impacts to warmwater fish species in San Luis Reservoir, Alternative A would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Export Service Area Reservoirs

Export Service Area Reservoir Fisheries

Changes in modeled total SWP and CVP Delta exports (Appendix 12H) under Alternative A relative to the No Project/No Action Alternative were analyzed to evaluate potential changes in storage and water surface elevations and associated impacts on fisheries in export service area reservoirs.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Equivalent or improved export service area reservoir fisheries habitat conditions, because of modeling results indicating: (1) long-term average and average monthly by water year type Delta exports would be generally slightly higher during most months of all water year types, and would be higher by 10 percent or more during September and October of wet water years, during November of above normal and dry water years, and during August, September, November and January of critical water years, and would be lower by 10 percent or more during December of critical water years; (2) higher monthly export exceedance probabilities during January, February and July through November, and lower export exceedance probabilities during March through June, and December; and (3) a net 10 percent or more export probability of exceedance increase during most months of the year.

In conclusion, in consideration of potential impacts to SWP and CVP export service area reservoir fisheries, Alternative A would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

12C.5.2 Secondary Study Area – Alternative A Relative to the No Project/No Action Alternative

12C.5.2.1 Construction, Operation, and Maintenance Impacts

Construction, operation, and maintenance impacts to fisheries and aquatic biological resources in the Secondary Study Area would be identical to those discussed under Alternative A relative to Existing Conditions, above.

12C.5.2.2 SWP and CVP Operations

Trinity Lake

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Trinity Lake during April through November.

Relative to the No Project/No Action Alternative, Alternative A would be expected to provide:

- Potentially improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage, and higher average monthly storage by water year type during all months of the evaluation period; (2) higher monthly storage exceedance probabilities during the all of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during all months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Trinity Lake, Alternative A would result in potentially beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Trinity Lake during March through June.

Relative to the No Project/No Action Alternative, Alternative A would be expected to provide:

- Similar or improved warmwater fish spawning and early life stage conditions, because of modeling results indicating similar or slightly reduced frequencies of monthly water surface elevation reductions of six feet or more.

In conclusion, in consideration of potential impacts to warmwater fish species in Trinity Lake, Alternative A would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Trinity River

Coho Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Equivalent or slightly improved adult immigration and holding conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be slightly lower more frequently; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar or lower (particularly during September and October), and therefore more suitable, average monthly probabilities of exceeding specified water temperature index values, except during January when probabilities of exceeding the lowest water temperature index values would be higher.

- Equivalent or slightly improved adult spawning and embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values, with lower probabilities, and therefore more suitable water temperatures, occurring slightly more frequently over the evaluation period, with the exception of January when probabilities of exceeding the lowest water temperature index values would be higher.

- Equivalent or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows over the entire year, and similar or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the year; and (4) equivalent or lower probabilities of exceeding specified water temperature index values throughout most of the year, particularly during August through October.
- Equivalent or slightly improved smolt emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values during the evaluation period.

In conclusion, in consideration of potential impacts to all life stages of Coho salmon in the Trinity River, Alternative A would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Spring-Run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Improved adult immigration and holding conditions due to: (1) equivalent or slightly higher long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be slightly higher more frequently; (2) equivalent or slightly higher monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar, or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values, particularly during July through September.
- Improved adult spawning and egg incubation conditions due to modeling results indicating: (1) equivalent or slightly higher long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during all water year types; (2) equivalent or slightly higher monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period;

and (4) lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, at most water temperature indices.

- Equivalent or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows over the entire year, and similar or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during July through September.
- Equivalent or slightly improved smolt emigration conditions due to: (1) similar long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during June and July.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Trinity River, Alternative A would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Fall-Run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork, in addition to model results for early life stage mortality (Appendix 12J).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be slightly lower more frequently; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar or lower (particularly during August and September), and therefore more suitable, average monthly probabilities of exceeding specified water temperature index values.
- Equivalent adult spawning conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar

probabilities of exceeding specified water temperature index values, with lower probabilities, and therefore more suitable water temperatures, during October.

- Improved embryo incubation conditions due to modeling results indicating reduced total annual early life stage mortality, and equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during October.
- Generally equivalent or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) generally equivalent or lower probabilities of exceeding specified water temperature index values throughout most the evaluation period, particularly during July through September.
- Equivalent smolt emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values, particularly during June and July.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Trinity River, Alternative A would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Steelhead (Winter-run and Summer-run)

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions for winter-run steelhead due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar, or slightly lower (particularly during September and October) average monthly probabilities of exceeding specified water temperature index values.
- Equivalent adult immigration and holding conditions for summer-run steelhead due to modeling results indicating: (1) equivalent long-term average monthly flows during the evaluation period, and equivalent average monthly flows during all water year types; (2) equivalent monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent

flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values during the evaluation period.

- Equivalent adult spawning and egg incubation conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout the evaluation period.
- Equivalent or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows over the entire year, and similar or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance, and therefore more suitable water temperatures, during July through September.
- Equivalent smolt emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows, except for during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of steelhead (winter-run and summer-run) in the Trinity River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Green Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam and at North Fork.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Equivalent or slightly improved adult immigration and holding conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly higher monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar, or slightly lower (particularly during June, July and

September) average monthly probabilities of exceeding specified water temperature index values, although slightly higher probabilities of exceedance would occur during August.

- Equivalent or improved adult spawning conditions due to modeling results indicating: (1) equivalent long-term average monthly flows during the evaluation period, and equivalent average monthly flows during all water year types; (2) equivalent monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperature conditions, during July and August.
- Equivalent or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows over the entire year, and similar or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during June, July, and September, although higher probabilities of exceedance would occur during August.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Trinity River, Alternative A would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

White Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam and at North Fork.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Equivalent adult immigration and holding conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.
- Equivalent adult spawning conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.
- Equivalent or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows over the entire year, and equivalent or slightly higher average monthly flows during most water year types, except for above normal and below normal

water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during June, July, and September, although higher probabilities of exceedance would occur during August.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Trinity River, Alternative A would result in generally similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Equivalent adult immigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; and (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period.
- Equivalent adult spawning and egg incubation conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values, with lower probabilities of exceedance during July and August and slightly higher probabilities during April and May.
- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows over the entire year, and equivalent or slightly higher average monthly flows during most water year types, except for during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of remaining with the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Trinity River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Klamath River downstream of the Trinity River

Because potential changes within the Trinity River were considered to be less than significant under Alternative A, it is expected that any potential changes in the Klamath River downstream of the Trinity River also would be less than significant.

Lewiston Lake, Whiskeytown Lake, Keswick Reservoir, Lake Natoma, and the Thermalito Complex

Refer to Alternative A relative to Existing Conditions for a discussion of Lewiston Lake, Whiskeytown Lake, Keswick Reservoir, Lake Natoma, and the Thermalito Complex. That discussion also applies to Alternative A relative to the No Project/No Action Alternative.

Spring Creek

It is not anticipated that operations of Spring Creek Reservoir or flows in Spring Creek would be substantially affected under implementation of Alternative A. It is anticipated that Spring Creek Reservoir would continue to operate for flood control purposes, and to manage the release of contaminated water from Iron Mountain Mine.

Shasta Lake

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Shasta Lake during April through November.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage, and higher average monthly storage by water year type occurring more often during most months of the evaluation period; (2) higher monthly storage exceedance probabilities during the all of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during all months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Shasta Lake, Alternative A would result in potentially beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Shasta Lake during March through June.

Relative to the No Project/No Action Alternative, Alternative A would be expected to provide:

- Similar or improved warmwater fish spawning and early life stage conditions, because of modeling results indicating similar or slightly reduced frequencies of monthly water surface elevation reductions of six feet or more during the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Shasta Lake, Alternative A would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Sacramento River

Winter-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for spawning habitat availability (WUA) (Appendix 12N), early life stage mortality (SacSalMort) (Appendix 12J), overall population mortality and production potential (SALMOD) (Appendix 12K), and lifecycle modeling (IOS) (Appendix 12L).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly flows during most of the evaluation period, and lower average monthly flows by water year type occurring more often than higher average monthly flows during most water year types at all Sacramento River locations evaluated, except for below Keswick Dam when average monthly flows would be higher more often during wet and above normal water year types, and would be higher and lower with the same monthly frequency during below normal and dry water year types; (2) lower monthly flow exceedance probabilities occurring during more than half of the evaluation period at all locations evaluated; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring during most months of the evaluation period at all locations evaluated; (4) similar, or slightly higher (particularly during April) or slightly lower (particularly during May through July) average monthly probabilities of exceeding specified water temperature index values.
- Improved spawning conditions due to modeling results indicating increased spawning habitat availability during the entire April through August adult spawning period, and generally lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during months with relatively warm water temperature conditions (i.e., July and August).
- Improved embryo incubation conditions due to modeling results indicating reduced total annual early life stage mortality, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during months with relatively warm water temperature conditions (July and August).
- Improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly flows and average monthly flows by water year type occurring with similar monthly frequencies at most locations evaluated, but lower average monthly flows more often during most water year types below Red Bluff Diversion Dam; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies at most locations evaluated; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at most locations evaluated; and (4) lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values, particularly at the warmest water temperature index values (70°F and 75°F).
- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by 15 percent), and average annual mortality by water year type would

be reduced during all water year types (by nine percent during wet water years, 21 percent during above normal water years, eight percent during below normal water years, 20 percent during dry water years, and 20 percent during critical water years); (2) a decrease in total annual mortality exceedance probabilities over more than 90 percent of the distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction, with 10 percent or more exceedance probability reductions occurring over nearly 25 percent of the entire distribution; and (4) long-term average total annual winter-run Chinook salmon production would increase by two percent, while average total annual production would increase during wet water years by less than one percent, during above normal water years by six percent, during below normal water years by one percent, and during dry and critical water years by three percent.

- Improved conditions pertaining to early life stage survival and abundance of spawners (IOS) because modeling results indicating: (1) over the 81-year evaluation period, long-term average annual egg to fry survival would increase by three percent, and average annual egg to fry survival by water year type would decrease during wet and above normal water years by one percent, and would increase during below normal water years by three percent, during dry water years by five percent and during critical water years by 26 percent; (2) long-term average annual fry to smolt survival would increase by four percent, and average annual fry to smolt survival by water year type would increase during wet water years by three percent, during above normal water years by four percent, and during critical water years by 16 percent, and would be equivalent during below normal and dry water years; (3) long-term average annual female spawner abundance would increase by eight percent, and average annual female spawner abundance by water year type would increase during wet water years by nine percent, during above normal water years by 13 percent, during below normal water years by two percent, during dry water years by seven percent and during critical water years by 10 percent; (4) an increase in annual egg to fry survival exceedance probabilities over approximately 50 percent of the entire distribution, particularly at lower survival rates; (5) an increase in annual fry to smolt survival exceedance probabilities over approximately 85 percent of the entire distribution, particularly at lower survival rates; and (6) an increase in annual female spawner abundance exceedance probabilities over approximately 90 percent of the entire distribution.

In conclusion, in consideration of potential impacts to all life stages of winter-run Chinook salmon in the Sacramento River, Alternative A would result in beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Spring-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball’s Ferry, Jelly’s Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J) and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type during most of the evaluation period in the upper Sacramento River, and lower and higher long-term average monthly and average monthly flows by water year type occurring with similar monthly frequency in the lower Sacramento River; (2) lower monthly flow exceedance probabilities during more than half of the evaluation period in the upper Sacramento River, and higher monthly flow exceedance probabilities occurring more often in the lower Sacramento River; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated; (4) lower (particularly during May through September) and slightly higher (particularly during April) monthly probabilities of exceeding specified water temperature index values.

- Improved spawning conditions due to modeling results indicating lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during months with warm water temperature conditions (i.e., September and October).
- Improved embryo incubation conditions due to modeling results indicating reduced total annual early life stage mortality, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures.
- Similar or improved juvenile rearing conditions due to modeling results indicating: (1) lower long-term average monthly flows during more than half of the evaluation period in the upper Sacramento River; (2) lower monthly flow exceedance probabilities more often in the upper Sacramento River; (3) under low flow conditions, higher monthly flow exceedance probabilities more often below Keswick Dam, and higher and lower monthly flow exceedance probabilities with similar probabilities below Red Bluff Diversion Dam; and (4) lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values.
- Similar smolt emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type during more than half of the evaluation period during most water year types; (2) lower monthly flow exceedance probabilities more often at all locations evaluated; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at all locations evaluated; and (4) higher monthly probabilities of exceeding specified water temperature index values during April and May, and lower monthly probabilities of exceeding specified water temperature index values during October.
- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by 21 percent), and average annual mortality by water year type would be reduced during all water year types (by 43 percent during wet water years, two percent during above normal water years, four percent during below normal water years, 39 percent during dry water years, and 12 percent during critical water years); (2) a decrease in total annual mortality exceedance probabilities over nearly 100 percent of the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction; and (4) long-term average total annual spring-run Chinook salmon production would increase by three percent, while average total annual production would increase during wet water years by two percent, during above normal water years by one percent, during below normal water years by less than one percent, during dry water years by nine percent, and during critical water years by four percent.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Sacramento River, Alternative A would result in beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J), spawning habitat availability (WUA) (Appendix 12N), and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) lower or similar long-term average monthly and average monthly flows by water year type during most of the evaluation period in the upper Sacramento River, and higher long-term average monthly and average monthly flows by water year type in the lower Sacramento River; (2) higher and lower or lower monthly flow exceedance probabilities in the upper Sacramento River, and higher monthly flow exceedance probabilities during most months evaluated in the lower Sacramento River; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated; (4) lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values.
- Less suitable spawning conditions due to modeling results indicating reduced spawning habitat availability during most of the October through January spawning period, and similar or lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, specifically during October.
- Improved embryo incubation conditions due to modeling results indicating reduced total annual early life stage mortality, and similar or lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during more than half of the evaluation period at all locations evaluated; (2) lower monthly flow exceedance probabilities more often at all locations evaluated; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at all locations evaluated (except for below Red Bluff Diversion Dam where flows would be higher and lower with the same monthly frequency), particularly in the lower Sacramento River; and (4) similar monthly probabilities of exceeding specified water temperature index values, except for less suitable water temperatures during April more often.
- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by four percent), average annual mortality by water year type would increase during wet and below normal water years by six and one percent, respectively, and would decrease during above normal water years by 13 percent, during dry water years by 15 percent, and during critical water years by 20 percent; (2) a decrease in total annual mortality exceedance probabilities over approximately 61 percent of the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction; and (4) long-term average total annual fall-run Chinook salmon production would increase by three percent, while average total annual production would decrease during wet water years by eight percent and during below normal water

years by less than one percent, and increase during above normal water years by 11 percent, during dry water years by six percent, and during critical water years by 10 percent.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Late Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J) and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) higher long-term average monthly and average monthly flows by water year type below Keswick Dam, and lower long-term average monthly and average monthly flows by water year type below Red Bluff Diversion Dam and in the lower Sacramento River; (2) lower monthly flow exceedance probabilities during more than half of the months evaluated at all locations; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated; (4) similar monthly probabilities of exceeding specified water temperature index values, but with more suitable water temperatures during October and less suitable water temperatures during April.
- Similar spawning conditions due to modeling results indicating similar probabilities of exceeding specified water temperature index values, with more suitable water temperatures during May and less suitable water temperatures during April.
- Similar or less suitable embryo incubation conditions due to modeling results indicating similar or increased total annual early life stage mortality, and similar probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows more often in the upper Sacramento River, and higher average monthly flows more often in the lower Sacramento River; (2) lower monthly flow exceedance probabilities more often in the upper Sacramento River, and higher monthly flow exceedance probabilities in the lower Sacramento River; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at all locations evaluated, particularly in the lower Sacramento River; and (4) lower monthly probabilities of exceeding specified water temperature index values more often, and therefore more suitable water temperature conditions.
- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by three percent), average annual mortality by water year type would increase during wet water years by one percent, and would decrease during above normal water years by two percent, during below normal water 11 percent, during dry water years by one percent and during critical water years by 12 percent; (2) a decrease in total annual mortality exceedance

probabilities over approximately 80 percent of the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction; (4) long-term average total annual late fall-run Chinook salmon production would increase by two percent, while average total annual production by water year type would decrease during wet water years by less than one percent, and increase during above normal water years by two percent, during below normal water years by two percent, during dry water years by one percent, and during critical water years by eight percent.

In conclusion, in consideration of potential impacts to all life stages of late fall-run Chinook salmon in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Steelhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, and results from the SacEFT (Appendix 8B) were examined for steelhead egg mortality, spawning habitat availability, redd dewatering, redd scouring, juvenile rearing habitat availability and juvenile stranding.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly probabilities in the lower Sacramento River, higher average monthly flows more often during most water years below Keswick Dam, and lower average monthly flows more often below Red Bluff Diversion Dam; (2) higher and lower monthly flow exceedance probabilities with similar monthly frequencies in the lower Sacramento, higher monthly flow exceedance probabilities more often below Keswick Dam and lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period in the lower Sacramento River and below Keswick Dam, and lower flow exceedance probabilities below Red Bluff Diversion Dam; (4) lower monthly probabilities of exceeding specified water temperature index values during September and October, and higher monthly probabilities of exceeding specified water temperature index values during March.

- Similar spawning conditions due to modeling results indicating: (1) higher mean monthly flows and flow exceedance probabilities during December through February, and lower flows during March and April; (2) higher flow exceedance probabilities during low flow conditions; (3) similar probabilities of exceeding specified water temperature index values; and (4) SacEFT results indicate that spawning habitat availability conditions would be similar.

- Similar embryo incubation conditions due to: (1) similar probabilities of exceeding specified water temperature index values; (2) SacEFT results indicate that egg mortality associated with modeled water temperatures would be equivalent; (3) SacEFT results indicate that redd dewatering conditions may be improved slightly more often; and (4) SacEFT results indicate that redd scouring conditions would be equivalent.

- Similar juvenile rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies below Keswick Dam and at Bend Bridge, and lower average monthly flows occurring more often below Red Bluff Diversion Dam; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below Keswick Dam and at Bend Bridge, and lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam; (3) under low flow conditions, higher monthly flow exceedance probabilities more often below Keswick Dam and at Bend Bridge, and lower monthly flow exceedance probabilities below Red Bluff Diversion Dam; (4) equivalent monthly probabilities of exceeding specified water temperature index values, but with lower probabilities of exceeding 65°F during August and September, and therefore more suitable water temperature conditions; and (5) SacEFT results indicate that juvenile rearing habitat availability may be increased slightly more often while juvenile stranding potential may be increased more often.

- Similar smolt emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type more often; (2) lower monthly flow exceedance probabilities more often; (3) under low flow conditions, lower monthly flow exceedance probabilities below Red Bluff Diversion Dam, and higher monthly flow exceedance probabilities more often at all other locations evaluated; and (4) higher monthly probabilities of exceeding specified water temperature index values more often, and therefore less suitable water temperature conditions.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Green Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities, at Wilkins Slough, at Freeport and at Rio Vista, and egg survival results from the SacEFT (Appendix 8B) were examined.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type below Keswick Dam, and higher long-term average monthly and average monthly flows by water year type below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; (2) lower monthly flow exceedance probabilities more often below Keswick Dam, but higher monthly flow exceedance probabilities below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring more often at all locations evaluated; and (4) lower, and therefore more suitable, average monthly probabilities of exceeding specified water temperature index values.
- Similar spawning conditions because of: (1) lower long-term average monthly and average monthly flows by water year type below Keswick Dam and Red Bluff Diversion Dam, and higher long-term average monthly and average monthly flows by water year type at Wilkins Slough; (2) lower monthly flow exceedance probabilities more often below Keswick Dam and Red Bluff Diversion Dam, but higher monthly flow exceedance probabilities at Wilkins Slough; (3) during low flow conditions,

higher monthly flow exceedance probabilities occurring more often at all locations evaluated; and (4) equivalent monthly probabilities of exceeding the specified water temperature index value.

- Similar egg incubation conditions because of equivalent probabilities of exceeding the specified water temperature index value below Keswick Dam and Red Bluff Diversion Dam, while the SacEFT results indicate reduced water temperatures more often near Hamilton City and potentially increased survival.
- Similar or improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type more often below Red Bluff Diversion Dam, and higher average monthly flows and average monthly flows by water year type during June through November, and lower average monthly flows during December through April below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; (2) lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam, higher monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities, and higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies at Rio Vista; (3) under low flow conditions, higher monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista, and lower monthly flow exceedance probabilities below Red Bluff Diversion Dam; and (4) lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values at all locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Sacramento River, Alternative A would result in similar or beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

White Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River at Hamilton City, below the proposed Delevan Pipeline Intake Facilities, Wilkins Slough, Knights Landing, below the Feather River confluence, Freeport and Rio Vista.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) lower or similar long-term average monthly and average monthly flows by water year type during most of the evaluation period; (2) lower monthly flow exceedance probabilities during more than half of the evaluation period at all locations evaluated; (3) during low flow conditions, lower flow exceedance probabilities occurring more often at Hamilton City and higher monthly flow exceedance probabilities occurring more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.
- Less suitable spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows; (2) lower monthly flow exceedance probabilities, including during low flow conditions; and (3) higher or similar probabilities of exceeding specified water temperature index values, and therefore less suitable water temperatures.
- More suitable juvenile rearing and outmigration conditions due to modeling results indicating: (1) higher long-term average monthly and average by water year type monthly flows more often;

(2) higher monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) lower monthly probabilities of exceeding specified water temperature index values, and therefore more suitable water temperature conditions.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

River Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly flows by water year type occurring with similar monthly frequencies at all locations evaluated; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies at all locations evaluated; and (3) during low flow conditions, higher flow exceedance probabilities occurring more often at all locations evaluated.
- Similar spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows more often below Keswick Dam and below Red Bluff Diversion Dam, and higher and lower average monthly flows occurring with similar monthly frequencies below the proposed Delevan Pipeline Intake Facilities; (2) lower monthly flow exceedance probabilities more often below Keswick Dam and below Red Bluff Diversion Dam, and higher and lower flow exceedance probabilities occurring with the same monthly frequency below the proposed Delevan Pipeline Intake Facilities; (3) during low flow conditions, higher or similar monthly flow exceedance probabilities below Keswick Dam, lower monthly flow exceedance probabilities below Red Bluff Diversion Dam, and higher and lower flow exceedance probabilities occurring with the same monthly frequency below the proposed Delevan Pipeline Intake Facilities; and (4) higher probabilities of occurring within specified water temperature ranges, and therefore more suitable water temperatures.
- Generally similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values, but with lower probabilities of exceeding 72°F during July and August.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) lower long-term average and average monthly by water year type flows more often; (2) lower monthly flow exceedance probabilities more often; and (3) during low flow conditions, higher or similar flow exceedance probabilities below Keswick Dam, lower flow exceedance probabilities at Freeport, and higher and lower flow exceedance probabilities occurring with the same monthly frequency below the proposed Delevan Pipeline Intake Facilities.
- Similar spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average monthly by water year type flows below Keswick Dam and Red Bluff Diversion Dam, and higher and lower long-term average monthly and average monthly flows by water year type occurring with similar monthly frequencies below the proposed Delevan Pipeline Intake Facilities; (2) lower monthly flow exceedance probabilities more often below Keswick Dam and Red Bluff Diversion Dam, and higher and lower flow exceedance probabilities occurring with the same monthly frequency below the proposed Delevan Pipeline Intake Facilities; (3) during low flow conditions, higher or similar flow exceedance probabilities below Keswick Dam and the proposed Delevan Pipeline Intake Facilities, and lower flow exceedance probabilities below Red Bluff Diversion Dam; and (4) higher probabilities of water temperatures occurring within the specified water temperature range, and therefore more suitable water temperatures.
- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below Keswick Dam, and higher flow exceedance probabilities occurring more often below the proposed Delevan Pipeline Intake Facilities and at Freeport; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values, but with lower probabilities of exceeding 72°F during July and August at Freeport.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Hardhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below Keswick Dam, and higher flow exceedance probabilities occurring more often below the proposed Delevan Pipeline Intake Facilities and at Freeport; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) lower probabilities of water temperatures occurring within the specified range slightly more often, and therefore, potentially less suitable water temperatures.

- Similar or improved spawning conditions, because of modeling results indicating: (1) similar or slightly higher or lower long-term average and average by water year type monthly flows below the proposed Delevan Pipeline Intake Facilities and at Freeport, and lower average monthly flows below Keswick Dam more often; (2) lower monthly flow exceedance probabilities more often below Keswick Dam, higher monthly flow exceedance probabilities below the proposed Delevan Pipeline Intake Facilities and equivalent flow exceedance probabilities at Freeport; (3) during low flow conditions, higher or similar monthly flow exceedance probabilities; and (4) higher probabilities of occurring within the specified water temperature range, and therefore more suitable water temperatures.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

California Roach

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or improved adult and other life stage conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below Keswick Dam, and higher flow exceedance probabilities occurring more often below the proposed Delevan Pipeline Intake Facilities and at Freeport; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent probabilities of water temperatures exceeding the specified water temperature index value.

- Similar spawning conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows more often below Keswick Dam, and higher and lower average monthly flows occurring with similar monthly frequencies below the proposed Delevan Pipeline Intake Facilities and at Freeport; (2) lower monthly flow exceedance probabilities more often below Keswick Dam, higher and lower flow exceedance probabilities occurring with the same monthly frequency below the proposed Delevan Pipeline Intake Facilities, and equivalent or lower flow exceedance probabilities at Freeport; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities below Keswick Dam, higher and lower flow exceedance probabilities with the same monthly frequency below the proposed Delevan Pipeline Intake Facilities, and equivalent or lower flow exceedance probabilities at Freeport; and (4) similar probabilities of exceeding the specified water temperature index value, but a higher probability of exceedance during April below the proposed Delevan Pipeline Intake Facilities, and therefore slightly more suitable water temperatures (California roach initiate spawning at water temperatures of approximately 60°F or higher).

In conclusion, in consideration of potential impacts to all life stages of California roach in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Sacramento Splittail

Evaluation of water temperatures for splittail in the Sacramento River (i.e., 45-75° F) indicate that water temperature conditions would be essentially equivalent or similar under Alternative A relative to the No Project/No Action Alternative, resulting in a less than significant impact.

American Shad

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities, below the Feather River Confluence (Verona) and at Freeport. These

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or less suitable adult spawning and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type more often below Red Bluff Diversion Dam, and higher and lower average monthly flows occurring with similar monthly frequencies at Verona and Freeport; (2) lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam, equivalent or higher flow exceedance probabilities at Verona, and equivalent flow exceedance probabilities at Freeport; (3) during low flow conditions, lower flow exceedance probabilities below Red Bluff Diversion Dam and equivalent exceedance probabilities at Verona and Freeport; and (4) similar but slightly higher probabilities of water temperatures occurring within the specified water temperature range below the Feather River Confluence and at Freeport, and slightly lower probabilities of water temperatures occurring within the specified range below Red Bluff Diversion Dam.
- Similar or improved larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) higher long-term average and average by water year type monthly flows more often; (2) higher monthly flow exceedance probabilities more often; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) slightly lower probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of American shad in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Striped Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below the proposed Delevan Pipeline Intake Facilities and below the Feather River Confluence (Verona).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or improved adult spawning and other life stage conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly flows by water year type with similar monthly frequencies; (2) higher monthly flow exceedance probabilities more often; (3) during low flow conditions, equivalent or higher flow exceedance probabilities; and (4) slightly higher probabilities of water temperatures occurring within the specified water temperature range.
- Similar or improved larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) higher and lower long-term average and average by water year type monthly flows with similar monthly frequencies; (2) higher monthly flow exceedance probabilities more often; (3) during low flow conditions, higher monthly flow exceedance probabilities more often; and (4) higher probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Largemouth Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and Freeport.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Equivalent or improved adult and other life stage conditions, because of modeling results indicating: (1) higher long-term average monthly flows, and higher average monthly flows by water year type occurring during most water year types at all Sacramento River locations evaluated; (2) higher and lower monthly flow exceedance probabilities occurring with the same frequency below Keswick Dam and at Freeport, and higher monthly exceedance probabilities below proposed Delevan Pipeline Intake Facilities; and (3) during low flow conditions, higher monthly flow exceedance probabilities occurring during most months of the evaluation period at all locations evaluated.
- Equivalent or improved spawning conditions, because of modeling results indicating similar monthly probabilities of water temperatures occurring within the specified water temperature range below Keswick Dam and at Freeport, and higher probabilities of occurring within the range below the proposed Delevan Pipeline Intake Facilities during April.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the Sacramento River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

<u>Clear Creek</u>

Spring -run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for Clear Creek below Whiskeytown Dam, Clear Creek at Igo, and at the mouth of Clear Creek.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type, except for substantially higher mean monthly flows during July; (2) equivalent or similar monthly flow exceedance probabilities during most of the evaluation period; (3) during low flow conditions, equivalent monthly flow exceedance probabilities during most months of the evaluation period; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.

- Similar or improved spawning and embryo incubation conditions due to modeling results indicating: (1) equivalent or similar long-term average monthly and average monthly flows by water year type; (2) equivalent or similar monthly flow exceedance probabilities; (3) during low flow conditions, equivalent monthly flow exceedance probabilities; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing conditions due to modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type; (2) equivalent monthly flow exceedance probabilities; (3) during low flow conditions, equivalent monthly flow exceedance probabilities; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile emigration conditions due to modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type, except for substantially higher mean monthly flows during July; (2) equivalent or similar monthly flow exceedance probabilities; (3) during low flow conditions, equivalent monthly flow exceedance probabilities; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in Clear Creek, Alternative A would result in similar or beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for Clear Creek below Whiskeytown Dam, Clear Creek at Igo, and at the mouth of Clear Creek.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type; (2) equivalent or similar monthly flow exceedance probabilities; (3) during low flow conditions, equivalent monthly flow exceedance probabilities; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar or improved spawning and embryo incubation conditions due to modeling results indicating: (1) equivalent or similar long-term average monthly and average monthly flows by water year type; (2) equivalent or similar monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or similar monthly flow exceedance probabilities; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing conditions due to modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type; (2) equivalent or similar

monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or similar monthly flow exceedance probabilities; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

- Similar juvenile emigration conditions due to modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type; (2) equivalent or similar monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or similar monthly flow exceedance probabilities; and (4) similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in Clear Creek, Alternative A would result in similar or beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Late Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for Clear Creek below Whiskeytown Dam, Clear Creek at Igo, and at the mouth of Clear Creek.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Equivalent or similar adult immigration and holding conditions, because of modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type; (2) equivalent or slightly lower monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or slightly lower monthly flow exceedance probabilities; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.
- Equivalent or similar spawning and embryo incubation conditions due to modeling results indicating: (1) equivalent or similar long-term average monthly and average monthly flows by water year type; (2) equivalent or slightly lower monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or slightly lower monthly flow exceedance probabilities; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.
- Equivalent or similar juvenile rearing conditions due to modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type; (2) equivalent or slightly lower monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or slightly lower monthly flow exceedance probabilities; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.
- Equivalent or similar juvenile emigration conditions due to modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type; (2) equivalent monthly flow exceedance probabilities; (3) during low flow conditions, equivalent monthly flow exceedance probabilities; and (4) similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of late fall-run Chinook salmon in Clear Creek, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Steelhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for Clear Creek below Whiskeytown Dam, Clear Creek at Igo, and at the mouth of Clear Creek.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type; (2) equivalent or similar monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or similar monthly flow exceedance probabilities; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar spawning and embryo incubation conditions due to modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type; (2) equivalent or slightly lower monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or slightly lower monthly flow exceedance probabilities; and (4) similar monthly probabilities of exceeding specified water temperature index values.
- Similar juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type, except for generally substantially higher mean monthly flows during July; (2) equivalent or similar monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or similar monthly flow exceedance probabilities; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of steelhead in Clear Creek, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

River Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for Clear Creek below Whiskeytown Dam, Clear Creek at Igo, and at the mouth of Clear Creek.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type; (2) equivalent or similar monthly flow exceedance probabilities; and (3) during low flow conditions, equivalent or similar monthly flow exceedance probabilities.
- Similar spawning and embryo incubation conditions due to modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type, except for substantially higher mean monthly flows during July; (2) equivalent or similar monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or slightly lower monthly flow exceedance probabilities; and (4) similar monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type, except for generally

substantially higher mean monthly flows during July; (2) equivalent or similar monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or similar monthly flow exceedance probabilities; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in Clear Creek, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for Clear Creek below Whiskeytown Dam, Clear Creek at Igo, and at the mouth of Clear Creek.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type; (2) equivalent or slightly lower monthly flow exceedance probabilities; and (3) during low flow conditions, equivalent or slightly lower monthly flow exceedance probabilities.
- Similar spawning and embryo incubation conditions due to modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type, except for generally substantially higher mean monthly flows during July; (2) equivalent or similar monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or slightly lower monthly flow exceedance probabilities; and (4) similar monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type, except for generally substantially higher mean monthly flows during July; (2) equivalent or similar monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or similar monthly flow exceedance probabilities; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in Clear Creek, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Hardhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for Clear Creek below Whiskeytown Dam, Clear Creek at Igo, and at the mouth of Clear Creek.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult and other life stage conditions, because of: (1) equivalent long-term average monthly and average monthly flows by water year type, except for substantially higher mean monthly flows during July; (2) equivalent or similar monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or similar monthly flow exceedance probabilities; and (4) similar monthly probabilities of water temperatures occurring within the specified water temperature range.

- Similar spawning and embryo incubation conditions due to modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type; (2) monthly flow exceedance probabilities; (3) during low flow conditions, monthly flow exceedance probabilities; and (4) similar or slightly higher monthly probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of hardhead in Clear Creek, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

California Roach

Flow and water temperature model results (Appendix 12E and 12F) were examined for Clear Creek below Whiskeytown Dam, Clear Creek at Igo, and at the mouth of Clear Creek.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type, except for substantially higher mean monthly flows during July; (2) equivalent or similar monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or similar monthly flow exceedance probabilities; and (4) equivalent monthly probabilities of water temperatures exceeding the specified water temperature index value.
- Similar spawning conditions due to modeling results indicating: (1) equivalent long-term average monthly and average monthly flows by water year type; (2) equivalent or similar monthly flow exceedance probabilities; (3) during low flow conditions, equivalent or similar monthly flow exceedance probabilities; and (4) similar monthly probabilities of water temperatures exceeding the specified water temperature index value.

In conclusion, in consideration of potential impacts to all life stages of California roach in Clear Creek, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

<u>Lake Oroville</u>

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Lake Oroville during April through November.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage, and higher average monthly storage by water year type during most months of the evaluation period; (2) higher monthly storage exceedance probabilities during all months of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during all months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Lake Oroville, Alternative A would result in beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Lake Oroville during March through June.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar warmwater fish spawning and early life stage conditions, because of modeling results indicating no overall net change in frequencies of monthly water surface elevation reductions of six feet or more over the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Lake Oroville, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Feather River

Flows in the Low Flow Channel below the Fish Barrier Dam were modeled consistent with the terms of the FERC Settlement Agreement. As shown in Appendix 12F), modeled results for long-term average flows, average flows by water year type, and flow exceedance probabilities of 10 percent or more during all years and during low flow conditions would be equivalent for Alternative A, relative to the No Project/No Action Alternative. Although these results are not repeated for the discussions below, the model results for the Low Flow Channel below the Fish Barrier Dam were considered along with the information presented below and were incorporated into the impact determinations for the following species: spring-run Chinook salmon, fall-run Chinook salmon, steelhead, green sturgeon, white sturgeon, river lamprey, Pacific lamprey, hardhead, and California roach.

Spring-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N) and early life stage mortality (Appendix 12J).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) higher long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher average monthly flows by water year type occurring more often than lower average monthly flows during most water year types, except below normal and dry water year types when lower monthly flows would occur more often; (2) higher and lower monthly flow exceedance probabilities occurring with similar frequencies below the Thermalito Afterbay outlet, and higher monthly flow exceedance probabilities occurring more often at the mouth of the Feather River; (3) during low flow conditions, higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet, and higher and lower monthly flow exceedance probabilities occurring with similar frequencies at the mouth of the Feather River; and

(4) similar probabilities of exceeding specified water temperature index values at all Feather River locations evaluated.

- Similar or improved spawning conditions due to modeling results indicating significantly higher spawning habitat availability during half of the adult spawning period, although slightly lower spawning habitat availability would occur during the remainder of the evaluation period, and similar or slightly lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, during the evaluation period.
- Similar or improved embryo incubation conditions due to reduced total annual long-term average early life stage mortality, and similar or slightly lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures during the evaluation period.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet, and similar or higher average monthly flows by water year type occurring more often than lower average monthly flows during wet, above normal, and critical water year types below the Thermalito Afterbay outlet, and generally lower average monthly flows during below normal and dry water year types below the Thermalito Afterbay outlet; (2) similar or lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet; (3) under low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar frequencies below the Thermalito Afterbay outlet; and (4) similar monthly probabilities of exceeding specified water temperature index values at all Feather River locations evaluated.
- Similar smolt emigration conditions, because of modeling results indicating: (1) similar or lower long-term average monthly flows during most of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or lower average monthly flows by water year type occurring more often than higher average monthly flows during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except for above normal water year types when average monthly flows would be higher below the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) during low flow conditions, similar or lower monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Feather River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N) and early life stage mortality (Appendix 12J).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) higher and lower long-term average monthly flows occurring with similar monthly frequency during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and equivalent or higher average monthly flows by water year type occurring more often during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except for wet and below normal water year types when average monthly flows would be lower more often than higher at the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequency below the Thermalito Afterbay outlet and at the mouth of the Feather River with higher flows occurring during July through September; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequency below the Thermalito Afterbay outlet, and higher monthly flow exceedance probabilities occurring more often at the mouth of the Feather River; and (4) similar probabilities of exceeding specified water temperature index values during the evaluation period.
- Improved spawning conditions due to substantially higher spawning habitat availability during most of the adult spawning period, although slightly lower spawning habitat availability would occur during November, and similar or slightly lower probabilities of exceeding specified water temperature index values during most of the evaluation period.
- Similar or improved embryo incubation conditions due to reduced total annual long-term average early life stage mortality, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, during most of the evaluation period.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar long-term average monthly flows occurring during most months of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or higher average monthly flows by water year type occurring more often than lower average monthly flows during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during dry and critical water year types when flows would be lower more frequently; (2) similar or slightly lower monthly flow exceedance probabilities occurring during most months below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar monthly probabilities of exceeding specified water temperature index values at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Feather River, Alternative A would result in similar and less than significant impacts, relative to the No Project/No Action Alternative.

Steelhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) higher long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher average monthly flows by water year type occurring during above normal and critical water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, higher and lower average monthly flows by water year type occurring during below normal water year types, and lower average monthly flows by water year type occurring during wet, and critical water year types; (2) similar or lower monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) during low flow conditions, lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet, and higher monthly flow exceedance probabilities occurring more often at the mouth of the Feather River; and (4) similar or lower monthly probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, during most of the evaluation period.
- Similar spawning conditions due to higher and lower spawning habitat availability occurring with similar frequency during the adult spawning period, and similar or slightly lower probabilities of exceeding specified water temperature index values during most of the evaluation period.
- Generally similar embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet, and higher and lower long-term average monthly flows occurring with similar monthly frequency during the evaluation period below the Thermalito Afterbay outlet; (2) similar or slightly lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities below the Thermalito Afterbay outlet; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values during most of the evaluation period at all Feather River locations evaluated.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet, and similar or higher average monthly flows by water year type occurring more often than lower average monthly flows during wet, above normal, and critical water year types below the Thermalito Afterbay outlet, and lower average monthly flows during below normal and dry water year types below the Thermalito Afterbay outlet; (2) similar or lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet; (3) under low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar frequencies below the Thermalito Afterbay outlet; and (4) similar monthly probabilities of exceeding specified water temperature index values at all Feather River locations evaluated.
- Similar smolt emigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and lower average monthly flows by water year type occurring during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except for below normal water year types when average monthly flows would be higher more often; (2) lower monthly flow exceedance probabilities occurring more

often below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar or lower monthly probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the Feather River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Green Sturgeon

Flow model results (Appendix 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, at Shanghai Bend, and at the mouth of the Feather River. Water temperature results (Appendix 12E) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar or slightly higher long-term average monthly flows occurring more often during the evaluation period at Shanghai Bend and at the mouth of the Feather River, and higher average monthly flows by water year type during above normal and below normal water year types at Shanghai Bend and during above normal water year types at the mouth of the Feather River, higher and lower average monthly flows by water year type occurring with similar frequencies during wet water year types at Shanghai Bend and during below normal water year types at the mouth of the Feather River, lower average monthly flows by water year type during dry and critical water year types at Shanghai Bend and during wet, dry, and critical water year types at the mouth of the Feather River, (2) similar or lower monthly flow exceedance probabilities occurring more often at Shanghai Bend and at the mouth of the Feather River; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring more often at Shanghai Bend, and higher and lower monthly flow exceedance probabilities occurring with similar frequencies at the mouth of the Feather River; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values during the evaluation period.
- Similar adult spawning and embryo incubation conditions because of modeling results indicating: (1) higher long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet, and higher average monthly flows by water year type during wet and above normal water year types below the Thermalito Afterbay outlet, higher and lower average monthly flows by water year type occurring with similar frequency during below normal and critical water year types below the Thermalito Afterbay outlet, and lower average monthly flows occurring during dry water year types below the Thermalito Afterbay outlet; (2) higher and lower monthly flow exceedance probabilities occurring with similar frequency below the Thermalito Afterbay outlet; (3) during low flow conditions, similar or slightly higher monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet; and (4) similar monthly probabilities of exceeding specified water temperature index values below the Thermalito Afterbay outlet.

- Similar juvenile rearing conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and lower average monthly flows by water year type occurring during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except for below normal water year types when average monthly flows would be higher more often; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar monthly probabilities of exceeding specified water temperature index values at all Feather River locations evaluated.
- Similar or improved juvenile emigration conditions due to modeling results indicating: (1) higher long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet, at Shanghai Bend, and at the mouth of the Feather River, and higher average monthly flows by water year type occurring during most water year types below the Thermalito Afterbay outlet, at Shanghai Bend, and at the mouth of the Feather River; (2) higher monthly flow exceedance probabilities occurring during most months below the Thermalito Afterbay outlet, at Shanghai Bend, and at the mouth of the Feather River, except during May when probabilities of exceedance would be lower; (3) under low flow conditions, higher monthly flow exceedance probabilities occurring during most months at all evaluated locations, except during May when probabilities of exceedance would be lower; and (4) similar monthly probabilities of exceeding specified water temperature index values below the Thermalito Afterbay outlet and at the mouth of the Feather River.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Feather River, Alternative A would result in similar and non-significant impacts, relative to the No Project/No Action Alternative.

White Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, at Shanghai Bend, and at the mouth of the Feather River. Water temperature results were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type occurring more often during the evaluation period at Shanghai Bend and at the mouth of the Feather River, except during above normal water years when higher average monthly flows occur; (2) lower monthly flow exceedance probabilities during most of the evaluation period at Shanghai Bend and at the mouth of the Feather River; (3) during low flow conditions, similar or lower flow exceedance probabilities during the evaluation period at Shanghai Bend, and higher and lower flow exceedance probabilities occurring with similar frequencies at the mouth of the Feather River; and (4) equivalent monthly probabilities of exceeding specified water temperature index values at all locations evaluated.

- Similar or less suitable spawning and egg incubation conditions because of modeling results indicating: (1) higher and lower long-term average monthly flows occurring with similar frequency during the evaluation period at Shanghai Bend and at the mouth of the Feather River, and higher average monthly flows by water year type occurring more often during most water year types at Shanghai Bend and at the mouth of the Feather River, except during dry and critical water year types when lower average monthly flows occurred; (2) lower monthly flow exceedance probabilities during at least half of the evaluation period at Shanghai Bend and at the mouth of the Feather River; (3) during low flow conditions, equivalent monthly flow exceedance probabilities occurring with similar monthly frequency during the evaluation period at Shanghai Bend, and lower monthly flow exceedance probabilities occurring during at least half of the evaluation period at the mouth of the Feather River; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values at all locations evaluated.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) higher long-term average monthly flows occurring during the evaluation period at Shanghai Bend and at the mouth of the Feather River, and higher and lower average monthly flows by water year type occurring with similar frequency during wet and critical water year types at Shanghai Bend and at the mouth of the Feather River, higher average monthly flows would occur during above normal water year types, and lower average monthly flows would occur during below normal and dry water year types; (2) generally lower monthly flow exceedance probabilities during at least half of the evaluation period at Shanghai Bend and at the mouth of the Feather River; (3) during low flow conditions, similar or slightly higher monthly flow exceedance probabilities during the evaluation period at Shanghai Bend, and higher and lower monthly flow exceedance probabilities occurring with the same frequency during the evaluation period at the mouth of the Feather River; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values at all locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Feather River, Alternative A would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

River Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River, in the Feather River.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or slightly reduced adult immigration conditions, because of modeling results indicating: (1) higher and lower long-term average monthly flows occurring with similar frequency, and higher and lower generally average monthly flows during wet water year types occurring with similar frequency during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, generally higher average monthly flows occurring during above normal and below normal water year types below the Thermalito Afterbay outlet, and at the mouth of the Feather River, lower average monthly flows occurring during dry and critical water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the

Feather River, except generally during March, June, and September months when higher monthly flow exceedance probabilities occur; and (3) during low flow conditions, lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance would occur throughout the evaluation period, particularly during March and September.

- Similar or less suitable adult spawning and egg incubation conditions, because of modeling results indicating: (1) similar or slightly higher long-term average monthly flows and average monthly flows by water year type during most water years below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during dry and critical water year types when lower monthly flows would occur; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) during low flow conditions, similar or slightly higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet, and similar or slightly lower monthly flow exceedance probabilities at the mouth of the Feather River; and (4) equivalent or lower probability of water temperatures occurring within the specified water temperature range with similar frequency during the evaluation period at all Feather River locations evaluated.
- Similar ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher average monthly flows by water year type occurring during wet and above normal water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, lower average monthly flows occurring during below normal and dry water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows occurring with similar frequency during critical water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) higher and lower monthly flow exceedance probabilities occurring with similar frequency below the Thermalito Afterbay outlet and at the mouth of the Feather River, with higher monthly flow exceedance probabilities during the June through September period; (3) during low flow conditions, similar or slightly higher monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) equivalent probability of water temperatures occurring within the specified water temperature range during most of the evaluation period at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the Feather River, Alternative A would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) similar or slightly higher long-term average monthly flows and average monthly flows by water year type occurring during most water years below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during dry and critical water year types when lower monthly flows would occur; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (3) during low flow conditions, similar or slightly higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet, and similar or slightly lower monthly flow exceedance probabilities at the mouth of the Feather River

- Similar or less suitable spawning and egg incubation conditions, because of modeling results indicating: (1) similar or higher long-term average monthly flows below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher average monthly flows by water year type occurring during wet and above normal water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, and lower average monthly flows by water year type occurring during below normal, dry and critical water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) higher and lower monthly flow exceedance probabilities occurring with similar frequency during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar frequency during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) slightly lower probability of water temperatures occurring within the specified water temperature range during the evaluation period at all Feather River locations evaluated.
- Similar ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or higher average monthly flows by water year type occurring during wet and above normal water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, lower average monthly flows occurring during below normal and dry water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows occurring with similar frequency during critical water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, and; (2) higher and lower monthly flow exceedance probabilities occurring with similar frequency below the Thermalito Afterbay outlet and at the mouth of the Feather River, with generally higher monthly flow exceedance probabilities during the June through September period; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar frequency below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar probability of water temperatures occurring within the specified water temperature range during most the evaluation period at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Feather River, Alternative A would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Hardhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult and juvenile life stage conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or higher average monthly flows by water year type occurring during wet and above normal water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, lower average monthly flows occurring during below normal and dry water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows occurring with similar frequency during critical water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) higher and lower monthly flow exceedance probabilities occurring with similar frequency below the Thermalito Afterbay outlet and at the mouth of the Feather River, with higher monthly flow exceedance probabilities during the June through September period; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar frequency below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar probability of water temperatures occurring within the specified water temperature range during most of the evaluation period at all Feather River locations evaluated.
- Similar or less suitable adult spawning conditions, because of modeling results indicating: (1) lower long-term average monthly flows during April and May months and higher long-term monthly flows during June below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher average monthly flows by water year type during wet and above average water year types, and lower average monthly flows by water year type during dry and critical water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) lower monthly flow exceedance probabilities flows during April and May months; and higher monthly flow exceedance probabilities during June at all Feather River locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities flows during April and May months and higher monthly flow exceedance probabilities during June below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar or slightly lower probabilities of water temperatures occurring within the specified water temperature range at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the Feather River, Alternative A would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

California Roach

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult and other life stage conditions due to modeling results indicating: (1) higher long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, higher average monthly flows by water year type occurring during wet and above normal water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, lower average monthly flows occurring during below normal and dry water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows occurring with similar frequency during critical water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, and; (2) higher and lower monthly flow exceedance probabilities occurring with similar frequency below the Thermalito Afterbay outlet and at the mouth of the Feather River, with higher monthly flow exceedance probabilities during the June through September period; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar frequency below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) equivalent probability of exceeding specified water temperature values during all month of the evaluation period at all Feather River locations evaluated.

- Similar adult spawning conditions, because of modeling results indicating: (1) lower long-term average monthly flows during April through May months, and higher long-term monthly flows during March and June month below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher average monthly flows by water year type during most water year types, except during dry and critical water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) lower monthly flow exceedance probabilities during April through May and higher monthly flow exceedance probabilities during March and June months below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) during low flow conditions, lower monthly flow exceedance probabilities during April through May and higher monthly flow exceedance probabilities during March and June months below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar probabilities of exceeding specified water temperature values during the evaluation period at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of roach in the Feather River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Splittail

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or less suitable spawning conditions, because of modeling results indicating: (1) higher long-term monthly flows during February and March and lower long-term average monthly flows during April and May at the mouth of the Feather River, and similar or slightly higher average monthly flows by water year type during most water year types, although lower average monthly flows would occur during dry and critical water year types; (2) higher flow exceedance probabilities during March, and slightly lower monthly flow exceedance probabilities during the remainder of the evaluation period; (3) during low flow conditions, higher flow exceedance probabilities during March, and lower monthly flow exceedance probabilities during the remainder of the evaluation period at the mouth of the Feather River; (4) similar changes in usable flooded area (UFA) exceedance probabilities of 10 percent or more; and (5) equivalent probability of exceeding specified water temperature values occurring during the evaluation period.

In conclusion, in consideration of potential impacts to all life stages of splittail in the Feather River, Alternative A would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Striped Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or less suitable adult spawning and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly flows during April and May months and higher long-term monthly flows during June at all Feather River locations evaluated; and higher average monthly flows by water year type during most water year types, except during dry and critical water year types; (2) lower monthly flow exceedance probabilities flows during April and May months and higher monthly flow exceedance probabilities during June at all Feather River locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities flows during April and May months at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June below Thermalito Afterbay outlet; and (4) similar or slightly lower monthly probabilities of water temperatures occurring within the specified water temperature range throughout the evaluation period below the Thermalito Afterbay Outlet and at the mouth of the Feather River.
- Generally similar larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) higher long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, higher average monthly flows by water year type during wet and above normal water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, generally lower average monthly flows during below normal and dry water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows occurring with similar frequency during critical water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, and; (2) higher and lower monthly flow exceedance probabilities occurring with similar frequency below the Thermalito Afterbay outlet and at the mouth of the Feather River, with higher monthly flow exceedance probabilities during the June through September period; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar frequency below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar probability of water temperatures occurring within the specified water temperature range during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the Feather River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

American Shad

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River below the Thermalito Afterbay outlet and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or less suitable adult spawning and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly flows during April and May months and generally higher long-term monthly flows during June at all Feather River locations evaluated; and higher average monthly flows by water year type during most water year types, except during dry and critical water year types; (2) lower monthly flow exceedance probabilities flows during April and May months and higher monthly flow exceedance probabilities during June at all Feather River locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities flows during April and May months at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June below Thermalito Afterbay outlet; and (4) similar or slightly higher monthly probabilities of water temperatures occurring within the specified water temperature range throughout the evaluation period below the Thermalito Afterbay Outlet and at the mouth of the Feather River.

- Similar larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) higher long-term average and average monthly flows by water year type occurring with similar frequency during most water year types during the evaluation period at all Feather River locations evaluated, except during wet and below normal water year types when similar and slightly lower average monthly flows by water year type would occur more often than higher average monthly flows; (2) similar or lower monthly flow exceedance probabilities occurring during August, October, and November at all Feather River locations evaluated, and higher monthly flow exceedance probabilities occurring during the remainder of the evaluation period at all Feather River locations evaluated;(3) during low flow conditions, lower monthly flow exceedance probabilities occurring during October and November at all Feather River locations evaluated, and higher monthly flow exceedance probabilities occurring during July through September at all Feather River locations evaluated; and (4) similar probability of water temperatures occurring within the specified water temperature range at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of American shad in the Feather River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Largemouth Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River below Thermalito Afterbay Outlet and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) higher long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, higher average monthly flows by water year type occurring during wet and above normal water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, lower average monthly flows occurring during below normal and dry water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows occurring with similar frequency during critical water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, and; (2) higher and lower monthly flow exceedance probabilities occurring with similar frequency below the Thermalito Afterbay outlet and at the mouth of the Feather River, with generally higher monthly flow exceedance probabilities during the June through September period; and (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar frequency below the Thermalito Afterbay outlet and at the mouth of the Feather River.

- Similar spawning conditions, because of modeling results indicating generally similar monthly probabilities of water temperatures occurring within the specified water temperature range for all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the Feather River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Sutter Bypass

Potential impacts to fisheries and aquatic resources in the Sutter Bypass under Alternative A relative to the No Project/No Action Alternative would be similar to those discussed under Alternative A relative to Existing Conditions, above.

Folsom Lake

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Folsom Lake during April through November.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage, and higher average monthly storage by water year type occurring during most months of the evaluation period; (2) higher monthly storage exceedance probabilities occurring during all months of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during all months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Folsom Lake, Alternative A would result in beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Folsom Lake during March through June.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar warmwater fish spawning and early life stage conditions, because of modeling results indicating similar frequencies of monthly water surface elevation reductions of six feet or more.

In conclusion, in consideration of potential impacts to warmwater fish species in Folsom Lake, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

American River

Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River, in addition to model results for spawning habitat availability (WUA) (Appendix 12N) at Sailor Bar through Rossmoor and early life stage mortality (Appendix 12J).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or improved adult immigration and holding conditions due to modeling results indicating: (1) higher long-term average monthly flows during most months of the evaluation period, and higher average monthly flows by water year type during most water year types at the locations evaluated in the American River, although lower flows would occur throughout the evaluation period; (2) higher monthly flow exceedance probabilities during the evaluation period at all locations evaluated, although equivalent or slightly lower probabilities of exceedance would occur during November; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring during most months of the evaluation period at all locations evaluated, except for during November, when probabilities of exceedance would be slightly lower; and (4) equivalent or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Similar adult spawning conditions due to modeling results indicating slightly lower spawning habitat availability during the evaluation period, although significantly higher spawning habitat availability would occur during November, and similar monthly probabilities of exceeding specified water temperature index values.
- Similar embryo incubation conditions due to modeling results indicating slightly lower, although similar, total annual early life stage mortality and similar monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) higher monthly flow exceedance probabilities during all months of the evaluation period; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities during March through June, with significantly higher probabilities of exceedance during May and June, although slightly lower probabilities of exceedance would occur during January and February; and (4) similar probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the American River, Alternative A would result in slightly beneficial, although generally similar, less-than-significant impacts, relative to the No Project/No Action Alternative.

Spring-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined at the mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar non-natal juvenile rearing conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with the exception of November when probabilities of exceedance would be lower; (3) during low flow conditions, equivalent or lower flow exceedance probabilities during most months of the evaluation period, although slightly higher probabilities of exceedance would occur during December and April; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values throughout the evaluation period.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the American River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Steelhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River, in addition to model results for spawning habitat availability (WUA) (Appendix 12N) at Sailor Bar through Rossmoor.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult immigration and holding conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with the exception of November when probabilities of exceedance would be equivalent or lower; (3) during low flow conditions, equivalent or lower flow exceedance probabilities during most months of the evaluation period, although slightly higher probabilities of exceedance occur during December and April; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values, particularly during November and December.
- Similar or less suitable spawning conditions due to lower spawning habitat availability, and similar or slightly higher monthly probabilities of exceeding specified water temperature index values.
- Similar embryo incubation conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type; (2) higher monthly flow exceedance probabilities during entire the evaluation period; (3) during low flow conditions, lower flow exceedance probabilities during January and February, and equivalent or higher flow exceedance probabilities during March through May; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during November, June, and July; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with slightly lower flows during November at Watt Avenue and the mouth of the American River, and substantially lower flows during July at all evaluated locations; (3) during low flow conditions, higher flow exceedance probabilities during most months of the evaluation period, although equivalent or lower probabilities of exceedance would occur during November and January through March; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values.

- Similar or improved smolt emigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type; (2) higher monthly flow exceedance probabilities during entire the evaluation period; (3) during low flow conditions, equivalent or lower flow exceedance probabilities during March through June, although higher probabilities of exceedance would occur during January and February; and (4) similar probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the American River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Green Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined at the mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or improved adult immigration and holding conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during November, June, and July; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with slightly lower flows during November and substantially lower flows during July; (3) during low flow conditions, higher flow exceedance probabilities during most months of the evaluation period, although equivalent or lower probabilities of exceedance would occur during November, February, and March; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values.
- Similar spawning and egg incubation conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during July; (2) higher monthly flow exceedance probabilities occurring during most of the evaluation period, although lower probabilities of exceedance would occur during July; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities during all months of the evaluation period; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values, particularly during June through August.
- Similar or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during November, June, and July; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with slightly lower flows during November at Watt Avenue and the Mouth of the American River, and substantially lower flows during July at all evaluated locations; (3) during low flow conditions, higher flow exceedance probabilities during most months of the evaluation period, although equivalent or lower probabilities of exceedance would occur during November and January through March; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the American River, Alternative A would result in slightly beneficial, although generally similar, less-than-significant impacts, relative to the No Project/No Action Alternative.

River Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or improved adult immigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although slightly lower flows would occur more frequently during November and June; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with slightly lower flows during November at Watt Avenue and the mouth of the American River; and (3) during low flow conditions, higher flow exceedance probabilities during most months of the evaluation period, although equivalent or lower probabilities of exceedance would occur during November and January through March.
- Similar or improved spawning and egg incubation conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows generally would occur more frequently during July; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although substantially lower probabilities of exceedance would occur during July; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities, although lower probabilities of exceedance would occur during February; and (4) similar or slightly higher monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during November, June, and July; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with equivalent or lower flows during November and July; (3) during low flow conditions, higher flow exceedance probabilities during most months of the evaluation period, although equivalent or lower probabilities of exceedance would occur during November and January through March; and (4) equivalent or higher probabilities of remaining within the specified water temperature range throughout the year, particularly during June through September.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the American River, Alternative A would result in potentially beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or improved adult immigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type; (2) higher monthly flow exceedance probabilities during the evaluation period; and (3) during low flow conditions, equivalent or higher flow exceedance probabilities during most months of the evaluation period, although lower probabilities of exceedance would occur during January and February.
- Similar or improved spawning and egg incubation conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows generally would occur more frequently during July; (2) equivalent or higher monthly flow exceedance probabilities during most of the evaluation period at all locations, except for July when probabilities of exceedance would be lower; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at all evaluated locations, although equivalent or slightly lower probabilities of exceedance would occur during January through March; and (4) similar or slightly higher monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during November, June, and July; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with equivalent or lower flows occurring during November and July; (3) during low flow conditions, higher flow exceedance probabilities during most months of the evaluation period, although equivalent or lower probabilities of exceedance would occur during November and January through March; and (4) equivalent or lower probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the American River, Alternative A would result in beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Hardhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult and other life stage conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during November, June, and July; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with equivalent or lower flows during November and July; (3) during low flow conditions, higher flow exceedance probabilities during most months of the evaluation period, although equivalent or lower probabilities of exceedance would occur during November and January through March; and (4) similar or slightly higher probabilities of remaining within specified water temperature ranges.

- Improved spawning conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows by water year type; (2) higher monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, substantially higher monthly flow exceedance probabilities during the entire evaluation period; and (4) similar or slightly higher probabilities of remaining within specified water temperature ranges.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the American River, Alternative A would result in potentially beneficial, although similar, less-than-significant impacts, relative to the No Project/No Action Alternative.

California Roach

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult and other life stage conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during November, June, and July; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with equivalent or lower flows occurring during November and July; (3) during low flow conditions, higher flow exceedance probabilities during most months of the evaluation period, although equivalent or lower probabilities of exceedance would occur during November and January through March; and (4) equivalent probabilities of exceeding specified water temperature index values.
- Similar or slightly improved spawning conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type; (2) higher monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities; and (4) equivalent or slightly lower probabilities of exceeding specified water temperature index values.
- In conclusion, in consideration of potential impacts to all life stages of California roach in the American River, Alternative A would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Splittail

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at the mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar spawning conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type across all water year types; (2) higher monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities during most of the evaluation period, with slightly lower probabilities of exceedance during February(4) similar or slightly lower usable flooded area (UFA) exceedance probabilities of 10 percent or more; and (5) equivalent probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of splittail in the American River, Alternative A would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Striped Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam and the mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or improved adult spawning, embryo incubation, and initial rearing conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type; (2) higher monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, higher monthly flow exceedance probabilities during the entire evaluation period; and (4) similar or slightly higher probabilities of remaining within the specified water temperature range during the evaluation period.
- Similar or improved larvae, fry, and juvenile rearing and emigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during November, June, and July; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with equivalent or lower flows during November and July; (3) during low flow conditions, higher flow exceedance probabilities during most months of the evaluation period, although equivalent or lower probabilities of exceedance would occur during November and January through March; and (4) similar or higher probabilities of remaining within the specified water temperature range throughout the year, particularly during June through September.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the American River, Alternative A would result in beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

American Shad

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue and the mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or improved adult spawning, embryo incubation, and initial rearing conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type; (2) higher monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, higher monthly flow exceedance probabilities during the entire evaluation period; and (4) similar probabilities of remaining within the specified water temperature range during the evaluation period.

- Similar or improved larvae, fry, and juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during July; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although equivalent or lower probabilities of exceedance would occur during November and July; (3) during low flow conditions, higher monthly flow exceedance probabilities, although slightly lower probabilities of exceedance would occur during November; and (4) equivalent or slightly higher monthly probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of American shad in the American River, Alternative A would result in beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Largemouth Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue.

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult and other life stage conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows the evaluation period, and similar or slightly higher average monthly flows by water year type during most of the period; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with equivalent or lower flows during November and July; and (3) during low flow conditions, higher flow exceedance probabilities during most months of the evaluation period, although equivalent or lower probabilities of exceedance would occur during November and January through March.
- Similar spawning conditions due to equivalent probabilities of remaining within specified water temperature ranges.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the American River, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Sacramento-San Joaquin Delta and Yolo Bypass

Delta Smelt in the Delta Region

Model results were examined for water temperatures (Appendix 12E) in the Sacramento River at Freeport, OMR flows (Appendix 12E), Delta outflow (Appendix 12E), salvage at the SWP and CVP export facilities (Appendix 12I), and X2 location (Appendix 12E).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult conditions, because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range (December through May); (2) similar overall normalized mean monthly salvage at the SWP and CVP export facilities (December through April); and (3) similar monthly probabilities of OMR flows being more negative than -5,000 cfs (December through February)
- Less suitable spawning conditions in the Yolo Bypass (December through May), because of modeling results indicating: (1) lower long-term average Yolo Bypass outflow; (2) flow exceedance probabilities during December through April; and (3) during low flow conditions, higher flow exceedance probabilities during January and February, and lower flow exceedance probabilities during December, March and April, albeit similar flows during low flow conditions.
- Similar egg and embryo conditions (February through May), because of modeling results indicating similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range
- Similar larvae conditions (March through June), because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range; (2) during March through June of dry and critical water years, slightly higher (less negative) mean monthly OMR flows when flows would be equal to or more negative than -1,500 cfs; and (3) during the latter portion of the larval delta smelt downstream migration period (i.e., May and June), long-term average and average by water year type monthly Delta outflow would be similar during May but slightly increased during June, while monthly Delta outflow exceedance probabilities would be similar during May, but higher more often during June.
- Similar or improved juvenile conditions (May through July), because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range; (2) similar overall normalized mean monthly salvage at the SWP and CVP export facilities; (3) Between RKm 65 and 80, long-term average and average by water year type X2 location would be equivalent during May, move slightly downstream during June (by 0.6 RKm or less), and move downstream during July (by 1.2, 1.5 and 1.5 RKm during wet, above normal and below normal water years, respectively); and (4) lower Yolo Bypass outflow and potentially reduced productivity in the Delta.

In conclusion, in consideration of potential impacts to all life stages of delta smelt in the Delta, Alternative A would result in similar or beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Longfin Smelt in the Delta Region

Model results were examined for OMR flows (Appendix 12E), salvage at the SWP and CVP export facilities (Appendix 12I), and X2 location (Appendix 12E).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar adult conditions because of equivalent or similar monthly probabilities of OMR flows being more negative than -5,000 cfs during December through March
- Similar larvae and juvenile conditions because of modeling results indicating: (1) equivalent or similar monthly probabilities of OMR flows being more negative than -5,000 cfs during December

through March; (2) during April and May of dry and critical water years, mean monthly OMR flows would be lower during April of dry and critical water years (by 2.5 and 4.9 percent, respectively) and during May of critical water years (by 12.5 percent) and would be higher during May of dry water years (by 6.6 percent); (3) similar overall mean monthly salvage at the SWP and CVP export facilities; (4) slightly lower (during January through May) and slightly higher (during June) monthly exceedance probabilities of X2 location occurring at or downstream of 75 RKm during January through June; and (5) lower Yolo Bypass outflow and potentially reduced productivity in the Delta.

In conclusion, in consideration of potential impacts to all life stages of longfin smelt in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Splittail in the Delta Region

Model results were examined for Yolo Bypass outflow (Appendix 12E) and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Less suitable egg and larval conditions (February through May) because of modeling results indicating: (1) slightly reduced mean monthly Yolo Bypass outflow during most months of wet water years and reduced mean monthly flows during February through April of above normal and below normal water years, during February and March of dry water years and during March of critical water years, with mean monthly reductions of 10 percent or more during March of above normal water years, during February through April of below normal water years, and during March of dry and critical water years; and (2) lower flow exceedance probabilities (of 10 percent or more) more often during February through April, and similar flow exceedance probabilities during May
- Similar juvenile rearing and emigration conditions (April through July) because of modeling results indicating: (1) similar mean monthly Yolo Bypass outflow during all water year types; (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; (3) similar flow exceedance probabilities (of 10 percent or more); and (4) similar overall simulated mean monthly salvage at the SWP and CVP export facilities during April through July
- Less suitable adult spawning and upstream migration conditions, because of modeling results indicating: (1) reduced mean monthly Yolo Bypass outflow during February and March, as discussed above for egg and larval conditions; and (2) similar overall simulated mean monthly salvage at the SWP and CVP export facilities during December through March

In conclusion, in consideration of potential impacts to all life stages of splittail in the Delta Region including the Yolo Bypass, Alternative A would result in less suitable and potentially significant impacts, relative to the No Project/No Action Alternative. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Winter-run Chinook Salmon in the Delta Region

Model results were examined for through-Delta juvenile survival (Appendix 12M).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or less suitable juvenile conditions, because of modeling results indicating: (1) slightly lower monthly Delta survival exceedance probabilities more often; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile winter-run Chinook salmon in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Spring-run Chinook Salmon in the Delta Region

Model results were examined for through-Delta juvenile survival (Appendix 12M).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or less suitable juvenile rearing and emigration conditions, because of modeling results indicating: (1) slightly reduced monthly Delta survival exceedance probabilities more often; and (2) generally lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile spring-run Chinook salmon in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Fall-run and Late Fall-run Chinook Salmon in the Delta Region

Model results were examined for OMR flows (Appendix 12E) and through-Delta juvenile survival (Appendix 12M).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar San Joaquin River adult straying conditions because of equivalent or similar monthly probabilities of OMR flows being more negative than -5,000 cfs during December through February
- Similar or less suitable juvenile conditions because of modeling results indicating: (1) slightly lower monthly Delta survival exceedance probabilities more often; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile and San Joaquin River adult fall and late fall-run Chinook salmon in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Steelhead in the Delta Region

Model results were examined for Sacramento River flows (Appendix 12F) at Rio Vista, Yolo Bypass outflow (Appendix 12E), Delta outflow (Appendix 12E), OMR flows (Appendix 12E), and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar juvenile rearing and emigration conditions in the Delta (October through July) because of modeling results indicating: (1) higher long-term average and average by water year type monthly flows at Rio Vista during October, November, June and July, and lower average monthly flows during December through April; (2) higher monthly flow exceedance probabilities at Rio Vista during October through November, June and July, and lower flow exceedance probabilities during December through April, with higher flow exceedance probabilities during all months except for during March through May during low flow conditions; (3) lower mean monthly Yolo Bypass outflow and lower flow exceedance probabilities; (4) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; (5) lower long-term average and average by water year type monthly Delta outflow during most months of most water year types, but with higher Delta outflow during June, July of all water year types, during October and November of below normal water years, during October of dry water years and during October and December of critical water years; (6) lower or similar long-term average and average by water year type monthly OMR flows; and (7) similar overall simulated mean monthly salvage at the SWP and CVP export facilities, but with higher mean monthly salvage during below normal and critical water years at the CVP export facility

In conclusion, in consideration of potential impacts to all life stages of Central Valley steelhead in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative. Alternative A impacts on steelhead in the Yolo Bypass are considered potentially significant, relative to the No Project/No Action Alternative. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Green Sturgeon in the Delta Region

Model results were examined for Yolo Bypass outflow (Appendix 12E) and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar or less suitable juvenile rearing and emigration conditions (year-round) because of modeling results indicating: (1) lower mean monthly Yolo Bypass outflow and lower flow exceedance probabilities; (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; and (3) similar simulated mean monthly salvage at the SWP and CVP export facilities

In conclusion, in consideration of potential impacts to green sturgeon in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative. Alternative A impacts on green sturgeon in the Yolo Bypass are considered potentially significant, relative to the No Project/No Action Alternative. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

White Sturgeon in the Delta Region

Model results were examined for Yolo Bypass outflow (Appendix 12E) and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar juvenile rearing and emigration conditions (year-round) because of modeling results indicating: (1) lower mean monthly Yolo Bypass outflow and lower flow exceedance probabilities; (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; and (3) similar simulated mean monthly salvage at the SWP and CVP export facilities

In conclusion, in consideration of potential impacts to white sturgeon in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative. Alternative A impacts on white sturgeon in the Yolo Bypass are considered potentially significant, relative to the No Project/No Action Alternative. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Pacific and River Lamprey in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar macropthalmia emigration conditions (year-round) because of modeling results indicating similar simulated mean monthly salvage at the SWP export facility, slightly lower mean monthly salvage at the CVP export facility during most water year types, but higher mean monthly salvage at both facilities during critical water years

In conclusion, in consideration of potential impacts to Pacific and river lamprey in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

American Shad in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I) and X2 location (Appendix 12E).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar egg and larval conditions in the Delta because of modeling results indicating: (1) slightly lower (during April and May) and slightly higher (during June) exceedance probabilities of X2 location being located at or downstream of 75 RKm during April through June; (2) slightly higher overall mean monthly salvage at the SWP and CVP export facilities; and (3) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to American shad in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Striped Bass in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I) and X2 location (Appendix 12E).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Similar egg and larval conditions in the Delta because of modeling results indicating: (1) slight upstream mean monthly movements in X2 location during April and May of all water year types, but with upstream movements of 0.5 RKm or more during April of below normal and dry water years, and slight downstream mean monthly movements in X2 location during June of all water year types, but with downstream movements of 0.5 RKm or more during June of below normal and dry water years; (2) similar overall normalized mean monthly salvage at the SWP and CVP export facilities; and (3) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to striped bass in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Largemouth Bass in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I) and X2 location (Appendix 12E).

Relative to the No Project/No Action Alternative, Alternative A would generally be expected to provide:

- Less suitable juvenile rearing conditions in the Yolo Bypass because of modeling results indicating: (1) lower mean monthly Yolo Bypass outflow, in addition to lower flow exceedance probabilities; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta
- Similar juvenile and adult conditions in the Delta because of modeling results indicating: (1) upstream mean monthly movements in X2 location of 0.5 RKm or more during December of wet water years, during December through March of above normal water years, during January through April of below normal and dry water years and during January through March of critical water years, and downstream mean monthly movements in X2 location of 0.5 RKm or more during July and August of wet water years, during July through September of above normal water years, during June through December of below normal water years, during June through October of dry water years and during July, August and October of critical water years; and (2) similar overall simulated mean monthly salvage at the SWP and CVP export facilities, but with slightly higher mean monthly salvage under above normal, below normal and critical water years at the SWP export facility and during critical water years at the CVP export facility.

In conclusion, in consideration of potential impacts to largemouth bass in the Delta, Alternative A would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative. Alternative A impacts on largemouth bass in the Yolo Bypass are considered potentially significant, relative to the No Project/No Action Alternative. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Suisun, San Pablo, and San Francisco Bays

Fish species of primary management concern, including Chinook salmon, steelhead, river lamprey, Pacific lamprey, green sturgeon, white sturgeon, and splittail utilize the bays as a migration corridor and/or for juvenile rearing. Potential increases in Delta outflow during the summer and fall and reductions in Delta outflow during the spring would not result in substantial changes to migration or rearing habitat for these fish species in the bays. Striped bass and American shad also utilize the bays for migration and rearing, however, changes in X2 location were evaluated during the striped bass and American shad spawning and initial rearing period to evaluate potential changes in larval transport and rearing habitat in the Bay-Delta (see the Delta Region, above). Potential effects on delta smelt and longfin smelt migration and rearing in the Bay-Delta also were analyzed through evaluation of changes in X2 location (see the Delta Region, above).

12C.5.3 Primary Study Area – Alternative A Relative to the No Project/No Action Alternative

12C.5.3.1 Construction, Operation, and Maintenance Impacts

For a discussion of impacts to fisheries and aquatic resources under Alternative A relative to the No Project/No Action Alternative in the Primary Study Area, refer to the Environmental Consequences section of Chapter 12 Aquatic Biological Resources.

12C.6 Impacts Associated with Alternative B Relative to Existing Conditions

12C.6.1 Extended Study Area – Alternative B Relative to Existing Conditions

12C.6.1.1 SWP and CVP Operations

Agricultural Water Use

Potential impacts to fisheries and aquatic resources associated with agricultural water use are discussed under Alternative A relative to Existing Conditions, above, and are applicable to Alternative B relative to Existing Conditions.

Municipal and Industrial Water Use

Potential impacts to fisheries and aquatic resources associated with municipal and industrial water use are discussed under Alternative A relative to Existing Conditions, above, and are applicable to Alternative B relative to Existing Conditions.

Wildlife Refuge Water Use

Potential impacts to fisheries and aquatic resources associated with wildlife refuge water use are discussed under Alternative A relative to Existing Conditions, above, and are applicable to Alternative B relative to Existing Conditions.

San Luis Reservoir

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for San Luis Reservoir during April through November.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Less suitable coldwater pool storage conditions, because of modeling results indicating: (1) lower long-term average monthly storage, and lower monthly storage exceedance probabilities occurring more often during the evaluation period

In conclusion, in consideration of potential impacts to coldwater fish species in San Luis Reservoir, Alternative B would result in similar or slightly less suitable and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for San Luis Reservoir during March through June.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar or slightly less suitable warmwater fish spawning and early life stage conditions, because of modeling results indicating similar or slightly increased frequencies of monthly water surface elevation reductions of six feet or more during most months of the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in San Luis Reservoir, Alternative B would result in similar or slightly less suitable and less-than-significant impacts, relative to Existing Conditions.

Export Service Area Reservoirs

Export Service Area Reservoir Fisheries

Changes in modeled total SWP and CVP Delta exports (Appendix 12H) under Alternative B relative to Existing Conditions were analyzed to evaluate potential changes in storage and water surface elevations and associated impacts on fisheries in export service area reservoirs, including Anderson Reservoir, Diamond Valley Lake, Castaic Lake, Lake Mathews, and Lake Perris.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Equivalent or improved export service area reservoir fisheries habitat conditions, because of modeling results indicating: (1) long-term average and average monthly by water year type Delta exports would be slightly higher during most months of all water year types, and would be higher by 10 percent or more during September through November of wet water years, during September and November of above normal, and during August, September and November of critical water years, and would be lower by 10 percent or more during December of critical water years; (2) higher monthly export exceedance probabilities during June through January, and lower export exceedance probabilities during February through May; and (3) a net 10 percent or more export probability of exceedance increase during most months of the year.

In conclusion, in consideration of potential impacts to SWP and CVP export service area reservoir fisheries, Alternative B would result in potentially more suitable and less-than-significant impacts, relative to Existing Conditions.

12C.6.2 Secondary Study Area – Alternative B Relative to Existing Conditions

12C.6.2.1 Construction, Operation, and Maintenance Impacts

Construction, operation, and maintenance impacts in the Secondary Study Area under Alternative B would be similar to those discussed above under Alternative A relative to Existing Conditions.

12C.6.2.2 SWP and CVP Operations

Trinity Lake

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Trinity Lake during April through November.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage, and higher average monthly storage by water year type during all months of the evaluation period; (2) higher monthly storage exceedance probabilities during all months of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during all months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Trinity Lake, Alternative B would result in potentially more suitable and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Trinity Lake during March through June.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Slightly improved warmwater fish spawning and early life stage conditions, because of modeling results indicating slightly reduced frequencies of monthly water surface elevation reductions of six feet or more during most of the March through June evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Trinity Lake, Alternative B would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

Trinity River

Coho Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Equivalent adult immigration and holding conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during the evaluation period; and (4) similar, or slightly lower (particularly during September and October) or slightly higher (particularly during November) average monthly probabilities of exceeding specified water temperature index values.

- Equivalent adult spawning and embryo incubation conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values, with slightly lower monthly probabilities of exceedance during October, and slightly higher probabilities during April.

- Equivalent or slightly improved juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year, with slightly lower probabilities of exceedance, and therefore more suitable water temperatures during July through October, although slightly higher probabilities of exceedance occur during April and June.

- Equivalent smolt emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values, particularly during June.

In conclusion, in consideration of potential impacts to all life stages of Coho salmon in the Trinity River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Spring-Run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, with slightly lower average monthly flows during wet water years; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during the evaluation period; and (4) similar, or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values, particularly during July through September.

- Improved adult spawning and egg incubation conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly lower average monthly flows during all water year types; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during the evaluation period; and (4) lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, at most water temperature indices during August through October.
- Equivalent or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during July through September.
- Equivalent smolt emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent or similar probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during July.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Trinity River, Alternative B would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

Fall-Run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork, in addition to model results for early life stage mortality (Appendix 12J).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly lower average monthly flows during most water year types; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during the evaluation period; and (4) similar, or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values, particularly during August and September.

- Equivalent adult spawning conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during June and October, although slightly higher probabilities of exceedance would occur during April.
- Improved embryo incubation conditions due to modeling results indicating reduced total annual early life stage mortality, and equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during June and October, although slightly higher probabilities of exceedance would occur during April.
- Equivalent or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) equivalent or similar probabilities of exceeding specified water temperature index values throughout most of the evaluation period, with slightly lower probabilities of exceedance during June through September.
- Equivalent or slightly improved smolt emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) equivalent or similar probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during July.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Trinity River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Steelhead (Winter-run and Summer-run)

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Equivalent adult immigration and holding conditions for winter-run steelhead due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) similar average monthly probabilities of exceeding specified water temperature index values, with slightly lower monthly probabilities of exceedance during August through October, although slightly higher probabilities would occur during March and April.
- Equivalent adult immigration and holding conditions for summer-run steelhead due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly lower average monthly flows during all water year types; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout the evaluation period, with higher probabilities of exceedance during June and slightly lower probabilities during August.
- Equivalent or reduced adult spawning and egg incubation conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year, with higher probabilities of exceedance during March through June.
- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with slightly lower probabilities of exceedance during July and higher probabilities during September.

- Equivalent or reduced smolt emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or lower average monthly flows, particularly during wet water years when average monthly flows would be lower more frequently, and during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent or lower probabilities of exceeding specified water temperature index values, particularly during March through June.

In conclusion, in consideration of potential impacts to all life stages of steelhead (winter-run and summer-run) in the Trinity River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Green Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam and at North Fork.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Equivalent adult immigration and holding conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) similar average monthly probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during June.

- Equivalent adult spawning conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values during the evaluation period.

- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Trinity River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

White Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam and at North Fork.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Equivalent adult immigration and holding conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.
- Equivalent adult spawning conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.
- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Trinity River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Equivalent adult immigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; and (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period.
- Equivalent adult spawning and egg incubation conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar average monthly probabilities of remaining within the specified water temperature range, although slightly higher probabilities of exceedance would occur during June.
- Generally equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and generally similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values, although slightly higher probabilities of exceedance would occur during September.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Trinity River, Alternative B would result in generally similar and less-than-significant impacts, relative to Existing Conditions.

Klamath River downstream of the Trinity River

Because potential changes within the Trinity River were considered to be less than significant under Alternative B, it is expected that any potential changes in the Klamath River downstream of the Trinity River also would be less than significant.

Lewiston Lake, Whiskeytown Lake, Keswick Reservoir, Lake Natoma, and the Thermalito Complex

Modeling was not conducted for Lewiston Lake, Keswick Reservoir, Lake Natoma, or the Thermalito Complex. However, modeling conducted on the reservoirs upstream of these regulating reservoirs indicates that Alternative B, when compared to Existing Conditions, would result in either no change or insignificant changes to storage and water surface elevation fluctuations. Because these reservoirs would continue to operate as regulating reservoirs, it is assumed that there would not be substantial changes in storage or water surface elevations, resulting in less-than-significant impacts to fish species of primary management concern.

Because flows released from Whiskeytown Lake would not experience significant changes, storage and water surface elevations would not be expected to substantially change under Alternative B. Therefore, potential changes in storage and water surface elevation in Whiskeytown Lake are anticipated to result in less-than-significant impacts to coldwater and warmwater fish species, respectively.

Spring Creek

It is not anticipated that operations of Spring Creek Reservoir or flows in Spring Creek would be substantially affected under implementation of Alternative B. It is anticipated that Spring Creek Reservoir would continue to operate for flood control purposes, and to manage the release of contaminated water from Iron Mountain Mine.

Shasta Lake

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Shasta Lake during April through November.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Improved coldwater pool storage conditions, because of modeling results indicating: (1) higher average monthly storage, and slightly higher average monthly storage by water year type during most months of the evaluation period; (2) equivalent or higher monthly storage exceedance probabilities during all months of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during all months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Shasta Lake, Alternative B would result in potentially more suitable and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Shasta Lake during March through June.

Relative to Existing Conditions, Alternative B would be expected to provide:

- Similar or improved warmwater fish spawning and early life stage conditions, because of decreased frequencies of monthly water surface elevation reductions of six feet or more during most months of the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Shasta Lake, Alternative B would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

Sacramento River

Winter-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for spawning habitat availability (WUA) (Appendix 12N), early life stage mortality (SacSalMort) (Appendix 12J), overall population mortality and production potential (SALMOD) (Appendix 12K) and lifecycle modeling (IOS) (Appendix 12L).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) lower or similar long-term average and average by water year type monthly flows in the upper Sacramento River, and similar or higher average monthly flows in the lower Sacramento River; (2) lower monthly flow exceedance probabilities occurring over more than half of the evaluation period in the upper Sacramento River and below the Feather River confluence, and higher flow exceedance probabilities at Freeport and Verona; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at most locations, and lower flow exceedance probabilities below Red Bluff Diversion Dam; (4) equivalent monthly probabilities of exceeding specified water temperature index values, but with higher probabilities of exceeding specified water temperature index values during April and May.
- Improved spawning conditions due to modeling results indicating increased spawning habitat availability during most months of the spawning period, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during months with relatively warm water temperature conditions (i.e., July and August).
- Similar or improved embryo incubation conditions due to reduced mean total annual early life stage mortality, reduced annual early life stage mortality over approximately 50 percent of the entire cumulative frequency distribution, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during months with relatively warm water temperature conditions (i.e., July and August).
- Generally improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type occurring more often in the upper Sacramento River, and higher and lower average monthly flows occurring with similar monthly frequencies in the lower Sacramento River; (2) higher monthly flow exceedance probabilities occurring more often below Keswick Dam, at Freeport and at Rio Vista, and lower monthly flow exceedance probabilities below Red Bluff Diversion Dam and below the Feather River Confluence; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at most locations evaluated; and (4) lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values during July through September, and higher probabilities of exceeding specified water temperature index values during April.
- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by 13 percent), and average annual mortality by water year type would be reduced during all water year types (by six percent during wet water years, 22 percent during

above normal water years, seven percent during below normal water years, 20 percent during dry water years, and 13 percent during critical water years); (2) a decrease in total annual mortality exceedance probabilities over more than 75 percent of the distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction, with 10 percent or more exceedance probability reductions occurring over 15 percent of the entire distribution; and (4) long-term average total annual winter-run Chinook salmon production would increase by two percent, while average total annual production would decrease during wet water years by less than one percent, and increase during above normal water years by six percent, during below normal water years by one percent, during dry water years by three percent, and during critical water years by two percent.

- Improved conditions pertaining to early life stage survival and abundance of spawners (IOS) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual egg to fry survival would increase by three percent, and average annual egg to fry survival by water year type would be decreased during wet and above normal water years by one percent and less than one percent, respectively, and would increase during below normal and dry water years by four percent, and during critical water years by 26 percent; (2) long-term average annual fry to smolt survival would increase by two percent, and average annual fry to smolt survival by water year type would be equivalent during wet and above normal water years, reduced during below normal water years by three percent and during dry water years by two percent, and would increase during critical water years by 21 percent; (3) long-term average annual female spawner abundance would increase by 10 percent, and average annual female spawner abundance by water year type would increase during wet water years by 11 percent, during above normal water years by 18 percent, during below normal water years by four percent, during dry water years by eight percent, and during critical water years by 15 percent; (4) an increase in annual egg to fry survival exceedance probabilities over approximately 65 percent of the entire distribution, particularly at lower survival rates; (5) an increase in annual fry to smolt survival exceedance probabilities over approximately 65 percent of the entire distribution, particularly at lower survival rates; and (6) an increase in annual female spawner abundance exceedance probabilities over more than 95 percent of the entire distribution.

In conclusion, in consideration of potential impacts to all life stages of winter-run Chinook salmon in the Sacramento River, Alternative B would result in beneficial and less-than-significant impacts, relative to Existing Conditions.

Spring-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball’s Ferry, Jelly’s Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J) and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type more often in the upper Sacramento River, and higher and lower long-term average monthly and average monthly flows by water year type occurring with similar monthly frequencies in the lower Sacramento River; (2) lower monthly flow exceedance probabilities more often in the upper

Sacramento River, and higher monthly flow exceedance probabilities more often in the lower Sacramento River; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at most locations evaluated, with lower average monthly flows more often below Red Bluff Diversion Dam; (4) lower (particularly during July through September) and slightly higher (particularly during April and May) monthly probabilities of exceeding specified water temperature index values.

- Improved spawning conditions due to modeling results indicating higher average monthly flows and flow exceedance probabilities more often, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during months with warm water temperature conditions (i.e., September and October).

- Improved embryo incubation conditions due to modeling results indicating reduced average total annual early life stage mortality and reduced early life stage mortality over most of the cumulative frequency distribution, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures.

- Similar juvenile rearing conditions due to modeling results indicating: (1) lower long-term average monthly flows during more than half of the evaluation period in the upper Sacramento River; (2) lower monthly flow exceedance probabilities more often in the upper Sacramento River; (3) under low flow conditions, higher monthly flow exceedance probabilities more often below Keswick Dam, and lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam; and (4) equivalent or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values.

- Similar smolt emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type during more than half of the evaluation period below Red Bluff Diversion Dam and at Verona, and higher average monthly flows more often at Freeport and Rio Vista; (2) lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam and at Verona, and higher flow exceedance probabilities more often at Freeport and Rio Vista; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at most locations evaluated, but with lower flow exceedance probabilities below Red Bluff Diversion Dam; and (4) higher monthly probabilities of exceeding specified water temperature index values during April and May, and lower monthly probabilities of exceeding specified water temperature index values during October and June.

- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by 20 percent), and average annual mortality by water year type would be reduced during all water year types (by 26 percent during wet water years, three percent during above normal water years, six percent during below normal water years, 42 percent during dry water years, and 13 percent during critical water years); (2) a decrease in total annual mortality exceedance probabilities over approximately 85 percent of the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction, with reductions of 10 percent or more occurring over more than 65 percent of the distribution; and (4) long-term average total annual spring-run Chinook salmon production would increase by four percent, while average total annual production increases during wet, above normal and below normal water years by one percent, during dry water years by 10 percent, and during critical water years by six percent.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Sacramento River, Alternative B would result in beneficial and less-than-significant impacts, relative to Existing Conditions.

Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J), spawning habitat availability (WUA) (Appendix 12N), and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type during most of the evaluation period in the upper Sacramento River, and higher long-term average monthly and average monthly flows by water year type in the lower Sacramento River; (2) higher or equivalent monthly flow exceedance probabilities in the upper Sacramento River, and higher monthly flow exceedance probabilities during most months evaluated in the lower Sacramento River; (3) during low flow conditions, higher or equivalent monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated; (4) lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values.
- Less suitable spawning conditions due to modeling results indicating reduced spawning habitat availability during December and January, and lower or equivalent probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, specifically during October.
- Improved embryo incubation conditions due to modeling results indicating reduced mean total annual early life stage mortality and reduced annual early life stage mortality over almost the entire cumulative frequency distribution, and lower or equivalent probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during more than half of the evaluation period at all locations evaluated; (2) lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam and at Verona, and higher monthly flow exceedance probabilities more often at Freeport and Rio Vista; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at all locations evaluated, except for below Red Bluff Diversion Dam where flows would be lower with more often; and (4) similar monthly probabilities of exceeding specified water temperature index values, but with less suitable water temperatures during April and May more often.
- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by five percent), average annual mortality by water year type would increase during wet and below normal water years by four and less than one percent, respectively, and would decrease during above normal water years by 13 percent, during dry water years by 11 percent, and during critical water years by 23 percent; (2) a decrease in total annual mortality exceedance

probabilities over more than 55 percent of the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction; and (4) long-term average total annual fall-run Chinook salmon production would increase by three percent, while average total annual production decreases during wet water years by eight percent and during below normal water years by less than one percent, and increases during above normal water years by 11 percent, during dry water years by four percent, and during critical water years by 13 percent.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Late Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J) and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly flows by water year type with similar monthly frequencies below Keswick Dam, and lower long-term average monthly and average monthly flows by water year type more often below Red Bluff Diversion Dam and in the lower Sacramento River; (2) lower monthly flow exceedance probabilities during more than half of the months evaluated below Red Bluff Diversion Dam and at Verona, and higher monthly flow exceedance probabilities more often below Keswick Dam, at Freeport and at Rio Vista; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated except for below Red Bluff Diversion Dam where flow exceedance probabilities would be lower more often; (4) similar monthly probabilities of exceeding specified water temperature index values, but with more suitable water temperatures during October and less suitable water temperatures during April.

- Similar spawning conditions due to modeling results indicating higher average monthly flows during January and February and lower average monthly flows during March through May, and similar probabilities of exceeding specified water temperature index values.

- Similar or less suitable embryo incubation conditions due to modeling results indicating: (1) slightly reduced average total annual early life stage mortality, but with higher annual mortality during above normal, below normal, dry and critical water years, and higher annual mortality over about 68 percent of the cumulative frequency distribution; and (2) similar probabilities of exceeding specified water temperature index values.

- Similar or improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows more often below Red Bluff Diversion Dam, and higher average monthly flows more often in the lower Sacramento River; (2) similar or lower monthly flow exceedance probabilities below Red Bluff Diversion Dam, and higher monthly flow exceedance probabilities in the lower Sacramento River; (3) under low flow conditions, similar or lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam and higher monthly flow exceedance probabilities more often at all other locations evaluated; and (4) similar or lower monthly probabilities of exceeding specified water temperature index values during most of the year.

- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduce (by one percent), average annual mortality by water year type would increase during wet water years by less than one percent and during above normal water years by six percent, and would decrease during below normal water seven percent, during dry water years by two percent and during critical water years by seven percent; (2) a decrease in total annual mortality exceedance probabilities over approximately 70 percent of the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction; (4) long-term average total annual late fall-run Chinook salmon production would increase by one percent, while average total annual production by water year type would decrease during above normal water years by one percent, and would increase during wet water years by less than one percent, during below normal and dry water years by one percent, and during critical water years by six percent.

In conclusion, in consideration of potential impacts to all life stages of late fall-run Chinook salmon in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Steelhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, and results from the SacEFT (Appendix 8B) were examined for steelhead egg mortality, spawning habitat availability, redd dewatering, redd scouring, juvenile rearing habitat availability and juvenile stranding.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies in the lower Sacramento River, and lower average monthly flows occurring more often in the upper Sacramento River; (2) higher monthly flow exceedance probabilities occurring more often in the lower Sacramento and below Keswick Dam, and lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period in the lower Sacramento River and below Keswick Dam, and higher and lower flow exceedance probabilities occurring with the same monthly frequency below Red Bluff Diversion Dam; (4) lower monthly probabilities of exceeding specified water temperature index values more often during September and October, and higher monthly probabilities of exceeding specified water temperature index values during March.
- Similar spawning conditions due to modeling results indicating: (1) higher mean monthly flows and flow exceedance probabilities during December through February, and lower flows during March and April; (2) higher flow exceedance probabilities more often during low flow conditions; (3) similar probabilities of exceeding specified water temperature index values; and (4) SacEFT results indicating that spawning habitat availability conditions would be similar.

- Similar embryo incubation conditions due to modeling results indicating: (1) similar probabilities of exceeding specified water temperature index values; (2) SacEFT results indicating that egg mortality associated with modeled water temperatures would be equivalent; (3) SacEFT results indicating that redd dewatering conditions may be improved slightly more often; and (4) SacEFT results indicating that redd scouring conditions would be equivalent.
- Similar juvenile rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies below Keswick Dam and at Bend Bridge, and lower average monthly flows occurring more often below Red Bluff Diversion Dam; (2) higher monthly flow exceedance probabilities more often below Keswick Dam and at Bend Bridge, and lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam; (3) under low flow conditions, higher monthly flow exceedance probabilities more often below Keswick Dam and at Bend Bridge, and lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam; (4) equivalent monthly probabilities of exceeding specified water temperature index values, but with lower probabilities of exceeding 65°F during August and September, and therefore more suitable water temperature conditions; and (5) SacEFT results indicating that juvenile rearing habitat availability may be increased slightly more often while juvenile stranding potential may be increased more often.
- Similar smolt emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type more often; (2) lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam and at Verona, and higher monthly flow exceedance probabilities more often at Freeport and Rio Vista; (3) under low flow conditions, lower monthly flow exceedance probabilities below Red Bluff Diversion Dam, and higher monthly flow exceedance probabilities more often at all other locations evaluated; and (4) higher monthly probabilities of exceeding specified water temperature index values during March and April, and lower monthly probabilities of exceeding specified water temperature index values during October.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Green Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities, at Wilkins Slough, at Freeport and at Rio Vista, and egg survival results from the SacEFT (Appendix 8B) were examined.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type below Keswick Dam, and higher long-term average monthly and average monthly flows by water year type more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; (2) higher monthly flow exceedance probabilities more often at all locations evaluated; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring more often at all locations evaluated; and (4) lower, and therefore more suitable, average monthly probabilities of exceeding specified water temperature index values.

- Similar spawning conditions because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type below Keswick Dam and Red Bluff Diversion Dam, and higher and lower long-term average monthly and average monthly flows by water year type with similar monthly frequencies at Wilkins Slough; (2) lower or equivalent monthly flow exceedance probabilities more often below Keswick Dam and Red Bluff Diversion Dam, but higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies at Wilkins Slough; (3) during low flow conditions, similar or slightly higher monthly flow exceedance probabilities below Keswick Dam, lower flow exceedance probabilities more often below Red Bluff Diversion Dam and higher flow exceedance probabilities more often at Wilkins Slough; and (4) equivalent monthly probabilities of exceeding the specified water temperature index value.
- Similar egg incubation conditions because of modeling results indicating equivalent probabilities of exceeding the specified water temperature index value below Keswick Dam and Red Bluff Diversion Dam, and SacEFT results indicating reduced water temperatures more often near Hamilton City and potentially increased survival.
- similar or improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type more often below Red Bluff Diversion Dam, and higher average monthly flows and average monthly flows by water year type during June through November, and lower average monthly flows during December through April below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; (2) lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam and higher monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; (3) under low flow conditions, higher monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista, and lower monthly flow exceedance probabilities below Red Bluff Diversion Dam; and (4) equivalent or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values at all locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Sacramento River, Alternative B would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

White Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River at Hamilton City, below the proposed Delevan Pipeline Intake Facilities, Wilkins Slough, Knights Landing, below the Feather River confluence, Freeport and Rio Vista.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) lower or similar long-term average monthly and average monthly flows by water year type during most of the evaluation period; (2) lower monthly flow exceedance probabilities more often at Hamilton City and below the proposed Delevan Pipeline Intake Facilities, and higher flow exceedance probabilities more often at Rio Vista; (3) during low flow conditions, lower flow exceedance probabilities more often at Hamilton City and higher monthly flow exceedance probabilities occurring more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.

- Less suitable spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows; (2) lower monthly flow exceedance probabilities, including during low flow conditions; and (3) equivalent or higher probabilities of exceeding specified water temperature index values, and therefore less suitable water temperatures.
- More suitable juvenile rearing and outmigration conditions due to modeling results indicating: (1) higher long-term average monthly and average by water year type monthly flows more often; (2) higher monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent or lower monthly probabilities of exceeding specified water temperature index values, and therefore more suitable water temperature conditions.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Sacramento River, Alternative B would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

River Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly flows by water year type occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below Keswick Dam and the proposed Delevan Pipeline Intake Facilities, and higher flow exceedance probabilities more often at Freeport; and (3) during low flow conditions, higher flow exceedance probabilities occurring more often at all locations evaluated.
- Similar spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows more often; (2) lower monthly flow exceedance probabilities more often; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities below Keswick Dam, lower monthly flow exceedance probabilities below Red Bluff Diversion Dam, and higher flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities; and (4) higher probabilities of occurring within specified water temperature ranges, and therefore more suitable water temperatures.
- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values, but with lower probabilities of exceeding 72°F during July and August.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) lower long-term average and average monthly by water year type flows more often; (2) lower monthly flow exceedance probabilities more often below Keswick Dam and the proposed Delevan Pipeline Intake Facilities, and higher monthly flow exceedance probabilities more often at Freeport; and (3) during low flow conditions, higher or similar flow exceedance probabilities.
- Similar spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average monthly by water year type flows below Keswick Dam and Red Bluff Diversion Dam, and higher and lower long-term average monthly and average monthly flows by water year type occurring with similar monthly frequencies below the proposed Delevan Pipeline Intake Facilities; (2) lower monthly flow exceedance probabilities more often; (3) during low flow conditions, higher or similar flow exceedance probabilities below Keswick Dam and the proposed Delevan Pipeline Intake Facilities, and lower flow exceedance probabilities below Red Bluff Diversion Dam; and (4) higher probabilities of water temperatures occurring within the specified water temperature range, and therefore more suitable water temperatures.
- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values, but with lower probabilities of exceeding 72°F during July and August at Freeport.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Hardhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar or improved adult and other life stage conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) lower probabilities of water temperatures occurring within the specified range slightly more often, and therefore, potentially less suitable water temperatures.

- Similar spawning conditions, because of: (1) similar or slightly higher or lower long-term average and average by water year type monthly flows below the proposed Delevan Pipeline Intake Facilities and at Freeport, and lower average monthly flows below Keswick Dam more often; (2) lower monthly flow exceedance probabilities more often below Keswick Dam and the proposed Delevan Pipeline Intake Facilities and equivalent or higher monthly flow exceedance probabilities below the proposed Delevan Pipeline Intake Facilities; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities; and (4) higher probabilities of water temperatures occurring within the specified water temperature range during April and June, and lower probabilities of occurring within the specified range during May.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

California Roach

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar or improved adult and other life stage conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent probabilities of water temperatures occurring within the specified range.
- Similar spawning conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows more often; (2) lower monthly flow exceedance probabilities more often below Keswick Dam and the proposed Delevan Pipeline Intake Facilities, and higher and lower flow exceedance probabilities occurring with the same monthly frequency at Freeport; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities below Keswick Dam, and higher and lower flow exceedance probabilities with the same monthly frequency below the proposed Delevan Pipeline Intake Facilities and at Freeport; and (4) similar probabilities of exceeding the specified water temperature index value, but a higher probability of exceedance during April below the proposed Delevan Pipeline Intake Facilities, and therefore slightly more suitable water temperatures (California roach initiate spawning at water temperatures of approximately 60°F or higher).

In conclusion, in consideration of potential impacts to all life stages of California roach in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Sacramento Splittail

Evaluation of water temperatures (Appendix 12E) for splittail in the Sacramento River (i.e., 45-75° F) indicate that water temperature conditions would be essentially equivalent or similar under Alternative B relative to Existing Conditions, resulting in a less than significant impact.

American Shad

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities, below the Feather River Confluence (Verona) and at Freeport.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar adult spawning and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type more often below Red Bluff Diversion Dam, and similar or slightly higher or lower long-term average and average by water year type monthly flows at Verona and Freeport; (2) lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam and at Verona, equivalent or higher flow exceedance probabilities at Freeport; (3) during low flow conditions, lower flow exceedance probabilities below Red Bluff Diversion Dam and equivalent or higher flow exceedance probabilities at Verona and Freeport; and (4) similar but slightly higher probabilities of water temperatures occurring within the specified water temperature range below the Feather River confluence and at Freeport, and slightly lower probabilities of water temperatures occurring within the specified range below Red Bluff Diversion Dam.
- Similar or improved larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) higher long-term average and average by water year type monthly flows more often; (2) higher monthly flow exceedance probabilities more often; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) slightly lower and higher probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of American shad in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Striped Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below the proposed Delevan Pipeline Intake Facilities and below the Feather River Confluence (Verona).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar adult spawning and other life stage conditions, because of modeling results indicating: (1) similar or slightly higher or lower long-term average monthly and average monthly flows by water year type; (2) lower monthly flow exceedance probabilities during April and May and higher monthly flow exceedance probabilities during June; (3) during low flow conditions, equivalent or higher flow exceedance probabilities; and (4) slightly higher probabilities of water temperatures occurring within the specified water temperature range.

- Similar or improved larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) higher and lower long-term average and average by water year type monthly flows with similar monthly frequencies; (2) higher monthly flow exceedance probabilities slightly more often; (3) during low flow conditions, higher monthly flow exceedance probabilities more often; and (4) higher probabilities of water temperatures occurring within the specified water temperature range more often.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Largemouth Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and Freeport.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Equivalent or improved adult and other life stage conditions, because of modeling results indicating: (1) lower and higher long-term average monthly flows, and lower and higher average monthly flows by water year type occurring with the same frequency during most water year types at all Sacramento River locations evaluated; (2) higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated; and (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated.

- Equivalent or improved spawning conditions, because of similar monthly probabilities of water temperatures occurring within the specified water temperature range at all locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the Sacramento River, Alternative B would result in beneficial and less-than-significant impacts, relative to Existing Conditions.

Clear Creek

Potential impacts to fisheries and aquatic resources in Clear Creek under Alternative B relative to Existing Conditions would be similar to those discussed under Alternative A relative to Existing Conditions, above.

Lake Oroville

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Lake Oroville during April through November.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Equivalent or slightly improved coldwater pool storage conditions, because of modeling results indicating: (1) higher and lower long-term average monthly storage occurring with the same frequency during the evaluation period, slightly lower average monthly storage by water year type occurring during wet and above normal water years, and slightly higher average monthly storage occurring during below normal, dry and critical water years; (2) equivalent or higher and lower monthly storage exceedance probabilities occurring with the same frequency during the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during most months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Lake Oroville, Alternative B would result in similar or slightly more suitable and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Lake Oroville during March through June.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar warmwater fish spawning and early life stage conditions, because of increased and decreased monthly water surface elevation reductions of six feet or more occurring with similar monthly frequencies during the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Lake Oroville, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Feather River

Flows in the Low Flow Channel below the Fish Barrier Dam were modeled consistent with the terms of the FERC Settlement Agreement. As shown in the Appendix 12F), modeled results for long-term average flows, average flows by water year type, and flow exceedance probabilities of 10 percent or more during all years and during low flow conditions would be equivalent for Alternative B, relative to Existing Conditions. Although these results are not repeated for the discussions below, they were considered along with the information presented below and were incorporated into the impact determinations for the following species: spring-run Chinook salmon, fall-run Chinook salmon, steelhead, green sturgeon, white sturgeon, river lamprey, Pacific lamprey, hardhead, and California roach.

Spring-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River, in addition to model results for spawning habitat availability (WUA) (Appendix 12N) and early life stage mortality (Appendix 12J).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, although slightly higher flows would occur during August and September, and higher and lower average monthly flows by water year type would occur with similar frequencies during most water year types at the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) higher monthly flow exceedance probabilities during June through September, and lower flow exceedance probabilities during October through December below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring more often during the evaluation period below the Thermalito Afterbay outlet, although lower flows would occur during March through May, and higher and lower monthly flow exceedance probabilities would occur with similar frequency at the mouth of the Feather River; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values occurring at all locations evaluated in the Feather River.

- Improved spawning conditions due to modeling results indicating: (1) higher spawning habitat availability during most of the evaluation period; and (2) similar or slightly lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, during most of the evaluation period at the evaluated locations.
- Similar embryo incubation conditions due to modeling results indicating slightly increased total annual long-term average early life stage mortality, and similar or slightly lower probabilities of exceeding specified water temperature index values during most of the evaluation period at the evaluated locations.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet, and higher and lower average monthly flows by water year type occurring with similar frequencies during most water year types, although lower flows would occur more frequently during dry water year types; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet, although higher probabilities of exceedance would occur during June through September; (3) under low flow conditions, similar or lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet, although substantially higher flows would occur during June through October; and (4) slightly lower, and therefore suitable, monthly probabilities of exceeding specified water temperature index values during the evaluation period.
- Similar smolt emigration conditions, because of modeling results indicating: (1) lower long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type occurring with similar frequencies during most water year types at the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) lower monthly flow exceedance probabilities occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar monthly probabilities of exceeding specified water temperature index values occurring at all Feather River locations.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Feather River, Alternative B would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N) and early life stage mortality (Appendix 12J).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type occurring with similar frequency during most water year types at the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) higher monthly flow exceedance probabilities during July through September, and lower exceedance probabilities during October through December below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) under low flow conditions, similar or higher monthly flow exceedance probabilities occurring with more often during the evaluation period, although lower flows would occur during November and December below the Thermalito Afterbay outlet; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values during the evaluation period at all the Feather River locations.
- Improved spawning conditions due to modeling results indicating: (1) higher spawning habitat availability during the adult spawning period; and (2) similar or lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, during most of the evaluation period for all Feather River locations.
- Similar embryo incubation conditions due to slightly increased total annual long-term average early life stage mortality, and similar or lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, during most of the evaluation period for all Feather River locations.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) slightly lower long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or lower average monthly flows by water year type during most water year types at the Thermalito Afterbay outlet and at the mouth of the Feather River, except for during above normal and below normal water years when flows would be slightly higher more frequently; (2) lower monthly flow exceedance probabilities during most months of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance would occur during June; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar monthly probabilities of exceeding specified water temperature index values at all Feather River locations.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Feather River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Steelhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar adult immigration and holding conditions due to modeling results indicating: (1) slightly lower long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or lower average monthly flows by water year type during most water year types, although slightly higher average monthly flows would occur during critical water year types; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although significantly higher exceedance probabilities would occur during August and September; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring with more frequency during the evaluation period below the Thermalito Afterbay outlet, and similar or higher monthly flow exceedance probabilities occurring more often during the evaluation period at the mouth of the Feather River; and (4) similar or lower monthly probabilities of exceeding specified water temperature index values occurring during the evaluation period at all Feather River locations.
- Improved spawning conditions due to modeling results indicating: (1) higher spawning habitat availability during the adult spawning period; and (2) similar probabilities of exceeding specified water temperature index values during the evaluation period at all Feather River locations.
- Similar embryo incubation conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet, and similar or lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities below the Thermalito Afterbay outlet; (3) under low flow conditions, similar or lower monthly flow exceedance probabilities during the evaluation period below the Thermalito Afterbay outlet; and (4) similar probabilities of exceeding specified water temperature index values during the evaluation period at all Feather River locations.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet, and higher and lower average monthly flows by water year type occurring with similar frequencies during most water year types, although lower flows would occur more frequently during dry water year types; (2) lower monthly flow exceedance probabilities occurring more often during the evaluation period below the Thermalito Afterbay outlet, although higher exceedance probabilities would occur during June through September; (3) under low flow conditions, lower monthly flow exceedance probabilities occurring more often during the evaluation period at Thermalito Afterbay outlet, although substantially higher flows would occur during June through October; and (4) similar probabilities of exceeding specified water temperature index values during the evaluation period.
- Similar smolt emigration conditions due to modeling results indicating: (1) slightly lower long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or lower average monthly flows by water year type during most water year types at the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) generally lower monthly flow exceedance probabilities occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) under low flow conditions, similar or lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth

of the Feather River; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values at all Feather River locations.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the Feather River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Green Sturgeon

Flow model results (Appendix 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, at Shanghai Bend, and at the mouth of the Feather River. Water temperature results (Appendix 12E) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period at the Feather River at Shanghai Bend and at the mouth of the Feather River, and higher average monthly flows by water year type occurring more often than lower average monthly flows during above normal water year types, lower average monthly flows during dry and critical water year types, and higher and lower average monthly flows by water year type occurring with similar frequency during wet and below normal water year types at the Feather River at Shanghai Bend and at the mouth of the Feather River; (2) lower monthly flow exceedance probabilities occurring more often at Shanghai Bend and at the mouth of the Feather River, although higher probabilities of exceedance would occur during June through September; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities, although significantly higher flows would occur during July through September, at Shanghai Bend and at the mouth of the Feather River; and (4) similar monthly probabilities of exceeding specified water temperature index values at all Feather River locations.
- Similar or slightly less suitable adult spawning and embryo incubation conditions because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period at the Feather River at Shanghai Bend and at the mouth of the Feather River, and similar or slightly higher average monthly flows by water year type occurring during most year types, although lower average monthly flows would occur during dry and critical water year types at the Feather River at Shanghai Bend and at the mouth of the Feather River; (2) lower monthly flow exceedance probabilities during March through May, and higher exceedance probabilities during June through August below the Thermalito Afterbay outlet; (3) under low flow conditions, lower monthly flow exceedance probabilities during March through May, and higher exceedance probabilities during June through August below the Thermalito Afterbay outlet; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values during the evaluation period below the Thermalito Afterbay outlet.
- Similar or less suitable juvenile rearing conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type occurring with similar frequencies during most water year types, although lower flows would occur more frequently during dry water year types; (2) lower monthly flow exceedance probabilities occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance would occur

during June through September; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring more often during the evaluation period below the Thermalito Afterbay outlet although higher probabilities of exceedance would occur during June through October, and higher and lower monthly flow exceedance probabilities occurring with similar frequency at the mouth of the Feather River; and (4) similar monthly probabilities of exceeding specified water temperature index values below the Thermalito Afterbay outlet, and similar or slightly higher monthly exceedance probabilities at the mouth of the Feather River.

- Improved juvenile outmigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period at all Feather River locations, and similar or slightly higher average monthly flows by water year type occurring during most year types, although lower average monthly flows would occur more frequently during dry and critical water year types at the Feather River at Shanghai Bend and at the mouth of the Feather River; (2) higher monthly flow exceedance probabilities occurring most months of the evaluation period below the Thermalito Afterbay outlet, at the Feather River at Shanghai Bend and at the mouth of the Feather River, except during May when exceedance probabilities would be lower; (3) under low flow conditions, higher monthly flow exceedance probabilities occurring nearly all months below the Thermalito Afterbay outlet, at the Feather River at Shanghai Bend, and at the mouth of the Feather River, except during May when exceedance probabilities would be lower; and (4) higher and lower monthly probabilities of exceeding specified water temperature index values occurring with similar frequency during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Feather River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

White Sturgeon

Flow model results (Appendix 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, at Shanghai Bend, and at the mouth of the Feather River. Water temperature results (Appendix 12E) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Less suitable adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly flows during the evaluation period at the Feather River at Shanghai Bend and at the mouth of the Feather River, and similar or lower average monthly flows by water year type during wet, dry, and critical water year types, and higher and lower average monthly flows by water year type occurring with similar frequency during above normal and below normal water year types at the Feather River at Shanghai Bend and at the mouth of the Feather River; (2) lower monthly flow exceedance probabilities occurring more often at Shanghai Bend and at the mouth of the Feather River; (3) under low flow conditions, similar or lower monthly flow exceedance probabilities during the evaluation period at Shanghai Bend and at the mouth of the Feather River; and (4) equivalent monthly probabilities of exceeding specified water temperature index values at all Feather River locations.

- Less suitable spawning and egg incubation conditions because of modeling results indicating: (1) lower long-term average monthly flows during the evaluation period at the Feather River at Shanghai Bend and at the mouth of the Feather River, and higher and lower average monthly flows by water year type occurring with similar frequency during wet water year types, similar or higher average monthly flows by water year type during above normal and below normal water year types, and similar or lower average monthly flows by water year type during dry and critical water year types at the Feather River at Shanghai Bend and at the mouth of the Feather River; (2) lower monthly flow exceedance probabilities occurring more often at the Feather River at Shanghai Bend and at the mouth of the Feather River; (3) during low flow conditions, similar or lower monthly flow exceedance probabilities occurring at the Feather River at Shanghai Bend and at mouth of the Feather River; and (4) similar monthly probabilities of exceeding specified water temperature index values occurring all months of the evaluation period at all the Feather River locations.
- Similar or less suitable juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period at all Feather River locations, and similar or slightly higher average monthly flows by water year type during most year types, although lower average monthly flows would occur more frequently during dry and critical water year types at the Feather River at Shanghai Bend and at the mouth of the Feather River; (2) lower flow exceedance probabilities occurring more often during the evaluation period at the Feather River at Shanghai and at the mouth of the Feather River, although higher probabilities of exceedance would occur during June through September; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring more often during the evaluation period below the Thermalito Afterbay outlet although higher probabilities of exceedance would occur during June through October, and higher and lower monthly flow exceedance probabilities occurring with similar frequency at the mouth of the Feather River; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values at all Feather River locations.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Feather River, Alternative B would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

River Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar or less suitable adult migration conditions due to modeling results indicating: (1) lower long-term average monthly flows below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or slightly lower average monthly flows by water year type occurring more often than higher average monthly flows during wet, dry, and critical water year types, and similar or slightly higher average monthly flows during above normal and below normal water year types at the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the

Feather River; and (3) under low flow conditions, similar or lower monthly flow exceedance probabilities occurring during most months of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River.

- Similar or less suitable adult spawning and egg incubation conditions due to: (1) lower long-term average monthly flows during the evaluation period below the Thermalito Afterbay Outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type occurring with similar frequency during wet water year types, similar or higher average monthly flows by water year type during above normal and below normal water year types, and similar or lower average monthly flows by water year type during dry and critical water year types below the Thermalito Afterbay Outlet and at the mouth of the Feather River; (2) lower monthly flow exceedance probabilities occurring most months of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher exceedance probabilities would occur during June and July; (3) under low flow conditions, lower monthly flow exceedance probabilities occurring most months of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher exceedance probabilities would occur during June and July; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River.
- Similar ammocoete rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type occurring with similar frequencies during most water year types, although lower flows would occur more frequently during dry water year types; (2) lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance would occur during June through September; (3) under low flow conditions, similar lower monthly flow exceedance probabilities occurring more often during the evaluation period below the Thermalito Afterbay outlet and higher and lower monthly flow exceedance probabilities occurring with the same frequency at the mouth of the Feather River; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values at all Feather River locations.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the Feather River, Alternative B would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar or less suitable adult migration conditions because of modeling results indicating: (1) lower long-term average monthly flows occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or higher average monthly flows by water year type occurring during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during dry and critical water year types when higher average monthly flows would occur; (2) lower monthly flow exceedance probabilities occurring during most of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during June when higher monthly flow exceedance probabilities would occur; and (3) during low flow conditions, similar or lower monthly flow exceedance probabilities during most of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during June when higher monthly flow exceedance probabilities would occur

- Similar or less suitable spawning and egg incubation conditions due to modeling results indicating: (1) lower long-term average monthly flows occurring below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher average monthly flows by water year type monthly flows during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during dry and critical water year types when lower monthly flows would occur; (2) lower monthly flow exceedance probabilities during most of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during June through August when higher monthly flow exceedance probabilities would occur; and (3) during low flow conditions, equivalent monthly flow exceedance probabilities during most of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during June through August when higher monthly flow exceedance probabilities would occur; and (4) similar or lower probabilities of water temperatures occurring within the specified water temperature range at all Feather River locations evaluated.
- Similar ammocoete rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period at all Feather River locations evaluated, and similar or higher average monthly flows by water year type occurring with similar frequency during most water year types at all Feather River locations evaluated, except during dry and critical water year types when lower average monthly flows would occur more often than higher average monthly flows; (2) lower monthly flow exceedance probabilities during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September at all Feather River locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September; and (4) similar or slightly lower probabilities of exceeding specified water temperatures at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Feather River, Alternative B would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Hardhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar or slightly less suitable adult and juvenile life stage conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period at all Feather River locations evaluated, and similar or higher average monthly flows by water year type occurring with similar frequency during most water year types at all Feather River locations evaluated, except during dry and critical water year types when lower average monthly flows occur more often than higher average monthly flows; (2) lower monthly flow exceedance probabilities during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September; (3) lower monthly flow exceedance probabilities during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September at all Feather River locations evaluated; and (4) equivalent or slightly lower probabilities of water temperatures remaining within the specified water temperature range during the evaluation period at all Feather River locations evaluated.
- Similar or less suitable adult spawning conditions, because of modeling results indicating: (1) lower long-term average monthly flows during April and May and higher long-term monthly flows during June at all Feather River locations evaluated, and higher average monthly flows by water year type during most water year types, except during dry and critical water year types; (2) lower monthly flow exceedance probabilities flows during April and May and higher monthly flow exceedance probabilities during June at all Feather River locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities flows during April and May, and higher monthly flow exceedance probabilities during June at all Feather River locations evaluated; and (4) similar or slightly lower probabilities of water temperatures occurring within the specified water temperature range at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the Feather River, Alternative B would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

California Roach

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar adult and other life stage conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period at all Feather River locations evaluated, and similar or higher average monthly flows by water year type occurring with similar frequency during most water year types at all Feather River locations evaluated, except during dry and critical water year types when lower average monthly flows would occur more often than higher average monthly flows; (2) lower monthly flow exceedance probabilities during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September; (3) during low flow conditions, lower monthly flow exceedance probabilities during October through May at most Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September; and (4) equivalent probabilities of exceeding specified water temperatures during all months of the evaluation period at all Feather River locations evaluated.

- Similar or less suitable adult spawning conditions, because of modeling results indicating: (1) lower long-term average monthly flows during March through May, with higher long-term average monthly flows during June at all Feather River locations evaluated, and higher average monthly flows by water year type during most water year types, except during dry and critical water year types; (2) similar or slightly lower monthly flow exceedance probabilities flows during March through May, and higher monthly flow exceedance probabilities during June at all Feather River locations evaluated; (3) during low flow conditions, similar or slightly lower monthly flow exceedance probabilities flows during March through May, and higher monthly flow exceedance probabilities during June at all Feather River locations evaluated; and (4) similar or slightly lower probabilities of exceeding specified water temperatures during the evaluation period at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of California roach in the Feather River, Alternative B would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Splittail

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the mouth of the Feather River.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar or less suitable spawning conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows, and higher and lower average monthly flows by water year type occurring with similar frequency during most water year types at the mouth of the Feather River, except during dry water year types when lower average monthly flows would occur during all months; (2) lower monthly flow exceedance probabilities during most of the evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities during February through May, at the mouth of the Feather River; (4) similar or lower usable flooded area (UFA) exceedance probabilities of 10 percent or more; and (5) equivalent monthly probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of splittail in the Feather River, Alternative B would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Striped Bass

Flow model and water temperature results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Thermalito Afterbay and at the mouth of the Feather River.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Less suitable adult spawning, embryo incubation and initial rearing conditions, due to modeling results indicating: (1) lower long-term average monthly flows during April and May and higher long-term monthly flows during June at all Feather River locations evaluated; and higher average monthly flows by water year type during most water year types, except during dry and critical water year types; (2) lower monthly flow exceedance probabilities flows during April and May and higher monthly flow exceedance probabilities during June at all Feather River locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities flows during April and May and higher monthly flow exceedance probabilities during June at all Feather River locations evaluated; and (4) similar or lower monthly probabilities of water temperatures occurring within the specified water temperature range at all Feather River locations evaluated.

- Similar larvae, fry, and juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type occurring with similar frequencies during most water year types, although lower flows would occur more frequently during dry water year types; (2) lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance would occur during June through September; (3) under low flow conditions, similar lower monthly flow exceedance probabilities occurring more often during the evaluation period below the Thermalito Afterbay outlet and higher and lower monthly flow exceedance probabilities occurring with the same frequency at the mouth of the Feather River; and (4) similar monthly probabilities of exceeding specified water temperature index values below the Thermalito Afterbay outlet and at the mouth of the Feather River.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the Feather River, Alternative B would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

American Shad

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Less suitable adult spawning, embryo incubation and initial rearing conditions because of modeling results indicating: (1) lower long-term average monthly flows during April and May months and higher long-term monthly flows during June at all Feather River locations evaluated, and higher average monthly flows by water year type during most water year types, except during dry and critical water year types; (2) lower monthly flow exceedance probabilities flows during April and May and higher monthly flow exceedance probabilities during June at all Feather River locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities flows during April and May and higher monthly flow exceedance probabilities during June at all Feather River locations evaluated; and (4) slightly lower monthly probabilities of exceeding specified water temperature index values during the evaluation period at all Feather River locations.
- Similar larvae, fry, and juvenile rearing and emigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type occurring with similar frequencies during most water year types, although lower flows would occur more frequently during dry water year types; (2) lower monthly

flow exceedance probabilities during October and November below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher probabilities of exceedance during July through September; (3) under low flow conditions, similar or higher monthly flow exceedance probabilities occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of American shad in the Feather River, Alternative B would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Largemouth Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River below Thermalito Afterbay Outlet and at the mouth of the Feather River.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly flows during the evaluation period at all Feather River locations evaluated, and similar or higher average monthly flows by water year type occurring with similar frequency during most water year types at all Feather River locations evaluated, except during dry and critical water year types when lower average monthly flows would occur more often than higher average monthly flows; (2) lower monthly flow exceedance probabilities during October through May at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September; and (3) lower monthly flow exceedance probabilities during October through May at most Feather River locations evaluated, and higher monthly flow exceedance probabilities during June through September.
- Similar spawning conditions, because of modeling results indicating similar monthly probabilities of water temperatures occurring within the specified water temperature range for all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the Feather River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Sutter Bypass

Potential impacts to fisheries and aquatic resources in the Sutter Bypass under Alternative B relative to Existing Conditions would be similar to those discussed under Alternative A relative to Existing Conditions, above.

Folsom Lake

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Folsom Lake during April through November.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar coldwater pool storage conditions, because of modeling results indicating: (1) slightly higher long-term average monthly storage, and equivalent or higher average monthly storage during critical and dry water years, respectively, and slightly lower average monthly storage during wet, above and below normal water years for most of the evaluation period; (2) equivalent or lower monthly storage exceedance probabilities occurring for more than half of the evaluation period; and (3) a slight net 10 percent or more monthly storage exceedance increase during more than half of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Folsom Lake, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Folsom Lake during March through June.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Slightly less suitable warmwater fish spawning and early life stage conditions, because of modeling results indicating slightly increased frequencies of monthly water surface elevation reductions of six feet or more during most of the March through June evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Folsom Lake, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

American River

Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River, in addition to model results for spawning habitat availability (WUA) (Appendix 12N) at Sailor Bar through Rossmoor and early life stage mortality (Appendix 12J).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Less suitable adult immigration and holding conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) similar or slightly lower monthly flow exceedance probabilities during most of the evaluation period, with substantially lower probabilities of exceedance during September at all locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated, although higher probabilities of exceedance would occur during October; and (4) equivalent or higher monthly probabilities of exceeding specified water temperature index values.
- Similar or less suitable spawning conditions due to modeling results indicating similar flows and spawning habitat availability during the evaluation period, and equivalent or higher monthly probabilities of exceeding specified water temperature index values.

- Less suitable embryo incubation conditions due to modeling results indicating higher total annual early life stage mortality, and equivalent or higher monthly probabilities of exceeding specified water temperature index values.
- Similar or less suitable juvenile rearing and emigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows, and similar or slightly lower average monthly flows by water year type during the evaluation period at all locations evaluated; (2) similar monthly flow exceedance probabilities during most months of the evaluation period, although substantially lower probabilities of exceedance would occur during June; (3) during low flow conditions, similar monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated, although substantially higher probabilities of exceedance would occur during April and May, and substantially lower probabilities would occur during June; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values, particularly during May and June.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in American River, Alternative B would result in potentially adverse and potentially significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative B (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative B would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative B.

Spring-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined at the mouth of the American River.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar non-natal juvenile rearing conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and similar or slightly lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities during most months of the evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities during the evaluation period; and (4) similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in American River, Alternative B would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Steelhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River, in addition to model results for spawning habitat availability (WUA) (Appendix 12N) at Sailor Bar through Rossmoor.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar or less suitable adult immigration and holding conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and similar or slightly lower average monthly flows by water year type during most water year types at all evaluated locations; (2) similar or slightly lower monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated, although slightly higher probabilities of exceedance would occur primarily during April; (3) during low flow conditions, similar or slightly lower monthly flow exceedance probabilities during most months of the evaluation period, although higher flows would occur during January and February at Watt Avenue and during April at all evaluated locations; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values.
- Similar or improved spawning conditions due to modeling results indicating slightly higher flows and higher spawning habitat availability during January, February, and April, and similar monthly probability of exceeding specified water temperature index values, although slightly higher probabilities of exceedance would occur during March.
- Similar embryo incubation conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and similar or slightly lower average monthly flows by water year type during most water year types; (2) similar or slightly higher monthly flow exceedance probabilities during most months of the evaluation period, although slightly lower probabilities of exceedance would occur during February and March; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period, with significantly higher flows during April and May, although slightly lower flows would occur during March; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values, particularly during March.
- Less suitable juvenile rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated, although higher flows would occur during some water year types; (2) lower monthly flow exceedance probabilities during most months of the evaluation period, with significantly lower flows during June through September, although slightly higher probabilities of exceedance would occur during November, January, April, and May; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, with significantly lower flows during June through September, although slightly higher probabilities of exceedance would occur during some months at the evaluated locations, particularly during November, January, April, and May; and (4) similar or higher monthly probabilities of exceeding specified water temperature index values.
- Similar or less suitable smolt emigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and similar or slightly lower average monthly flows by water year type during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities during most of the evaluation period, with substantially lower flows during June, although slightly higher probabilities of exceedance would occur during April and May; (3) during low flow conditions, similar or higher monthly flow exceedance probabilities during most months of the evaluation period, with lower probabilities of exceedance

during March and June; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of steelhead in American River, Alternative B would result in potentially adverse and potentially significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative B (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative B would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative B.

Green Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined at the mouth of the American River.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar or less suitable adult immigration and holding conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and similar or slightly lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities, with significantly lower flows during June through September; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, with substantially lower flows during June through August, although higher probabilities of exceedance would occur during October, April, and May; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values.
- Similar or less suitable spawning and egg incubation conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probabilities, with particularly lower probabilities of exceedance during June through August but higher probability of exceedance during April; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during April and May; and (4) similar or higher monthly probabilities of exceeding specified water temperature index values.
- Similar or less suitable juvenile rearing and emigration conditions due to modeling results indicating: (1) similar or lower long-term average monthly flows during the evaluation period, and similar or lower average monthly flows by water year type during most water year types at all locations evaluated; (2) similar or lower monthly flow exceedance probabilities during most of the evaluation period, with particularly lower probabilities of exceedance during June through September; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, with substantially lower flows during June through September, although higher probabilities of exceedance would occur during October, April, and May; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values at all locations evaluated more often.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the American River, Alternative B would result in potentially adverse and potentially significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative B (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative B would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative B.

River Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar or less suitable adult immigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and similar or slightly lower average monthly flows by water year type during most water year types at all locations evaluated; (2) similar monthly flow exceedance probabilities occurring over the evaluation period, although higher probabilities of exceedance would occur during October, January, April, and May and substantially lower probabilities of exceedance would occur during September and June; and (3) during low flow conditions, similar monthly flow exceedance probabilities occurring over the evaluation period, although slightly higher probabilities of exceedance would occur during October, April and May, and substantially lower probabilities of exceedance would occur during September and June.
- Less suitable spawning and egg incubation conditions due to modeling results indicating: (1) similar or lower long-term average monthly flows during the evaluation period, and similar or lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probabilities during most months of the evaluation period, with substantially lower flows during June and July, although higher probabilities of exceedance would occur during April and May; (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower flows during June and July, although higher probabilities of exceedance would occur during February, April, and May; and (4) similar or slightly lower probabilities of remaining within specified water temperature ranges.
- Less suitable ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar or lower long-term average monthly flows during the evaluation period, and similar or lower average monthly flows by water year type during most water year types at all locations evaluated; (2) similar or lower monthly flow exceedance probabilities during most of the evaluation period, with substantially lower probabilities of exceedance during June through September; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, with substantially lower probabilities of exceedance during June through August, although higher probabilities of exceedance would occur during some months at the evaluated locations, particularly during October, April, and May; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the American River, Alternative B would result in potentially adverse and potentially significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative B (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative B would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative B.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and similar or slightly lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probabilities during most months of the evaluation period, although higher probabilities of exceedance would occur during January, April, and May; and (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period, although lower probabilities of exceedance would occur generally during March and June.
- Less suitable spawning and egg incubation conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and similar or slightly lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probabilities during most months of the evaluation period with substantially lower probabilities of exceedance during June through August, although higher probabilities of exceedance would occur during January, April, and May; (3) during low flow conditions, similar monthly flow exceedance probabilities during most of the evaluation period, with substantially lower probabilities of exceedance during June through August, and higher probabilities of exceedance during April and May; and (4) equivalent or slightly lower probabilities of occurring within specified water temperature ranges.
- Less suitable ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar or lower long-term average monthly flows during the evaluation period, and similar or lower average monthly flows by water year type during most water year types at all locations evaluated; (2) similar or lower monthly flow exceedance probabilities during most of the evaluation period, with substantially lower probabilities of exceedance during June through September; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, with substantially lower probabilities of exceedance during June through August, although higher probabilities of exceedance would occur during some months at the evaluated locations, particularly during October, April, and May; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the American River, Alternative B would result in potentially adverse and potentially significant impacts, relative to

Existing Conditions. However, these impacts would occur with or without implementation of Alternative B (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative B would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative B.

Hardhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Less suitable adult and other life stage conditions due to modeling results indicating: (1) similar or lower long-term average monthly flows during the evaluation period, and similar or lower average monthly flows by water year type during most water year types at all locations evaluated; (2) similar or lower monthly flow exceedance probabilities during most of the evaluation period, with particularly lower probabilities of exceedance during June through September; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, with substantially lower flows during June through August, although slightly higher probabilities of exceedance would occur during some months at the evaluated locations, particularly during April and May; and (4) equivalent or slightly higher probabilities of occurring within specified water temperature ranges.
- Improved spawning conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and similar or slightly lower average monthly flows by water year type during most water year types at all locations evaluated; (2) higher monthly flow exceedance probabilities during April and May, with substantially lower probabilities of exceedance during June; (3) during low flow conditions, lower monthly flow exceedance probabilities during April and May, with substantially lower probabilities of exceedance during June; and (4) similar or slightly higher probabilities of occurring within specified water temperature ranges.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the American River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

California Roach

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar or less suitable adult and other life stage conditions due to modeling results indicating: (1) similar or lower long-term average monthly flows during the evaluation period, and similar or lower average monthly flows by water year type during most water year types at all locations evaluated; (2) similar or lower monthly flow exceedance probabilities during most of the evaluation period, with particularly lower probabilities of exceedance during June through September; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, with substantially lower flows during June through August, although slightly higher probabilities of exceedance would occur during some months at the evaluated locations, particularly during April and May; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.

- Similar spawning conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and similar or slightly lower average monthly flows by water year type during most water year types at all locations evaluated; (2) similar monthly flow exceedance probabilities during the evaluation period, although significantly lower probabilities of exceedance would occur during June; (3) during low flow conditions, similar monthly flow exceedance probabilities during the evaluation period, with significantly lower probabilities of exceedance would occur during June; and (4) lower monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of California roach in the American River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Splittail

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at the mouth of the American River.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar spawning conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and similar or slightly lower average monthly flows by water year type during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or lower monthly flow exceedance probabilities during February and March, and higher monthly flow exceedance probabilities during April and May; (4) lower usable flooded area (UFA) exceedance probabilities of 10 percent or more; and (5) equivalent probabilities of remaining within specified water temperature ranges.

In conclusion, in consideration of potential impacts to all life stages of splittail in the American River, Alternative B would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Striped Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam and the mouth of the American River.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar or improved adult spawning, embryo incubation, and initial rearing conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and similar or slightly lower average monthly flows by water year type during most water year types at all locations evaluated; (2) similar or slightly higher monthly flow exceedance probabilities during April and May, although substantially lower monthly flow exceedance probabilities would occur during June; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring during April and May, although substantially lower flows would occur during June at the evaluated locations; and (4) similar probabilities of remaining within the specified water temperature range during the evaluation period, with slightly higher probabilities during April and May, and lower probabilities during June.

- Less suitable larvae, fry, and juvenile rearing and emigration conditions due to modeling results indicating: (1) similar or lower long-term average monthly flows during the evaluation period, and similar or lower average monthly flows by water year type during most water year types at all locations evaluated; (2) similar or lower monthly flow exceedance probabilities during most of the evaluation period, with particularly lower probabilities of exceedance during June through September; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, with substantially lower flows during June through August, although slightly higher probabilities of exceedance would occur during some months at the evaluated locations, particularly during October, April, and May; and (4) similar or slightly lower probabilities of remaining within the specified water temperature range during the evaluation period.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the American River, Alternative B would result in potentially adverse, but less-than-significant impacts, relative to Existing Conditions.

American Shad

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue and the mouth of the American River.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar adult spawning, embryo incubation, and initial rearing conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and similar or slightly lower average monthly flows by water year type during most water year types at all locations evaluated; (2) similar or slightly higher monthly flow exceedance probabilities during April and May, although substantially lower monthly flow exceedance probabilities would occur during June; (3) during low flow conditions, higher monthly flow exceedance probabilities during April and May, although substantially lower flows would occur during June at the evaluated locations; and (4) similar probabilities of remaining within the specified water temperature range during the evaluation period, with slightly higher probabilities of occurring within the range during April and May, and lower probabilities occurring during June.
- Less suitable larvae, fry, and juvenile rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated; (2) lower monthly flow exceedance probability during most months of the evaluation period with substantially lower flow exceedance probabilities during July through September at all locations; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period with substantially lower flow exceedance probabilities during July through September; and (4) similar or slightly higher probabilities of remaining within the specified water temperature range during the evaluation period.

In conclusion, in consideration of potential impacts to all life stages of American shad in the American River, Alternative B would result in potentially adverse and potentially significant impacts, relative to

Existing Conditions. However, these impacts would occur with or without implementation of Alternative B (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative B would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative B.

Largemouth Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar or less suitable adult and other life stage conditions due to modeling results indicating: (1) similar or lower long-term average monthly flows during the evaluation period, and similar or lower average monthly flows by water year type during most water year types at all locations evaluated; (2) similar or lower monthly flow exceedance probabilities during most of the evaluation period, with particularly lower probabilities of exceedance during June through September; and (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, with substantially lower flows during June through August, although slightly higher probabilities of exceedance would occur during some months at the evaluated locations, particularly during April and May.
- Similar spawning conditions due to modeling results indicating equivalent or similar probabilities of remaining within specified water temperature ranges.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the American River, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Sacramento-San Joaquin Delta and Yolo Bypass

Delta Smelt in the Delta Region

Model results were examined for water temperatures (Appendix 12E) in the Sacramento River at Freeport, OMR flows (Appendix 12E), Delta outflow (Appendix 12E), salvage at the SWP and CVP export facilities (Appendix 12I), and X2 location (Appendix 12E).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar adult conditions, because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range (December through May), but a slightly higher probability during April and a lower probability during May of occurring within the specified water temperature range; (2) similar overall normalized mean monthly salvage at the SWP and CVP export facilities (December through April); and (3) similar or slightly higher monthly probabilities of OMR flows being more negative than -5,000 cfs (December through February)
- Less suitable spawning conditions in the Yolo Bypass (December through May), because of modeling results indicating: (1) lower long-term average Yolo Bypass flows; (2) similar or lower Yolo Bypass

flow exceedance probabilities; and (3) during low flow conditions, lower flow exceedance probabilities (of 10 percent or more) during December and February and higher flow exceedance probabilities during January and March, albeit similar simulated flows throughout the period

- Similar egg and embryo conditions (February through May), because of modeling results indicating similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range, as discussed above for adult delta smelt
- Similar larvae conditions (March through June), because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range, but a slightly higher probability during April and a lower probability during May of occurring within the specified water temperature range; (2) during March through June of dry and critical water years, slightly higher (less negative) mean monthly OMR flows when flows would be equal to or more negative than -1,500 cfs; and (3) during the latter portion of the larval delta smelt downstream migration period (i.e., May and June), long-term average and average by water year type monthly Delta outflow would slightly decrease during May but would slightly increase during June, while monthly Delta outflow exceedance probabilities would be lower more often during May, but would be higher more often during June.
- Similar or improved juvenile conditions (May through July), because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range; (2) slightly higher overall normalized mean monthly salvage at the SWP export facility and similar overall normalized mean monthly salvage at the CVP export facility; (3) between RKm 65 and 80, long-term average and average by water year type X2 location would move slightly upstream during May (by 0.6 RKm or less), move slightly downstream during June (by 0.5 RKm or less), and move downstream during July (by 1.2, 1.8 and 1.8 RKm during wet, above normal and below normal water years, respectively); and (4) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to all life stages of delta smelt in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Longfin Smelt in the Delta Region

Model results were examined for OMR flows (Appendix 12E), salvage at the SWP and CVP export facilities (Appendix 12I), and X2 location (Appendix 12E).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar adult conditions because of modeling results indicating slightly higher (during December through February) and slightly lower (during March) monthly probabilities of OMR flows being more negative than -5,000 cfs during December through March
- Similar larvae and juvenile conditions because of modeling results indicating: (1) slightly higher (during December) and equivalent (during January through March) monthly probabilities of OMR flows being more negative than -5,000 cfs during December through March; (2) during April and May of dry and critical water years, mean monthly OMR flows would be lower (more negative) during April of dry and critical water years (by 13.1 and 3.9%, respectively), would be equivalent during May of critical water years and would be higher during May of dry water years (by 5.8%); (3) similar or slightly lower overall mean monthly salvage at the SWP and CVP export facilities;

(4) slightly lower (during February through May) and slightly higher (during January and June) monthly exceedance probabilities of X2 location occurring at or downstream of 75 RKm during January through June; and (5) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to all life stages of longfin smelt in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Splittail in the Delta Region

Model results were examined for Yolo Bypass outflow (Appendix 12E) and salvage at the SWP and CVP export facilities.

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Less suitable egg and larval conditions (February through May) because of modeling results indicating: (1) slightly reduced mean monthly Yolo Bypass outflow during most months of wet water years and reduced mean monthly flows during February through April of above normal and below normal water years, during February and March of dry water years and during March of critical water years, with mean monthly reductions of 10 percent or more during March and April of above normal water years and during March of below normal, dry and critical water years; and (2) lower flow exceedance probabilities (of 10% or more) more often during February through May
- Similar juvenile rearing and emigration conditions (April through July) because of modeling results indicating: (1) lower (during April) and similar (during May through July) mean monthly Yolo Bypass outflow during all water year types; (2) similar flow exceedance probabilities (of 10% or more); and (3) slightly higher overall simulated mean monthly salvage at the SWP export facility and similar overall mean monthly salvage at the CVP export facility during April through July
- Less suitable adult spawning and upstream migration conditions, because of modeling results indicating: (1) reduced mean monthly Yolo Bypass outflow during February through April, as discussed above for egg and larval conditions; and (2) similar simulated mean monthly salvage at the SWP and CVP export facilities during December through March

In conclusion, in consideration of potential impacts to all life stages of splittail in the Delta Region including the Yolo Bypass, Alternative B would result in less suitable and potentially significant impacts, relative to Existing Conditions. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources*)* is anticipated to reduce these impacts to less than significant levels.

Winter-run Chinook Salmon in the Delta Region

Model results were examined for through-Delta juvenile survival (Appendix 12M).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar or improved juvenile conditions, because of modeling results indicating: (1) higher monthly Delta survival exceedance probabilities more often; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile winter-run Chinook salmon in the Delta, Alternative B would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Spring-run Chinook Salmon in the Delta Region

Model results were examined for through-Delta juvenile survival (Appendix 12M).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar or improved juvenile conditions, because of modeling results indicating: (1) slightly higher and lower monthly Delta survival exceedance probabilities occurring with similar probabilities over the entire distribution; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile spring-run Chinook salmon in the Delta, Alternative B would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Fall-run and Late Fall-run Chinook Salmon in the Delta Region

Model results were examined for OMR flows (Appendix 12E) and through-Delta juvenile survival (Appendix 12M).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar San Joaquin River adult straying conditions because of modeling results indicating similar or slightly higher monthly probabilities of OMR flows being more negative than -5,000 cfs during December through February
- Similar or improved juvenile conditions because of modeling results indicating: (1) slightly higher monthly Delta survival exceedance probabilities more often; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile and San Joaquin River adult fall and late fall-run Chinook salmon in the Delta, Alternative B would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Steelhead in the Delta Region

Model results were examined for Sacramento River flows (Appendix 12F) at Rio Vista, Yolo Bypass outflow (Appendix 12E), Delta outflow (Appendix 12E), OMR flows (Appendix 12E), and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar juvenile rearing and emigration conditions in the Delta (October through July) because of modeling results indicating: (1) higher long-term average and average by water year type monthly flows at Rio Vista during October, November, June and July, and lower average monthly flows during December through May; (2) higher monthly flow exceedance probabilities at Rio Vista during all months except for during March, including during low flow conditions; (3) lower mean monthly Yolo Bypass outflow and lower or similar flow exceedance probabilities during most of the evaluation period; (4) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; (5) lower long-term average and average by water year type monthly Delta outflow during most months of most water year types, but with higher Delta outflow during June and July of all water year types, during November of below normal water years, during October of dry water years and during October and December of critical water years; (6) lower long-term average and average by water year type monthly OMR flows during most months of most water years; and (7) similar overall simulated mean monthly salvage at the SWP and CVP export facilities

In conclusion, in consideration of potential impacts to all life stages of Central Valley steelhead in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions. Alternative B impacts on steelhead in the Yolo Bypass are considered potentially significant, relative to Existing Conditions. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Green Sturgeon in the Delta Region

Model results were examined for Yolo Bypass outflow (Appendix 12E) and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar or less suitable juvenile rearing and emigration conditions (year-round) because of modeling results indicating: (1) lower or similar mean monthly Yolo Bypass outflow and lower flow exceedance probabilities; (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; and (3) similar simulated mean monthly salvage at the SWP and CVP export facilities

In conclusion, in consideration of potential impacts to green sturgeon in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions. Alternative B impacts on green sturgeon in the Yolo Bypass are considered potentially significant, relative to Existing Conditions. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

White Sturgeon in the Delta Region

Model results were examined for Yolo Bypass outflow (Appendix 12E) and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar juvenile rearing and emigration conditions (year-round) because of modeling results indicating: (1) lower or similar mean monthly Yolo Bypass outflow and lower flow exceedance probabilities; (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; and (3) similar simulated mean monthly salvage at the SWP and CVP export facilities

In conclusion, in consideration of potential impacts to white sturgeon in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions. Alternative B impacts on white sturgeon in the Yolo Bypass are considered potentially significant, relative to Existing Conditions. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in

Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Pacific and River Lamprey in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar macropthalmia emigration conditions (year-round) because of modeling results indicating slightly higher overall simulated mean monthly salvage at the SWP and CVP export facilities, with higher mean monthly salvage at the SWP export facility during critical water years

In conclusion, in consideration of potential impacts to Pacific and river lamprey in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

American Shad in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I) and X2 location (Appendix 12E).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar egg and larval conditions in the Delta because of modeling results indicating: (1) slightly lower (during April and May) and slightly higher (during June) exceedance probabilities of X2 location being located at or downstream of 75 RKm during April through June; (2) slightly higher overall normalized mean monthly salvage at the SWP and CVP export facilities; and (3) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to American shad in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Striped Bass in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I) and X2 location (Appendix 12E).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Similar egg and larval conditions in the Delta (April through June) because of modeling results indicating: (1) slight upstream mean monthly movements in X2 location during April and May of all water year types and slight downstream mean monthly movements in X2 location during June of all water year types during April through June; (2) slightly higher overall normalized mean monthly salvage at the SWP export facility and similar overall normalized mean monthly salvage at the CVP export facility; and (3) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to striped bass in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions.

Largemouth Bass in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I) and X2 location (Appendix 12E).

Relative to Existing Conditions, Alternative B would generally be expected to provide:

- Less suitable juvenile rearing conditions in the Yolo Bypass because of modeling results indicating: (1) lower mean monthly Yolo Bypass outflow during most months, in addition to similar or lower flow exceedance probabilities (of 10% or more); and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta
- Similar juvenile and adult conditions in the Delta because of modeling results indicating: (1) upstream mean monthly movements in X2 location of 0.5 RKm or more during December of wet water years, during March through May of above normal, below normal and dry water years and during March of critical water years, and downstream mean monthly movements in X2 location of 0.5 RKm or more during July and August of wet water years, during June through September of above normal water years, during June through December of below normal water years, during July through December of dry water years and during June through October, December and January of critical water years; and (2) slightly higher overall simulated mean monthly salvage at the SWP export facility and similar mean monthly salvage at the CVP export facility.

In conclusion, in consideration of potential impacts to largemouth bass in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to Existing Conditions. Alternative B impacts on largemouth bass in the Yolo Bypass are considered potentially significant, relative to Existing Conditions. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Suisun, San Pablo, and San Francisco Bays

Fish species of primary management concern, including Chinook salmon, steelhead, river lamprey, Pacific lamprey, green sturgeon, white sturgeon, and splittail, utilize the bays as a migration corridor and/or for juvenile rearing. Potential increases in Delta outflow during the summer and fall and reductions in Delta outflow during the spring would not result in substantial changes to migration or rearing habitat for these fish species in the bays. Striped bass and American shad also utilize the bays for migration and rearing, however, changes in X2 location were evaluated during the striped bass and American shad spawning and initial rearing period to evaluate potential changes in larval transport and rearing habitat in the Bay-Delta (see the Delta Region, above). Potential effects on delta smelt and longfin smelt migration and rearing in the Bay-Delta also were analyzed through evaluation of changes in X2 location (see the Delta Region, above).

12C.6.3 Primary Study Area – Alternative B Relative to Existing Conditions

12C.6.3.1 Construction, Operation, and Maintenance Impacts

For a discussion of impacts to fisheries and aquatic resources under Alternative B relative to Existing Conditions in the Primary Study Area, refer to the Environmental Consequences section of Chapter 12 Aquatic Biological Resources.

12C.7 Impacts Associated with Alternative B Relative to the No Project/No Action Alternative

12C.7.1 Extended Study Area – Alternative B Relative to the No Project/No Action Alternative

12C.7.1.1 SWP and CVP Operations

Agricultural Water Use

Potential impacts to fisheries and aquatic resources associated with agricultural water use are discussed under Alternative A relative to Existing Conditions, above, and are applicable to Alternative B relative to the No Project/No Action Alternative.

Municipal and Industrial Water Use

Potential impacts to fisheries and aquatic resources associated with municipal and industrial water use are discussed under Alternative A relative to Existing Conditions, above, and are applicable to Alternative B relative to the No Project/No Action Alternative.

Wildlife Refuge Water Use

Potential impacts to fisheries and aquatic resources associated with wildlife refuge water use are discussed under Alternative A relative to Existing Conditions, above, and are applicable to Alternative B relative to the No Project/No Action Alternative.

San Luis Reservoir

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for San Luis Reservoir during April through November.

Relative to No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage occurring with the same frequency and higher average monthly storage by water year type occurring more often during most water years of the evaluation period; (2) higher monthly storage exceedance probabilities occurring more often during the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during most months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in San Luis Reservoir, Alternative B would result in potentially beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for San Luis Reservoir during March through June.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or slightly less suitable warmwater fish spawning and early life stage conditions, because of modeling results indicating slightly increased or similar frequencies of monthly water surface elevation reductions of six feet or more during the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in San Luis Reservoir, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Export Service Area Reservoirs

Export Service Area Reservoir Fisheries

Changes in modeled total SWP and CVP Delta exports under Alternative B relative to the No Project/No Action Alternative were analyzed to evaluate potential changes in storage and water surface elevations (Appendix 12H) and associated impacts on fisheries in export service area reservoirs, including Anderson Reservoir, Diamond Valley Lake, Castaic Lake, Lake Mathews, and Lake Perris.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Equivalent or improved export service area reservoir fisheries habitat conditions, because of modeling results indicating: (1) long-term average and average monthly by water year type Delta exports would be slightly higher during most months of all water year types, and would be higher by 10 percent or more during September through November of wet water years, during September and November of above normal and dry water years, and during January, February, August, September and November of critical water years, and would be lower by 10 percent or more during December of critical water years; (2) higher monthly export exceedance probabilities during July through February, and lower export exceedance probabilities during April through June; and (3) a net 10 percent or more export probability of exceedance increase during most months of the year.

In conclusion, in consideration of potential impacts to SWP and CVP export service area reservoir fisheries, Alternative B would result in potentially beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

12C.7.2 Secondary Study Area – Alternative B Relative to the No Project/No Action Alternative

12C.7.2.1 Construction, Operation, and Maintenance Impacts

Construction, operation, and maintenance impacts to fisheries and aquatic resources in the Secondary Study Area would be similar to those discussed under Alternative A relative to the No Project/No Action Alternative, above.

12C.7.2.2 SWP and CVP Operations

Trinity Lake

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Trinity Lake during April through November.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Equivalent or improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage during most of the evaluation period, and higher average monthly storage by water year type during all water years of the evaluation period; (2) equivalent or higher monthly storage exceedance probabilities during all months of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during all months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Trinity Lake, Alternative B would result in potentially beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Trinity Lake during March through June.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Improved warmwater fish spawning and early life stage conditions, because of modeling results indicating similar or slightly decreased frequencies of monthly water surface elevation reductions of six feet or more during the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Trinity Lake, Alternative B would result in similar or slightly more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Trinity River

Coho Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Equivalent adult immigration and holding conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) similar average monthly probabilities of exceeding specified water temperature index values, with lower probabilities of exceedance during September and October.

- Equivalent adult spawning and embryo incubation conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during October and November.

- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows over the entire year, and similar monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the year; and (4) equivalent or lower probabilities of exceeding specified water temperature index values throughout most of the year, particularly during August through October, although higher probabilities of exceedance would occur during June.
- Equivalent smolt emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values during the evaluation period, with slightly lower probabilities during April and May.

In conclusion, in consideration of potential impacts to all life stages of Coho salmon in the Trinity River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Spring-Run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Equivalent or slightly improved adult immigration and holding conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be slightly higher more frequently; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values, particularly during July through September.
- Equivalent or improved adult spawning and egg incubation conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly lower average monthly flows during all water year types; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) lower probabilities of exceeding specified water temperature

index values, and therefore more suitable water temperatures, at most water temperature indices during August through October.

- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows over the entire year, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) equivalent or similar probabilities of exceeding specified water temperature index values throughout the year.
- Equivalent smolt emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for wet years when flows would be slightly higher, and during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during July.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Trinity River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Fall-Run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork, in addition to model results for early life stage mortality (Appendix 12J).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Equivalent or slightly improved adult immigration and holding conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly lower average monthly flows during most water year types; (2) similar or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) similar or lower (particularly during September), and therefore more suitable, average monthly probabilities of exceeding specified water temperature index values.
- Equivalent adult spawning conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and

(4) similar probabilities of exceeding specified water temperature index values, with lower probabilities, and therefore more suitable water temperatures, during October.

- Improved embryo incubation conditions due to modeling results indicating reduced total annual early life stage mortality, and equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during October.
- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities over the evaluation period; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values.
- Equivalent smolt emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values, particularly during July.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Trinity River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Steelhead (Winter-run and Summer-run)

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Equivalent adult immigration and holding conditions for winter-run steelhead due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during the evaluation period; and (4) similar, or slightly lower (particularly during October) average monthly probabilities of exceeding specified water temperature index values.
- Equivalent adult immigration and holding conditions for summer-run steelhead due to modeling results indicating: (1) equivalent long-term average monthly flows during the evaluation period, and equivalent average monthly flows during all water year types; (2) equivalent monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities

of exceeding specified water temperature index values during the evaluation period, although slightly higher probabilities of exceedance would occur during June.

- Equivalent adult spawning and egg incubation conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout the evaluation period, with slightly higher probabilities of exceedance during March, May, and June, although slightly lower probabilities occur during April.
- Equivalent or slightly reduced juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows over the entire year, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during July, although higher probabilities would occur during August and September.
- Equivalent smolt emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows, except for during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values, with lower probabilities of exceedance during April, although higher probabilities would occur during May and June.

In conclusion, in consideration of potential impacts to all life stages of steelhead (winter-run and summer-run) in the Trinity River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Green Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam and at North Fork.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Equivalent adult immigration and holding conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) similar average monthly probabilities of exceeding specified water temperature index values.

- Equivalent adult spawning conditions due to modeling results indicating: (1) equivalent long-term average monthly flows during the evaluation period, and equivalent average monthly flows during all water year types; (2) equivalent monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values.
- Equivalent or reduced juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows over the entire year, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year, with slightly higher probabilities of exceedance during July through September.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Trinity River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

White Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam and at North Fork.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Equivalent adult immigration and holding conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.
- Equivalent adult spawning conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.
- Equivalent or reduced juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows over the entire year, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions,

equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with higher probabilities of exceedance during July through September.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Trinity River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Equivalent adult immigration conditions due to: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities during the evaluation period; and (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period.
- Equivalent adult spawning and egg incubation conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of remaining within the specified water temperature range, with lower probabilities of exceedance during July and August and slightly higher probabilities during April.
- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows over the entire year, and similar average monthly flows during most water year types, except for during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent or slightly lower flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values, with slightly higher probabilities of exceedance during September.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Trinity River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Klamath River downstream of the Trinity River

Because potential changes within the Trinity River were considered to be less than significant under Alternative B, it is expected that any potential changes in the Klamath River downstream of the Trinity River also would be less than significant.

Lewiston Lake, Whiskeytown Lake, Keswick Reservoir, Lake Natoma, and the Thermalito Complex

Refer to Alternative A relative to Existing Conditions for a discussion of Lewiston Lake, Whiskeytown Lake, Keswick Reservoir, Lake Natoma, and the Thermalito Complex. That discussion also applies to Alternative B relative to the No Project/No Action Alternative.

Spring Creek

It is not anticipated that operations of Spring Creek Reservoir or flows in Spring Creek would be substantially affected under implementation of the Alternative B. It is anticipated that Spring Creek Reservoir would continue to operate for flood control purposes, and to manage the release of contaminated water from Iron Mountain Mine.

Shasta Lake

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Shasta Lake during April through November.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Equivalent or improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage, and higher average monthly storage by water year type during most months of the evaluation period; (2) equivalent or higher monthly storage exceedance probabilities during all months of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during all months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Shasta Lake, Alternative B would result in potentially beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Shasta Lake during March through June.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Improved warmwater fish spawning and early life stage conditions, because of modeling results indicating decreased frequencies of monthly water surface elevation reductions of six feet or more during most of the March through June evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Shasta Lake, Alternative B would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Sacramento River

Winter-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for spawning habitat availability (WUA) (Appendix 12N), early life stage mortality (SacSalMort) (Appendix 12J), overall population mortality and production potential (SALMOD) (Appendix 12K), and lifecycle modeling (IOS) (Appendix 12L).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) lower or similar long-term average and average by water year type monthly flows more often; (2) lower monthly flow exceedance probabilities occurring more often in the upper Sacramento River and higher flow exceedance probabilities occurring more often in the lower Sacramento River; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring more often at most locations, and lower flow exceedance probabilities below Red Bluff Diversion Dam; (4) equivalent monthly probabilities of exceeding specified water temperature index values, but with higher probabilities of exceeding specified water temperature index values during April and May, and slightly lower probabilities of exceeding specified water temperatures during June and July.
- Improved spawning conditions due to modeling results indicating increased spawning habitat availability during all months of the spawning period, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during months with relatively warm water temperature conditions (i.e., July and August).
- Similar or improved embryo incubation conditions due to modeling results indicating: reduced mean total annual early life stage mortality, but with increased average annual mortality during above normal and below normal water years, reduced annual early life stage mortality over approximately 50 percent of the entire cumulative frequency distribution, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during months with relatively warm water temperature conditions (i.e., July and August).
- Improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type occurring more often in the upper Sacramento River, and higher and lower average monthly flows occurring with similar monthly frequencies in the lower Sacramento River; (2) higher monthly flow exceedance probabilities occurring more often below Keswick Dam, at Verona, Freeport and Rio Vista, and lower monthly flow exceedance probabilities below Red Bluff Diversion Dam; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at most locations evaluated, but lower flow exceedance probabilities below Red Bluff Diversion Dam; and (4) equivalent or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values during July through September, and equivalent or higher probabilities of exceeding specified water temperature index values during April.
- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by 13 percent), and average annual mortality by water year type would

be reduced during all water year types (by nine percent during wet water years, 25 percent during above normal water years, six percent during below normal water years, 14 percent during dry water years, and nine percent during critical water years); (2) a decrease in total annual mortality exceedance probabilities over more than 85 percent of the distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction, with 10 percent or more exceedance probability reductions occurring over 16 percent of the entire distribution; and (4) long-term average total annual winter-run Chinook salmon production would increase by one percent, while average total annual production would increase during wet water years by less than one percent, during above normal water years by eight percent, during below normal water years by less than one percent, during dry water years by two percent, and during critical water years by one percent.

- Improved conditions pertaining to early life stage survival and abundance of spawners (IOS) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual egg to fry survival would increase by three percent, and average annual egg to fry survival by water year type would decrease during wet and above normal water years by one percent, and would increase during below normal water years by four percent, dry water years by six percent, and during critical water years by 21 percent; (2) long-term average annual fry to smolt survival would increase by three percent, and average annual fry to smolt survival by water year type would increase during wet and above normal water years by one percent, would be reduced during below normal and dry water years by one percent, and would increase during critical water years by 20 percent; (3) long-term average annual female spawner abundance would increase by eight percent, and average annual female spawner abundance by water year type would increase during wet water years by 10 percent, during above normal water years by 13 percent, during dry water years by six percent and during critical water years by 11 percent, and would be reduced during below normal water years by less than one percent; (4) an increase in annual egg to fry survival exceedance probabilities over approximately 70 percent of the entire distribution, particularly at lower survival rates; (5) an increase in annual fry to smolt survival exceedance probabilities over approximately 80 percent of the entire distribution, particularly at lower survival rates; and (6) an increase in annual female spawner abundance exceedance probabilities over more than 95 percent of the entire distribution.

In conclusion, in consideration of potential impacts to all life stages of winter-run Chinook salmon in the Sacramento River, Alternative B would result in beneficial and less-than-significant impacts, relative to No Project/No Action Alternative.

Spring-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball’s Ferry, Jelly’s Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J) and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type more often in the upper Sacramento River, and higher and lower long-term average monthly and average monthly flows by water year type occurring with similar monthly frequencies in the lower Sacramento River; (2) lower monthly flow exceedance probabilities more often in the upper Sacramento River, and higher monthly flow exceedance probabilities more often in the lower Sacramento River; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at most locations evaluated, with lower average monthly flows more often below Red Bluff Diversion Dam; (4) equivalent or lower (particularly during August and September) and equivalent or higher (particularly during April and May) monthly probabilities of exceeding specified water temperature index values.

- Improved spawning conditions due to modeling results indicating higher average monthly flows and flow exceedance probabilities more often below Keswick Dam and at Bend Bridge, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during months with warm water temperature conditions (i.e., September and October).
- Improved embryo incubation conditions due to modeling results indicating reduced average total annual early life stage mortality and reduced early life stage mortality over most of the cumulative frequency distribution, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures.
- Similar juvenile rearing conditions due to modeling results indicating: (1) lower long-term average monthly flows during more than half of the evaluation period in the upper Sacramento River; (2) higher monthly flow exceedance probabilities below Keswick Dam and lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam; (3) under low flow conditions, higher monthly flow exceedance probabilities more often below Keswick Dam, and lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam; and (4) equivalent or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values.
- Similar smolt emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type more often; (2) lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam, and higher flow exceedance probabilities more often in the lower Sacramento River; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at most locations evaluated, but with lower flow exceedance probabilities below Red Bluff Diversion Dam; and (4) higher monthly probabilities of exceeding specified water temperature index values during April and May, and lower monthly probabilities of exceeding specified water temperature index values during October and June.
- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by 17 percent), and average annual mortality by water year type would be reduced during all water year types (by 29 percent during wet water years, three percent during above normal water years, four percent during below normal water years, 36 percent during dry water years, and eight percent during critical water years); (2) a decrease in total annual mortality exceedance probabilities over nearly the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction, with reductions of 10 percent or more occurring over more than 80 percent of the distribution; and (4) long-term average total annual spring-run Chinook salmon production would increase by three percent, while average total annual production would increase during wet water years by two percent, during above normal water years by one percent,

during below normal water years by less than one percent, during dry water years by eight percent, and during critical water years by three percent.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Sacramento River, Alternative B would result in similar or beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J), spawning habitat availability (WUA) (Appendix 12N), and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type during most of the evaluation period in the upper Sacramento River, and higher long-term average monthly and average monthly flows by water year type in the lower Sacramento River; (2) higher or equivalent monthly flow exceedance probabilities in the upper Sacramento River, and higher monthly flow exceedance probabilities during most months in the lower Sacramento River; (3) during low flow conditions, higher or equivalent monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated; (4) equivalent or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values.

- Less suitable spawning conditions due to modeling results indicating reduced spawning habitat availability during November through January, and lower or equivalent probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, specifically during October.

- Improved embryo incubation conditions due to modeling results indicating reduced mean total annual early life stage mortality and reduced annual early life stage mortality over almost the entire cumulative frequency distribution, and lower or equivalent probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures.

- Similar or less suitable juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during more than half of the evaluation period at all locations evaluated; (2) lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam, and higher monthly flow exceedance probabilities more often in the lower Sacramento River; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at all locations evaluated, except for below Red Bluff Diversion Dam where flows would be lower with more often; and (4) similar monthly probabilities of exceeding specified water temperature index values, but with less suitable water temperatures during April and May more often.

- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by four percent), average annual mortality by water year type would increase during wet and below normal water years by four and less than one percent, respectively, and would decrease during above normal water years by 13 percent, during dry water years by nine percent, and during critical water years by 17 percent; (2) a decrease in total annual mortality exceedance probabilities over approximately 55 percent of the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction; and (4) long-term average total annual fall-run Chinook salmon production would increase by two percent, while average total annual production would decrease during wet water years by eight percent and during below normal water years by less than one percent, and would increase during above normal water years by 10 percent, during dry water years by four percent, and during critical water years by nine percent.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Late Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J) and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly flows by water year type with similar monthly frequencies below Keswick Dam, and lower long-term average monthly and average monthly flows by water year type more often below Red Bluff Diversion Dam and in the lower Sacramento River; (2) lower monthly flow exceedance probabilities during more than half of the months evaluated below Red Bluff Diversion Dam, and higher monthly flow exceedance probabilities more often below Keswick Dam and in the lower Sacramento River; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated except for below Red Bluff Diversion where flow exceedance probabilities would be lower more often; (4) similar monthly probabilities of exceeding specified water temperature index values, but with more suitable water temperatures during October and less suitable water temperatures during April.

- Similar spawning conditions due to modeling results indicating higher average monthly flows during January and February and lower average monthly flows during March through May, and similar probabilities of exceeding specified water temperature index values.

- Similar or less suitable embryo incubation conditions due to modeling results indicating: (1) slightly reduced average total annual early life stage mortality, but with higher annual mortality during above normal, below normal, dry and critical water years, and higher annual mortality over about 65 percent of the cumulative frequency distribution; and (2) similar probabilities of exceeding specified water temperature index values.

- Similar or improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows more often below Red Bluff Diversion Dam, and higher average monthly flows more often in the lower Sacramento River; (2) similar or lower monthly flow exceedance probabilities below Red Bluff Diversion Dam, and higher monthly flow exceedance probabilities in the lower Sacramento River; (3) under low flow conditions, similar or lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam and higher monthly flow exceedance probabilities more often at all other locations evaluated; and (4) lower monthly probabilities of exceeding specified water temperature index values more often during June through October, but higher probabilities of exceeding specified water temperature index values more often during April and May.

- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by one percent), average annual mortality by water year type would be reduced during wet water years by less than one percent and during below normal and critical water years by eight percent, and would increase during above normal water years by six percent and during dry water years by less than one percent; (2) a decrease in total annual mortality exceedance probabilities over approximately 80 percent of the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction; (4) long-term average total annual late fall-run Chinook salmon production would increase by one percent, while average total annual production by water year type would decrease during above normal water years by three percent, and would increase during wet water years by less than one percent, during below normal water years by two percent, during dry water years by less than one percent, and during critical water years by seven percent.

In conclusion, in consideration of potential impacts to all life stages of late fall-run Chinook salmon in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Steelhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball’s Ferry, Jelly’s Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, and results from the SacEFT (Appendix 8B) were examined for steelhead egg mortality, spawning habitat availability, redd dewatering, redd scouring, juvenile rearing habitat availability and juvenile stranding.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) higher long-term average monthly and average monthly by water year type flows more often below Keswick Dam and in the lower Sacramento River, and lower average monthly flows more often below Red Bluff Diversion Dam; (2) higher monthly flow exceedance probabilities occurring more often, but with substantially lower monthly flow exceedance probabilities during several months below Red Bluff Diversion Dam; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period in the lower Sacramento River and below Keswick Dam, and lower flow exceedance probabilities more often below Red Bluff Diversion Dam; (4) similar or lower monthly probabilities of exceeding specified water temperature index values more often during September and October, and higher monthly probabilities of exceeding specified water temperature index values during March.

- Similar spawning conditions due to modeling results indicating: (1) higher mean monthly flows and flow exceedance probabilities during December through February, and lower flows during March and April; (2) higher or equivalent flow exceedance probabilities more often during low flow conditions; (3) similar probabilities of exceeding specified water temperature index values; and (4) SacEFT results indicating that spawning habitat availability conditions would be similar.
- Similar embryo incubation conditions due to modeling results indicating: (1) similar probabilities of exceeding specified water temperature index values; (2) SacEFT results indicating that egg mortality associated with modeled water temperatures would be equivalent; (3) SacEFT results indicating that redd dewatering conditions may be improved slightly more often; and (4) SacEFT results indicating that redd scouring conditions would be equivalent.
- Similar juvenile rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies below Keswick Dam and at Bend Bridge, and lower average monthly flows occurring more often below Red Bluff Diversion Dam; (2) higher monthly flow exceedance probabilities more often below Keswick Dam and at Bend Bridge, and lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam; (3) under low flow conditions, higher monthly flow exceedance probabilities more often below Keswick Dam and at Bend Bridge, and lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam; (4) equivalent monthly probabilities of exceeding specified water temperature index values, but with lower probabilities of exceeding 65°F during August and September, and therefore more suitable water temperature conditions; and (5) SacEFT results indicating that juvenile rearing habitat availability may increase slightly more often while juvenile stranding potential may increase more often.
- Similar smolt emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type more often; (2) lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam, and higher monthly flow exceedance probabilities more often in the lower Sacramento River; (3) under low flow conditions, lower monthly flow exceedance probabilities below Red Bluff Diversion Dam, and higher monthly flow exceedance probabilities more often at all other locations evaluated; and (4) higher monthly probabilities of exceeding specified water temperature index values during March and April, and lower monthly probabilities of exceeding specified water temperature index values during October.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Green Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities, at Wilkins Slough, at Freeport and at Rio Vista, and egg survival results from the SacEFT (Appendix 8B) were examined.

Relative to the No Project/No Action Alternative, NODOS Alternative B would be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type below Keswick Dam, and higher long-term average monthly and average monthly flows by water year type more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; (2) higher monthly flow exceedance probabilities more often at all locations evaluated; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring more often at all locations evaluated; and (4) lower, and therefore more suitable, average monthly probabilities of exceeding specified water temperature index values during June, September and October, and equivalent or higher probabilities of exceeding specified water temperature index values during April and May.
- Similar spawning conditions because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type below Keswick Dam and Red Bluff Diversion Dam, and higher and lower long-term average monthly and average monthly flows by water year type with similar monthly frequencies at Wilkins Slough; (2) lower or equivalent monthly flow exceedance probabilities more often below Keswick Dam and Red Bluff Diversion Dam, but higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies at Wilkins Slough; (3) during low flow conditions, equivalent monthly flow exceedance probabilities below Keswick Dam, lower flow exceedance probabilities more often below Red Bluff Diversion Dam and higher flow exceedance probabilities more often at Wilkins Slough; and (4) equivalent monthly probabilities of exceeding the specified water temperature index value.
- Similar egg incubation conditions because of modeling results indicating equivalent probabilities of exceeding the specified water temperature index value below Keswick Dam and Red Bluff Diversion Dam, and SacEFT results indicating reduced water temperatures more often near Hamilton City and potentially increased survival.
- Similar or improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type more often below Red Bluff Diversion Dam, and higher average monthly flows and average monthly flows by water year type during June through November, and lower average monthly flows during December through April below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; (2) lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam and higher monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; (3) under low flow conditions, higher monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista, and lower monthly flow exceedance probabilities below Red Bluff Diversion Dam; and (4) equivalent or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values at all locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Sacramento River, Alternative B would result in similar or beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

White Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River at Hamilton City, below the proposed Delevan Pipeline Intake Facilities, Wilkins Slough, Knights Landing, below the Feather River confluence, Freeport and Rio Vista.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) lower or similar long-term average monthly and average monthly flows by water year type during most of the evaluation period; (2) lower monthly flow exceedance probabilities more often at Hamilton City and below the proposed Delevan Pipeline Intake Facilities, and higher flow exceedance probabilities more often at Rio Vista; (3) during low flow conditions, lower flow exceedance probabilities more often at Hamilton City and higher monthly flow exceedance probabilities occurring more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.
- Less suitable spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows; (2) lower monthly flow exceedance probabilities at Hamilton City and below the proposed Delevan Pipeline Intake Facilities, and equivalent or lower monthly flow exceedance probabilities at Verona; (3) during low flow conditions, lower or equivalent flow exceedance probabilities at Hamilton City, and equivalent or lower flow exceedance probabilities below the proposed Delevan Pipeline Intake Facilities and at Verona; and (4) equivalent or higher probabilities of exceeding specified water temperature index values, and therefore less suitable water temperatures.
- More suitable juvenile rearing and outmigration conditions due to modeling results indicating: (1) higher long-term average monthly and average by water year type monthly flows more often; (2) higher monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent or lower monthly probabilities of exceeding specified water temperature index values, and therefore more suitable water temperature conditions.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Sacramento River Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

River Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly flows by water year type occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below the proposed Delevan Pipeline Intake Facilities, and higher flow exceedance probabilities more often below Keswick Dam and at Freeport; and (3) during low flow conditions, higher flow exceedance probabilities occurring more often at all locations evaluated.

- Similar spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows more often; (2) lower monthly flow exceedance probabilities more often; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities below Keswick Dam, lower monthly flow exceedance probabilities below Red Bluff Diversion Dam, and higher flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities; and (4) higher probabilities of occurring within specified water temperature ranges during most months, and therefore more suitable water temperatures.
- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values, but with lower probabilities of exceeding 72°F during July and August.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) lower long-term average and average monthly by water year type flows more often; (2) lower monthly flow exceedance probabilities more often; and (3) during low flow conditions, higher or similar flow exceedance probabilities.
- Similar spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average monthly by water year type flows below Keswick Dam and Red Bluff Diversion Dam, and higher and lower long-term average monthly and average monthly flows by water year type occurring with similar monthly frequencies below the proposed Delevan Pipeline Intake Facilities; (2) lower monthly flow exceedance probabilities more often; (3) during low flow conditions, higher or similar flow exceedance probabilities below Keswick Dam and the proposed Delevan Pipeline Intake Facilities, and lower flow exceedance probabilities more often below Red Bluff Diversion Dam; and (4) higher probabilities of water temperatures occurring within the specified water temperature range during most months, and therefore more suitable water temperatures.
- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities

more often; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values, but with lower probabilities of exceeding 72°F during July and August at Freeport.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Hardhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or improved adult and other life stage conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) lower probabilities of water temperatures occurring within the specified range slightly more often, and therefore, potentially less suitable water temperatures.
- Similar spawning conditions, because of modeling results indicating: (1) similar or slightly higher or lower long-term average and average by water year type monthly flows below the proposed Delevan Pipeline Intake Facilities and at Freeport, and lower average monthly flows below Keswick Dam more often; (2) lower monthly flow exceedance probabilities more often below Keswick Dam and the proposed Delevan Pipeline Intake Facilities and equivalent or higher monthly flow exceedance probabilities at Freeport; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities; and (4) higher probabilities of water temperatures occurring within the specified water temperature range during April through June below the proposed Delevan Pipeline Intake Facilities, and slightly lower probabilities of water temperatures occurring within the specified range during April and May at Freeport.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

California Roach

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or improved adult and other life stage conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent probabilities of water temperatures occurring within the specified range.

- Similar spawning conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows more often; (2) lower monthly flow exceedance probabilities more often below Keswick Dam and the proposed Delevan Pipeline Intake Facilities, and lower flow exceedance probabilities slightly more often at Freeport; (3) during low flow conditions, equivalent monthly flow exceedance probabilities below Keswick Dam, and higher and lower flow exceedance probabilities with the same monthly frequency below the proposed Delevan Pipeline Intake Facilities and at Freeport; and (4) similar probabilities of exceeding the specified water temperature index value, but a higher probability of exceedance during April below the proposed Delevan Pipeline Intake Facilities and at Freeport, and therefore slightly more suitable water temperatures (California roach initiate spawning at water temperatures of approximately 60°F or higher).

In conclusion, in consideration of potential impacts to all life stages of California roach in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Sacramento Splittail

Evaluation of water temperatures (Appendix 12E) for splittail in the Sacramento River (i.e., 45-75° F) indicate that water temperature conditions would be essentially equivalent or similar under Alternative B relative to the No Project/No Action Alternative, resulting in a less than significant impact.

American Shad

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities, below the Feather River Confluence (Verona) and at Freeport.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar adult spawning and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type more often below Red Bluff Diversion Dam, and similar or slightly higher or lower long-term average and average by water year type monthly flows at Verona and Freeport; (2) lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam, and equivalent or higher flow exceedance probabilities at Verona and Freeport; (3) during low flow conditions, lower flow exceedance probabilities below Red Bluff Diversion Dam and equivalent or slightly higher flow exceedance probabilities at Verona and Freeport; and (4) similar but slightly higher probabilities of water temperatures occurring within the specified water temperature range below the Feather River confluence and at Freeport, and slightly lower probabilities of water temperatures occurring within the specified range below Red Bluff Diversion Dam.

- Similar or improved larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) higher long-term average and average by water year type monthly flows more often; (2) higher monthly flow exceedance probabilities more often; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) equivalent or slightly lower probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of American shad in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Striped Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below the proposed Delevan Pipeline Intake Facilities and below the Feather River Confluence (Verona).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar adult spawning and other life stage conditions, because of modeling results indicating: (1) similar or slightly higher or lower long-term average monthly and average monthly flows by water year type; (2) lower monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities, and similar flow exceedance probabilities at Verona; (3) during low flow conditions, equivalent or higher flow exceedance probabilities; and (4) slightly higher probabilities of water temperatures occurring within the specified water temperature range.
- Similar or improved larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) higher and lower long-term average and average by water year type monthly flows with similar monthly frequencies; (2) higher monthly flow exceedance probabilities more often; (3) during low flow conditions, higher monthly flow exceedance probabilities more often; and (4) higher probabilities of water temperatures occurring within the specified water temperature range more often.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Largemouth Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and Freeport.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Equivalent or improved adult and other life stage conditions, because of modeling results indicating: (1) lower and higher long-term average monthly flows, and lower and higher average monthly flows by water year type occurring with the same frequency during most water year types at all Sacramento River locations evaluated; (2) higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated; and (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated.
- Equivalent spawning conditions, because of modeling results indicating similar monthly probabilities of water temperatures occurring within the specified water temperature range at all locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the Sacramento River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Clear Creek

Potential impacts to fisheries and aquatic resources in Clear Creek under Alternative B relative to the No Project/No Action Alternative would be similar to those discussed under Alternative A relative to the No Project/No Action Alternative, above.

Lake Oroville

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Lake Oroville during April through November.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Equivalent or improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage, and higher average monthly storage by water year type during most months of the evaluation period; (2) equivalent and higher monthly storage exceedance probabilities during all months the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during all months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Lake Oroville, Alternative B would result in beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Lake Oroville during March through June.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar warmwater fish spawning and early life stage conditions, because of slightly increased and decreased monthly water surface elevation reductions of six feet or more occurring with similar frequency during the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Lake Oroville, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Feather River

Flows in the Low Flow Channel below the Fish Barrier Dam were modeled consistent with the terms of the FERC Settlement Agreement. As shown in Appendix 12F, modeled results for long-term average flows, average flows by water year type, and flow exceedance probabilities of 10 percent or more during all years and during low flow conditions were equivalent for Alternative B, relative to the No Project/No Action Alternative. Although these results are not repeated for the discussions below, the model results for the Low Flow Channel below the Fish Barrier Dam were considered along with the information presented below and are incorporated into the impact determinations for the following species: spring-run Chinook salmon, fall-run Chinook salmon, steelhead, green sturgeon, white sturgeon, river lamprey, Pacific lamprey, hardhead, and California roach.

Spring run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N) and early life stage mortality (Appendix 12J).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or slightly higher average monthly flows by water year type occurring more often than lower average monthly flows during most water year types, except below normal and dry water year types when lower monthly flows would occur more often; (2) similar or higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet, and higher and lower monthly flow exceedance probabilities occurring with similar frequencies at the mouth of the Feather River; (3) during low flow conditions, similar or higher monthly flow exceedance probabilities during most months of the evaluation period below the Thermalito Afterbay outlet, and higher and lower monthly flow exceedance probabilities occurring with similar frequencies at the mouth of the Feather River; and (4) similar probabilities of exceeding specified water temperature index values at all Feather River locations evaluated.
- Similar or improved spawning conditions due to significantly higher spawning habitat availability during half of the adult spawning period, although slightly lower spawning habitat availability would occur during the remainder of the evaluation period, and similar or slightly lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, during the evaluation period.
- Similar or less suitable embryo incubation conditions due to modeling results indicating slightly increased total annual long-term average early life stage mortality, and similar or slightly lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures during the evaluation period.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet, and similar or higher average monthly flows by water year type occurring more often than lower average monthly flows during wet, above normal, below normal, and critical water year types below the Thermalito Afterbay outlet, and lower average monthly flows during dry water year types below the Thermalito Afterbay outlet; (2) higher and lower monthly flow exceedance probabilities occurring with similar frequencies below the Thermalito Afterbay outlet; (3) under low flow conditions, similar or slightly higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet, although lower exceedance probabilities would occur during the evaluation period; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values at all Feather River locations evaluated.
- Similar smolt emigration conditions, because of modeling results indicating: (1) similar or lower long-term average monthly flows during most of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or higher average monthly flows by water year type occurring more often than lower average monthly flows during most water year types below

the Thermalito Afterbay outlet and at the mouth of the Feather River, except for dry and critical water year types when average monthly flows would be lower below the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) during low flow conditions, similar or lower monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Feather River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N) and early life stage mortality (Appendix 12J).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or slightly lower average monthly flows by water year type occurring more often during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, although significantly higher flows would occur during August and September of dry and critical water year types; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequency below the Thermalito Afterbay outlet and at the mouth of the Feather River with higher flows occurring during July through September; (3) during low flow conditions, similar or slightly higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar probabilities of exceeding specified water temperature index values during the evaluation period.

- Improved spawning conditions due to modeling results indicating substantially higher spawning habitat availability during most of the adult spawning period, although slightly lower spawning habitat availability would occur during November, and similar or slightly lower probabilities of exceeding specified water temperature index values during most of the evaluation period.

- Similar or slightly less suitable embryo incubation conditions due to modeling results indicating slightly increased total annual long-term average early life stage mortality, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, during most of the evaluation period.

- Similar or less suitable juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during most months of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or higher average monthly flows by water year type occurring more often than lower average monthly flows during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during dry and critical water year types when flows would be lower more frequently; (2) similar or slightly lower monthly flow exceedance probabilities occurring more frequently below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar monthly probabilities of exceeding specified water temperature index values at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Feather River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Steelhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar average monthly flows by water year type during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, although slightly lower flows would occur during dry water year types; (2) similar or lower monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher exceedance probabilities would occur during August, September, and March; (3) during low flow conditions, similar or lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet, and similar or higher monthly flow exceedance probabilities occurring more often at the mouth of the Feather River; and (4) similar or lower monthly probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, during most of the evaluation period.
- Similar spawning conditions due to modeling results indicating higher spawning habitat availability occurring more frequently during the adult spawning period, and similar probabilities of exceeding specified water temperature index values during most of the evaluation period.
- Similar embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet, and higher and lower long-term average monthly flows occurring with similar monthly frequency during the evaluation period below the Thermalito Afterbay outlet; (2) similar or slightly lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities below the Thermalito Afterbay outlet; and (4) similar monthly probabilities of exceeding specified water temperature index values during most of the evaluation period at all Feather River locations evaluated.

- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet, and similar or generally higher average monthly flows by water year type occurring more often than lower average monthly flows during wet, above normal, below normal, and critical water year types below the Thermalito Afterbay outlet, and generally lower average monthly flows during dry water year types below the Thermalito Afterbay outlet; (2) higher and lower monthly flow exceedance probabilities occurring with similar frequencies below the Thermalito Afterbay outlet; (3) under low flow conditions, similar or slightly higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet, although lower exceedance probabilities would occur during the evaluation period; and (4) similar monthly probabilities of exceeding specified water temperature index values at all Feather River locations evaluated.
- Similar smolt emigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and lower average monthly flows by water year type occurring during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except for above normal water year types when average monthly flows would be higher more often; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) similar or lower monthly probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the Feather River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Green Sturgeon

Flow model results (Appendix F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, at Shanghai Bend, and at the mouth of the Feather River. Water temperature results (Appendix 12E) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period at Shanghai Bend and at the mouth of the Feather River, and similar or higher average monthly flows by water year type occurring during wet, above normal, below normal, and critical water year types, and generally lower average monthly flows during dry water year types at Shanghai Bend and at the mouth of the Feather River, (2) similar or lower monthly flow exceedance probabilities occurring more often at Shanghai Bend and at the mouth of the Feather River; (3) during low flow conditions, similar or higher monthly flow exceedance probabilities occurring more often at Shanghai Bend, and higher and lower monthly flow exceedance probabilities occurring with similar frequencies at the mouth of the Feather River; and (4) similar monthly probabilities of exceeding specified water temperature index values during the evaluation period.

- Similar adult spawning and embryo incubation conditions because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet, and similar or higher average monthly flows by water year type during wet and above normal water year types below the Thermalito Afterbay outlet, and lower average monthly flows occurring during below normal, dry, and critical water year types; (2) similar or higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet; (3) during low flow conditions, similar or higher monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet; and (4) similar monthly probabilities of exceeding specified water temperature index values below the Thermalito Afterbay outlet.
- Similar juvenile rearing conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower with similar frequency or higher average monthly flows by water year type occurring during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except for dry water year types when average monthly flows would be lower more often; (2) similar or lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher exceedance probabilities would occur during June through September; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher exceedance probabilities would occur during July through September; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values at all Feather River locations evaluated.
- Similar or slightly improved juvenile emigration conditions due to modeling results indicating: (1) similar or higher long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet, at Shanghai Bend, and at the mouth of the Feather River, and higher average monthly flows by water year type occurring during most water year types below the Thermalito Afterbay outlet, at Shanghai Bend, and at the mouth of the Feather River, except for during dry and critical water years when flows would be lower more frequently; (2) higher monthly flow exceedance probabilities occurring during most months below the Thermalito Afterbay outlet, at Shanghai Bend, and at the mouth of the Feather River, except during May and June when probabilities of exceedance would be lower; (3) under low flow conditions, higher monthly flow exceedance probabilities occurring during most months at all evaluated locations, except during May and June when probabilities of exceedance would be lower; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values below the Thermalito Afterbay outlet and at the mouth of the Feather River.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Feather River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

White Sturgeon

Flow model results (Appendix 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, at Shanghai Bend, and at the mouth of the Feather River. Water temperature results (Appendix 12E) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or less suitable adult immigration and holding conditions, because of modeling results indicating: (1) similar or lower long-term average monthly flows occurring more often during the evaluation period at Shanghai Bend and at the mouth of the Feather River, and similar or slightly higher average monthly flows by water year type during most water year types, except during dry water years when lower average monthly flows would occur more frequently; (2) similar or lower monthly flow exceedance probabilities during most of the evaluation period at Shanghai Bend and at the mouth of the Feather River; (3) during low flow conditions, similar or lower flow exceedance probabilities during the evaluation period at Shanghai Bend, and higher and lower flow exceedance probabilities occurring with similar frequencies at the mouth of the Feather River; and (4) equivalent monthly probabilities of exceeding specified water temperature index values at all locations evaluated.
- Similar or less suitable spawning and egg incubation conditions because of modeling results indicating: (1) higher and lower long-term average monthly flows occurring with similar frequency during the evaluation period at Shanghai Bend and at the mouth of the Feather River, and similar or higher average monthly flows by water year type occurring more often during most water year types at Shanghai Bend and at the mouth of the Feather River, except during dry and critical water year types when lower average monthly flows would occur; (2) lower monthly flow exceedance probabilities during most of the evaluation period at Shanghai Bend and at the mouth of the Feather River; (3) during low flow conditions, similar or lower monthly flow exceedance probabilities during the evaluation period at Shanghai Bend and at the mouth of the Feather River; and (4) similar monthly probabilities of exceeding specified water temperature index values at all locations evaluated.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period at Shanghai Bend and at the mouth of the Feather River, and similar or higher average monthly flows by water year type during wet, above normal, below normal, and critical water year types, and lower average monthly flows during dry water year types at Shanghai Bend and at the mouth of the Feather River, (2) similar or lower monthly flow exceedance probabilities occurring more often at Shanghai Bend and at the mouth of the Feather River; (3) during low flow conditions, similar or higher monthly flow exceedance probabilities occurring more often at Shanghai Bend, and higher and lower monthly flow exceedance probabilities occurring with similar frequencies at the mouth of the Feather River; and (4) generally similar or slightly higher monthly probabilities of exceeding specified water temperature index values at all locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Feather River, Alternative B would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

River Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or slightly reduced adult immigration conditions, because of modeling results indicating: (1) similar or lower long-term average monthly flows during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar average monthly flows by water year type during most water year types, although lower average monthly flows would occur more frequently dry water year types; (2) similar or lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher monthly flow exceedance probabilities would occur throughout the evaluation period; and (3) during low flow conditions, similar or lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance would occur throughout the evaluation period.
- Similar or less suitable adult spawning and egg incubation conditions, because of modeling results indicating: (1) similar long-term average monthly flows and average monthly flows by water year type occurring during most water years below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during dry and critical water year types when lower monthly flows would occur more frequently; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) during low flow conditions, similar or slightly lower monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although significantly higher flows would occur during June and July below the Thermalito Afterbay Outlet; and (4) similar or lower probability of water temperatures occurring within the specified water temperature range with similar frequency during the evaluation period at all Feather River locations evaluated.
- Similar ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower with similar frequency or higher average monthly flows by water year type occurring during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except for dry water year types when average monthly flows would be lower more often; (2) similar or lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher exceedance probabilities would occur during June through September; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher exceedance probabilities would occur during July through September; and (4) similar or slightly lower probability of water temperatures occurring within the specified water temperature range during most of the evaluation period at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the Feather River, Alternative B would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or less suitable adult immigration conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows and average monthly flows by water year type occurring during most water years below the Thermalito Afterbay outlet and at the mouth of the Feather River, except during dry and critical water year types when lower monthly flows would occur more frequently; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (3) during low flow conditions, similar or slightly lower monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River.
- Similar or less suitable spawning and egg incubation conditions, because of modeling results indicating: (1) similar long-term average monthly flows below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or higher average monthly flows by water year type occurring during wet and above normal water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, and lower average monthly flows by water year type occurring during below normal, dry and critical water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) higher and lower monthly flow exceedance probabilities occurring with similar frequency during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar frequency during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) slightly lower probability of water temperatures occurring within the specified water temperature range during the evaluation period at all Feather River locations evaluated.
- Similar ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower with similar frequency or higher average monthly flows by water year type occurring during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except for dry water year types when average monthly flows would be lower more often; (2) similar or lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher exceedance probabilities would occur during June through September; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher exceedance probabilities would occur during July through September; and (4) similar or slightly lower probability of water temperatures occurring within the specified water temperature range during most of the evaluation period at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Feather River, Alternative B would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Hardhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar adults and juveniles habitat conditions, due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and generally higher and lower with similar frequency or higher average monthly flows by water year type occurring during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except for dry water year types when average monthly flows would be lower more often; (2) similar or lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher exceedance probabilities would occur during June through September; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher exceedance probabilities would occur during July through September; and (4) similar or slightly lower probability of water temperatures occurring within the specified water temperature range during most of the evaluation period at all Feather River locations evaluated.
- Less suitable adult spawning conditions due to modeling results indicating: (1) lower long-term average monthly flows during April and May months and equivalent long-term monthly flows during June at all Feather River locations evaluated, and higher average monthly flows by water year type during most water year types, except during dry and critical water year types; (2) lower monthly flow exceedance probabilities flows during April and May months and higher monthly flow exceedance probabilities during June below Thermalito Afterbay outlet; (3) during low flow conditions, lower monthly flow exceedance probabilities flows during April and May months at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June below Thermalito Afterbay outlet; and (4) similar or slightly lower monthly probabilities of water temperatures occurring within the specified water temperature range throughout the evaluation period below the Thermalito Afterbay Outlet and at the mouth of the Feather River.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the Feather River, the Alternative B would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

California Roach

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar adult and other life stage conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower with similar frequency or higher average monthly flows by water year type occurring during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except for dry water year types when average monthly flows would be lower more often; (2) similar or lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher exceedance probabilities would occur during June through September; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher exceedance probabilities would occur during July through September; and (4) equivalent monthly probabilities of exceeding specified water temperature index values occurring all months of the evaluation period at all Feather River locations.

- Similar or less suitable adult spawning conditions due to modeling results indicating: (1) similar long-term average monthly flows below the Thermalito Afterbay outlet and at the mouth of the Feather River, and similar or higher average monthly flows by water year type occurring during wet, above normal, and below normal water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, and lower average monthly flows by water year type during dry and critical water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River; (2) higher and lower monthly flow exceedance probabilities occurring with similar frequency during the evaluation period below the Thermalito Afterbay outlet, and lower monthly flow exceedance probabilities occurring more often during the evaluation period at the mouth of the Feather River; (3) under low flows, similar or lower monthly flow exceedance probabilities occurring most months of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River; and (4) equivalent or slightly lower monthly probabilities of exceeding specified water temperature index values at all Feather River locations.

In conclusion, in consideration of potential impacts to all life stages of California roach in the Feather River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Splittail

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or less suitable spawning conditions, because of modeling results indicating: (1) higher long-term monthly flows during February and March and lower long-term average monthly flows during April and May at the mouth of the Feather River, and similar or slightly higher average monthly flows by water year type during most water year types, although lower average monthly flows would occur during dry and critical water year types; (2) higher flow exceedance probabilities during March, and slightly lower monthly flow exceedance probabilities during the remainder of the evaluation period; (3) during low flow conditions, higher flow exceedance probabilities during March, and lower monthly flow exceedance probabilities during the remainder of the evaluation period at the mouth of the Feather River; (4) similar changes in usable flooded area (UFA) exceedance probabilities of 10 percent or more; and (5) equivalent probability of exceeding specified water temperature values during the evaluation period.

In conclusion, in consideration of potential impacts to all life stages of splittail in the Feather River, Alternative B would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Striped Bass

Flow model and water temperature results (Appendix 12E and 12F) were examined for the Feather River below the Thermalito Afterbay, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or less suitable adult spawning and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly flows during April and May months and equivalent long-term monthly flows during June at all Feather River locations evaluated, and higher average monthly flows by water year type during most water year types, except during dry and critical water year types; (2) lower monthly flow exceedance probabilities flows during April and May months and higher monthly flow exceedance probabilities during June below Thermalito Afterbay outlet; (3) during low flow conditions, lower monthly flow exceedance probabilities flows during April and May months at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June below Thermalito Afterbay outlet; and (4) similar or slightly lower monthly probabilities of water temperatures occurring within the specified water temperature range throughout the evaluation period below the Thermalito Afterbay Outlet and at the mouth of the Feather River.
- Similar larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower with similar frequency or higher average monthly flows by water year type occurring during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except for dry water year types when average monthly flows would be lower more often; (2) similar or lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher exceedance probabilities would occur during June through September; (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher exceedance probabilities would occur during July through September; and (4) similar or slightly lower probability of water temperatures occurring within the specified water temperature range during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the Feather River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

American Shad

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River below the Thermalito Afterbay outlet and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or slightly less suitable adult spawning and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly flows during April and May months and equivalent long-term monthly flows during June at all Feather River locations evaluated, and higher average monthly flows by water year type during most water year types, except during dry and critical water year types; (2) lower monthly flow exceedance probabilities flows during April and May months and higher monthly flow exceedance probabilities during June below Thermalito Afterbay outlet; (3) during low flow conditions, lower monthly flow exceedance probabilities flows during April and May months at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during June below Thermalito Afterbay outlet; and (4) similar or slightly higher monthly probabilities of water temperatures occurring within the specified water temperature range throughout the evaluation period below the Thermalito Afterbay Outlet and at the mouth of the Feather River.
- Similar or more suitable larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) similar or slightly lower long-term average and average monthly flows by water year type during most water year types during the evaluation period at all Feather River locations evaluated; (2) similar or lower monthly flow exceedance probabilities during October and November at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during July through September at all Feather River locations evaluated;(3) during low flow conditions, lower monthly flow exceedance probabilities during October and November at all Feather River locations evaluated, and higher monthly flow exceedance probabilities during July through September at all Feather River locations evaluated; and (4) similar probability of water temperatures occurring within the specified water temperature range at all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of American shad in the Feather River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Largemouth Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River below Thermalito Afterbay Outlet and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower with similar frequency or higher average monthly flows by water year type during most water year types below the Thermalito Afterbay outlet and at the mouth of the Feather River, except for dry water year types when average monthly flows would be lower more often; (2) similar or lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher exceedance probabilities would occur during June through September; and (3) under low flow conditions, similar or slightly lower monthly flow exceedance probabilities occurring more often than higher monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher exceedance probabilities would occur during July through September.

- Similar spawning conditions, because of similar or slightly lower monthly probabilities of water temperatures occurring within the specified water temperature range during March through June for all Feather River locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the Feather River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Sutter Bypass

Potential impacts to fisheries and aquatic resources in the Sutter Bypass under Alternative B relative to the No Project/No Action Alternative would be similar to those discussed under Alternative A relative to Existing Conditions, above.

Folsom Lake

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Folsom Lake during April through November.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage, and higher average monthly storage by water year type during most months of the evaluation period; (2) equivalent and higher monthly storage exceedance probabilities during more than half of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during most months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Folsom Lake, Alternative B would result in potentially beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Folsom Lake during March through June.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar warmwater fish spawning and early life stage conditions, because of modeling results indicating similar frequencies of monthly water surface elevation reductions of six feet or more during the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Folsom Lake, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

American River

Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River, in addition to model results for spawning habitat availability (WUA) (Appendix 12N) at Sailor Bar through Rossmoor and early life stage mortality (Appendix 12J).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or improved adult immigration and holding conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during most months of the evaluation period, and similar or slightly higher average monthly flows by water year type during most water year types at the locations evaluated in the American River, although lower flows would occur throughout the evaluation period; (2) higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated, although slightly lower probabilities of exceedance would occur during September; (3) during low flow conditions, higher monthly flow exceedance probabilities during the evaluation period at all locations evaluated; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values.
- Improved adult spawning conditions due to modeling results indicating higher spawning habitat availability during the entire evaluation period, and similar monthly probabilities of exceeding specified water temperature index values.
- Similar embryo incubation conditions due to modeling results indicating slightly lower, although similar, total annual early life stage mortality and similar monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, although slightly lower probabilities of exceedance would occur during June; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities most of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the American River, Alternative B would result in slightly beneficial, although similar, less-than-significant impacts, relative to the No Project/No Action Alternative.

Spring-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined at the mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or slightly improved non-natal juvenile rearing conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during most months of the evaluation period, and similar or slightly higher average monthly flows by water year type; (2) higher monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or higher flow exceedance probabilities during most months of the evaluation period, although equivalent or slightly lower probabilities of exceedance would occur during January and February; and (4) similar probabilities of exceeding specified water temperature index values throughout the evaluation period.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the American River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Steelhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River, in addition to model results for spawning habitat availability (WUA) (Appendix 12N) at Sailor Bar through Rossmoor.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or improved adult immigration and holding conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period at all evaluated locations, and similar or slightly higher average monthly flows by water year type; (2) higher monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or higher flow exceedance probabilities during most months of the evaluation period, although slightly lower probabilities of exceedance would occur during January at the mouth of the American River; and (4) similar or slightly higher or lower probabilities of exceeding specified water temperature index values.
- Similar or improved spawning conditions due to modeling results indicating higher spawning habitat availability during most months of the January through April spawning period, and similar monthly probabilities of exceeding specified water temperature index values.
- Similar embryo incubation conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type; (2) slightly higher monthly flow exceedance probabilities during entire the evaluation period; (3) during low flow conditions, equivalent or higher flow exceedance probabilities during the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during June, July, and September; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with slightly lower flows during June, July, and September at all evaluated locations; (3) during low flow conditions, higher flow exceedance probabilities during most months of the evaluation period, although slightly lower probabilities of exceedance would occur during January and July at the mouth of the American River; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values, although slightly higher probabilities of exceedance would occur during June and July.

- Similar or improved smolt emigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type; (2) similar or higher monthly flow exceedance probabilities during most of the evaluation period; (3) during low flow conditions, equivalent or higher flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during January at the mouth of the American River; and (4) similar probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the American River, Alternative B would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Green Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined at the mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or improved adult immigration and holding conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur throughout the evaluation period; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with slightly lower flows during June and September and substantially lower flows during July; (3) during low flow conditions, higher flow exceedance probabilities during most months of the evaluation period, although equivalent or lower probabilities of exceedance would occur during February and July; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values.
- Similar spawning and egg incubation conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during June and July; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during June and July; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period, with slightly lower probabilities of exceedance during July; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during June, July, and September; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with slightly lower flows during June, July, and September; (3) during low flow conditions, higher flow exceedance probabilities during most months of the evaluation period, although slightly lower probabilities of exceedance would occur during January and July; and (4) similar probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the American River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

River Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Improved adult immigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur during July and September; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with slightly lower flows June and September; and (3) during low flow conditions, similar or higher flow exceedance probabilities during most months of the evaluation period, although lower probabilities of exceedance would occur during January at the mouth of the American River.
- Similar or improved spawning and egg incubation conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows by water year type, although lower flows would occur more frequently during July; (2) higher monthly flow exceedance probabilities during most of the evaluation period, with slightly lower flows during June and substantially lower flows during July; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities during most months of the evaluation period, although lower probabilities of exceedance would occur during July at the mouth of the American River; and (4) similar or slightly higher monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during June, July, and September; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with slightly lower flows during June, July, and September at all evaluated locations; (3) during low flow conditions, higher flow exceedance probabilities during most months of the evaluation period, although slightly lower probabilities of exceedance would occur during January and July at the mouth of the American River; and (4) equivalent or higher probabilities of remaining within the specified water temperature range throughout the year.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the American River, Alternative B would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or improved adult immigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows by water year type; (2) higher monthly flow exceedance probabilities during most of the evaluation period, with slightly lower probabilities of exceedance during June; and (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities during most months of the evaluation period, although lower probabilities of exceedance would occur during January at the mouth of the American River.
- Similar or improved spawning and egg incubation conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows by water year type, although lower flows would occur more frequently during July; (2) equivalent or higher monthly flow exceedance probabilities during most of the evaluation period at all locations, with slightly lower flows during June and substantially lower flows during July; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities during most months of the evaluation period at all evaluated locations, although slightly lower probabilities of exceedance would occur during January and July at the mouth of the American River; and (4) similar or slightly higher monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during June, July, and September; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with slightly lower flows during June, July, and September at all evaluated locations; (3) during low flow conditions, higher flow exceedance probabilities during most months of the evaluation period, although slightly lower probabilities of exceedance would occur during January and July at the mouth of the American River; and (4) equivalent or slightly lower probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the American River, Alternative B would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Hardhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or more suitable adult and other life stage conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during June, July, and September; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with lower flows during June, July, and September; (3) during low flow conditions, equivalent or higher flow exceedance probabilities during the entire evaluation period; and (4) similar probabilities of remaining within specified water temperature ranges.

- Similar or improved spawning conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows by water year type; (2) higher monthly flow exceedance probabilities during the evaluation period, although lower probabilities of exceedance would occur during June; (3) during low flow conditions, higher monthly flow exceedance probabilities during the entire evaluation period; and (4) similar probabilities of remaining within specified water temperature ranges.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the American River, Alternative B would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

California Roach

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or more suitable adult and other life stage conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during June, July, and September; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with lower flows during June, July, and September; (3) during low flow conditions, equivalent or higher flow exceedance probabilities during the entire evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values.
- Similar or slightly improved spawning conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows by water year type; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, although lower probabilities of exceedance occur during June; (3) during low flow conditions, higher monthly flow exceedance probabilities during the entire evaluation period; and (4) similar probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of California roach in the American River, Alternative B would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Splittail

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at the mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or more suitable spawning conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type across most water year types; (2) higher monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities during the evaluation period; (4) similar or slightly lower usable flooded area (UFA) exceedance probabilities of 10 percent or more; and (5) equivalent probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of splittail in the American River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Striped Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam and the mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or improved adult spawning, embryo incubation, and initial rearing conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type; (2) higher monthly flow exceedance probabilities during April and May, with lower probabilities of exceedance during June; (3) during low flow conditions, higher monthly flow exceedance probabilities during the entire evaluation period; and (4) similar probabilities of remaining within the specified water temperature range during the evaluation period.
- Similar or improved larvae, fry, and juvenile rearing and emigration conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during June, July, and September; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with slightly lower flows during June, July, and September at all evaluated locations; (3) during low flow conditions, higher flow exceedance probabilities during most months of the evaluation period, although slightly lower probabilities of exceedance would occur during January and July at the mouth of the American River; and (4) similar probabilities of remaining within the specified water temperature range throughout the year.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the American River, Alternative B would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

American Shad

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue and the mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or improved adult spawning, embryo incubation, and initial rearing conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type; (2) higher monthly flow exceedance probabilities during April and May, with lower probabilities of exceedance during June; (3) during low flow conditions, higher monthly flow exceedance probabilities during the entire evaluation period; and (4) similar or slightly lower probabilities of remaining within the specified water temperature range during the evaluation period.

- Similar or improved larvae, fry, and juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during July and September; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during July and September; (3) during low flow conditions, higher monthly flow exceedance probabilities, although slightly lower probabilities of exceedance would occur during July at the mouth of the American River; and (4) equivalent or slightly higher monthly probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of American shad in the American River, Alternative B would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Largemouth Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue.

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar adult and other life stage conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type, although lower flows would occur more frequently during June, July, and September; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, with lower flows during June, July, and September; and (3) during low flow conditions, equivalent or higher flow exceedance probabilities during the entire evaluation period.
- Similar spawning conditions due to modeling results indicating equivalent probabilities of remaining within specified water temperature ranges.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the American River, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

<u>Sacramento-San Joaquin Delta and Yolo Bypass</u>

Delta Smelt in the Delta Region

Model results were examined for water temperatures (Appendix 12E) in the Sacramento River at Freeport, OMR flows (Appendix 12E), Delta outflow (Appendix 12E), salvage at the SWP and CVP export facilities (Appendix 12I), and X2 location (Appendix 12E).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar adult conditions, because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range (December through May), but with a slightly higher probability during April and a slightly lower probability during May of water temperatures occurring within the specified range; (2) similar overall normalized mean monthly salvage at the SWP and CVP export facilities (December through April); and (3) similar or slightly higher monthly probabilities of OMR flows being more negative than -5,000 cfs (December through February)

- Less suitable spawning conditions in the Yolo Bypass (December through May), because of modeling results indicating: (1) lower long-term average Yolo Bypass outflow; (2) lower flow exceedance probabilities during December through May; and (3) during low flow conditions, higher flow exceedance probabilities during January, and lower flow exceedance probabilities during December, February and March, albeit similar flows during low flow conditions.
- Similar egg and embryo conditions (February through May), because of modeling results indicating similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range, as described above for adult delta smelt.
- Similar larvae conditions (March through June), because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range, but with a slightly higher probability during April and a slightly lower probability during May of water temperatures occurring within the specified range; (2) during March through June of dry and critical water years, slightly higher (less negative) mean monthly OMR flows when flows would be equal to or more negative than -1,500 cfs, but with lower mean monthly flows during April of dry water years and April and May of critical water years; and (3) during the latter portion of the larval delta smelt downstream migration period (i.e., May and June), long-term average and average by water year type monthly Delta outflow would be slightly decreased during May but increased during June, while monthly Delta outflow exceedance probabilities would be lower more often during May, but would be higher more often during June.
- Similar or improved juvenile conditions (May through July), because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range, but with a lower probability during May; (2) similar overall normalized mean monthly salvage at the SWP and CVP export facilities; (3) between RKm 65 and 80, long-term average and average by water year type X2 location would move slightly upstream during May (by less than 0.5 RKm), move slightly downstream during June (by 0.5 RKm or less), and move downstream during July (by 1.2, 1.7 and 1.4 RKm during wet, above normal and below normal water years, respectively); and (4) lower Yolo Bypass outflow and potentially reduced productivity in the Delta.

In conclusion, in consideration of potential impacts to all life stages of delta smelt in the Delta, Alternative B would result in similar or beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Longfin Smelt in the Delta Region

Model results were examined for OMR flows (Appendix 12E), salvage at the SWP and CVP export facilities (Appendix 12I), and X2 location (Appendix 12E).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar adult conditions because of modeling results indicating slightly higher (during December) and equivalent (during January through March) monthly probabilities of OMR flows being more negative than -5,000 cfs during December through March
- Similar larvae and juvenile conditions because of modeling results indicating: (1) slightly higher (during December) and equivalent (during January through March) monthly probabilities of OMR flows being more negative than -5,000 cfs during December through March; (2) during April and May of dry and critical water years, mean monthly OMR flows would be lower during April of dry and critical water years (by 1.6 and 6.4%, respectively) and during May of critical water years (by 14.6%), and would be higher during May of dry water years (by 9.8%); (3) similar or slightly lower overall mean monthly salvage at the SWP and CVP export facilities; and (4) slightly higher (during January, May and June) and lower (during February, March and April) monthly exceedance probabilities of X2 location occurring at or downstream of 75 RKm during January through June; and (5) lower Yolo Bypass outflow and potentially reduced productivity in the Delta.

In conclusion, in consideration of potential impacts to all life stages of longfin smelt in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Splittail in the Delta Region

Model results were examined for Yolo Bypass outflow (Appendix 12E) and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Less suitable egg and larval conditions (February through May) because of modeling results indicating: (1) slightly reduced mean monthly Yolo Bypass outflow during most months of wet water years and reduced mean monthly flows during February through April of above normal water years, during March and April of below normal water years, during February and March of dry water years and during March of critical water years, with mean monthly reductions of 10 percent or more during March and April of above normal water years, February and March of below normal water years, and during March of dry and critical water years; and (2) lower flow exceedance probabilities (of 10% or more) more often during February through May
- Similar or less suitable juvenile rearing and emigration conditions (April through July) because of modeling results indicating: (1) generally lower (during April) or similar mean monthly Yolo Bypass outflow during all water year types; (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; (3) lower (during April) or similar flow exceedance probabilities (of 10% or more); and (4) similar overall simulated mean monthly salvage at the SWP and CVP export facilities
- Less suitable adult spawning and upstream migration conditions, because of modeling results indicating: (1) reduced mean monthly Yolo Bypass outflow during February through April, as discussed above for egg and larval conditions; and (2) similar simulated mean monthly salvage at the SWP and CVP export facilities during December through March

In conclusion, in consideration of potential impacts to all life stages of splittail in the Delta Region including the Yolo Bypass, Alternative B would result in less suitable and potentially significant impacts, relative to the No Project/No Action Alternative. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Winter-run Chinook Salmon in the Delta Region

Model results were examined for through-Delta juvenile survival (Appendix 12M).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar juvenile conditions, because of modeling results indicating: (1) slightly lower monthly Delta survival exceedance probabilities over most of the distribution; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile winter-run Chinook salmon in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Spring-run Chinook Salmon in the Delta Region

Model results were examined for through-Delta juvenile survival (Appendix 12M).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar juvenile conditions, because of modeling results indicating: (1) slightly lower monthly Delta survival exceedance probabilities over most of the distribution; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile spring-run Chinook salmon in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Fall-run and Late Fall-run Chinook Salmon in the Delta Region

Model results were examined for OMR flows (Appendix 12E) and through-Delta juvenile survival (Appendix 12M).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar San Joaquin River adult straying conditions because of modeling results indicating similar or slightly higher monthly probabilities of OMR flows being more negative than -5,000 cfs during December through February
- Similar juvenile conditions because of modeling results indicating: (1) slightly lower monthly Delta survival exceedance probabilities over most of the distribution; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile and San Joaquin River adult fall and late fall-run Chinook salmon in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Steelhead in the Delta Region

Model results were examined for Sacramento River flows (Appendix 12F) at Rio Vista, Yolo Bypass outflow (Appendix 12E), Delta outflow (Appendix 12E), OMR flows (Appendix 12E), and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar juvenile rearing and emigration conditions in the Delta (October through July) because of modeling results indicating: (1) higher long-term average and average by water year type monthly flows at Rio Vista during October, November, June and July, and lower average monthly flows during December through May; (2) higher monthly flow exceedance probabilities at Rio Vista during October through February, June and July, and lower flow exceedance probabilities during March and April, with higher flow exceedance probabilities during all months except for during March through May during low flow conditions; (3) lower mean monthly Yolo Bypass outflow and flow exceedance probabilities during most of the evaluation period; (4) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; (5) lower long-term average and average by water year type monthly Delta outflow during most months of most water year types, but with higher Delta outflow during June and July of all water year types, during October of above normal water years, during October through December of below normal water years, during November of dry water years and during October and December of critical water years; (6) lower or similar long-term average and average by water year type monthly OMR flows; and (7) similar overall simulated mean monthly salvage at the SWP and CVP export facilities, but with higher mean monthly salvage during critical water years at the CVP export facility

In conclusion, in consideration of potential impacts to all life stages of Central Valley steelhead in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative. Alternative B impacts on steelhead in the Yolo Bypass are considered potentially significant, relative to the No Project/No Action Alternative. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Green Sturgeon in the Delta Region

Model results were examined for Yolo Bypass outflow (Appendix 12E) and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar or less suitable juvenile rearing and emigration conditions (year-round) because of modeling results indicating: (1) lower mean monthly Yolo Bypass outflow and flow exceedance probabilities; (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; and (3) similar simulated mean monthly salvage at the SWP and CVP export facilities

In conclusion, in consideration of potential impacts to green sturgeon in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative. Alternative B impacts on green sturgeon in the Yolo Bypass are considered potentially significant, relative to the No Project/No Action Alternative. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

White Sturgeon in the Delta Region

Model results were examined for Yolo Bypass outflow (Appendix 12E) and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar juvenile rearing and emigration conditions (year-round) because of modeling results indicating: (1) lower or similar mean monthly Yolo Bypass outflow and lower flow exceedance probabilities; (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; and (3) similar simulated mean monthly salvage at the SWP and CVP export facilities

In conclusion, in consideration of potential impacts to white sturgeon in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative. Alternative B impacts on white sturgeon in the Yolo Bypass are considered potentially significant, relative to the No Project/No Action Alternative. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Pacific and River Lamprey in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar macropthalmia emigration conditions (year-round) because of similar overall simulated mean monthly salvage at the SWP and CVP export facilities, but with higher mean monthly salvage at both facilities during critical water years

In conclusion, in consideration of potential impacts to Pacific and river lamprey in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

American Shad in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I) and X2 location (Appendix 12E).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar egg and larval conditions in the Delta because of modeling results indicating: (1) slightly lower (during April) and slightly higher (during May and June) exceedance probabilities of X2 location being located at or downstream of 75 RKm during April through June; (2) slightly higher overall mean monthly salvage at the SWP and CVP export facilities; and (3) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to American shad in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Striped Bass in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I) and X2 location (Appendix 12E).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Similar egg and larval conditions in the Delta because of modeling results indicating: (1) slight upstream mean monthly movements in X2 location during April and May of all water year types and slight downstream mean monthly movements in X2 location during June of all water year types during April through June; (2) similar overall normalized mean monthly salvage at the SWP and CVP export facilities; and (3) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to striped bass in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Largemouth Bass in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I) and X2 location (Appendix 12E).

Relative to the No Project/No Action Alternative, Alternative B would generally be expected to provide:

- Less suitable juvenile rearing conditions in the Yolo Bypass because of modeling results indicating: (1) lower mean monthly Yolo Bypass outflow, in addition to lower flow exceedance probabilities; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta
- Similar juvenile and adult conditions in the Delta because of modeling results indicating: (1) upstream mean monthly movements in X2 location of 0.5 RKm or more during December and March of wet water years, during December through April of above normal water years, during January through April of above normal water years, during January through April of below normal water years, during March and April of dry water years and during January through March of critical water years, and downstream mean monthly movements in X2 location of 0.5 RKm or more during July and August of wet water years, during June through September of above normal water years, during June through December of below normal water years, during July through October of dry water years and during June through August and October of critical water years; and (2) similar overall simulated mean monthly salvage at the SWP and CVP export facilities.

In conclusion, in consideration of potential impacts to largemouth bass in the Delta, Alternative B would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative. Alternative B impacts on largemouth bass in the Yolo Bypass are considered potentially significant, relative to the No Project/No Action Alternative. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Suisun, San Pablo, and San Francisco Bays

Fish species of primary management concern, including Chinook salmon, steelhead, river lamprey, Pacific lamprey, green sturgeon, white sturgeon, and splittail, utilize the bays as a migration corridor and/or for juvenile rearing. Potential increases in Delta outflow during the summer and fall and reductions in Delta outflow during the spring would not result in substantial changes to migration or rearing habitat for these fish species in the bays. Striped bass and American shad also utilize the bays for migration and rearing, however, changes in X2 location were evaluated during the striped bass and American shad spawning and initial rearing period to evaluate potential changes in larval transport and rearing habitat in the Bay-Delta (see the Delta Region, above). Potential effects on delta smelt and longfin smelt migration and rearing in the Bay-Delta also were analyzed through evaluation of changes in X2 location (see the Delta Region, above).

12C.7.3 Primary Study Area – Alternative B Relative to the No Project/No Action Alternative

12C.7.3.1 Construction, Operation, and Maintenance Impacts

For a discussion of impacts to fisheries and aquatic resources for Alternative B relative to the No Project/No Action Alternative in the Primary Study Area, refer to the Environmental Consequences section of Chapter 12 Aquatic Biological Resources.

12C.8 Impacts Associated with Alternative C Relative to Existing Conditions

12C.8.1 Extended Study Area – Alternative C Relative to Existing Conditions

12C.8.1.1 SWP and CVP Operations

Agricultural Water Use

Potential impacts to fisheries and aquatic resources associated with agricultural water use are discussed under Alternative A relative to Existing Conditions, above, and are applicable to Alternative C relative to Existing Conditions.

Municipal and Industrial Water Use

Potential impacts to fisheries and aquatic resources associated with municipal and industrial water use are discussed under Alternative A relative to Existing Conditions, above, and are applicable to Alternative C relative to Existing Conditions.

Wildlife Refuge Water Use

Potential impacts to fisheries and aquatic resources associated with wildlife refuge water use are discussed under Alternative A relative to Existing Conditions, above, and are applicable to Alternative C relative to Existing Conditions.

San Luis Reservoir

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for San Luis Reservoir during April through November.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or less suitable coldwater pool storage conditions, because of modeling results indicating: (1) lower long-term average monthly, and lower average monthly storage by water year type during most water years of the evaluation period; (2) lower monthly storage exceedance probabilities during most months of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance decrease during most months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in San Luis Reservoir, Alternative C would result in less suitable and potentially significant impacts, relative to Existing Conditions. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for San Luis Reservoir during March through June.

Relative to Existing Conditions, Alternative C would be expected to provide:

- Similar or slightly less suitable warmwater fish spawning and early life stage conditions, because of modeling results indicating slightly increased or similar frequencies of monthly water surface elevation reductions of six feet or more during the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in San Luis Reservoir, Alternative C would result in similar or slightly less suitable and less-than-significant impacts, relative to Existing Conditions.

Export Service Area Reservoirs

Export Service Area Reservoir Fisheries

Changes in modeled total SWP and CVP Delta exports under Alternative C relative to Existing Conditions were analyzed to evaluate potential changes in storage and water surface elevations (Appendix 12H) and associated impacts on fisheries in export service area reservoirs, including Anderson Reservoir, Diamond Valley Lake, Castaic Lake, Lake Mathews, and Lake Perris.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Equivalent or improved export service area reservoir fisheries habitat conditions, because of modeling results indicating: (1) long-term average and average monthly by water year type Delta exports would be higher during most months of all water year types, and would be higher by 10 percent or more during September through November of wet water years, during September and November of above normal water years, and during August, September and November of critical water years;(2) higher monthly export exceedance probabilities during June through January, and lower export exceedance probabilities during February through May; and (3) a net 10 percent or more export probability of exceedance increase during most months of the year.

In conclusion, in consideration of potential impacts to SWP and CVP export service area reservoir fisheries, Alternative C would result in potentially more suitable and less-than-significant impacts, relative to Existing Conditions.

12C.8.2 Secondary Study Area – Alternative C Relative to Existing Conditions

12C.8.2.1 Construction, Operation, and Maintenance Impacts

Construction, operation, and maintenance impacts in the Secondary Study Area under Alternative C would be similar to those discussed under Alternative A, above.

Erosion, Sedimentation and Turbidity

Adult, juvenile, and early life stages of fish species of primary management concern could be present within and downstream of construction, operation, and maintenance areas year-round. Therefore, fishes could potentially be affected by any increases in erosion, sedimentation, and turbidity, resulting in a potentially significant impact. However, any increases in turbidity in the Sacramento River are expected to be temporary, and implementation of mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) to minimize erosion, sedimentation, and turbidity is anticipated to result in a less than significant impact to fish species of primary management concern.

Hazardous Materials and Chemical Spills

Adult, juvenile, and early life stages of fish species of primary management concern could be present within and downstream of canal intake areas year-round. Therefore, fish species could potentially be affected by any in-water hazardous spills in the Sacramento River, resulting in a potentially significant impact. However, implementation of mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) to minimize the potential for in-water hazardous spills, in addition to the limited installation and operations and maintenance activities, is anticipated to result in a less than significant impact to fish species of primary management concern.

12C.8.2.2 SWP and CVP Operations

Trinity Lake

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Trinity Lake during April through November.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Equivalent or improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage during the evaluation period, higher average monthly storage during all water years; (2) equivalent or higher monthly storage exceedance probabilities during all months of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during all months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Trinity Lake, Alternative C would result in more suitable and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Trinity Lake during March through June.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Improved warmwater fish spawning and early life stage conditions, because of modeling results indicating decreased frequencies of monthly water surface elevation reductions of six feet or more during most of the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Trinity Lake, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

Trinity River

Coho Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Equivalent adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar, or slightly lower (particularly during September and October) or slightly higher (particularly during November and January) average monthly probabilities of exceeding specified water temperature index values.
- Equivalent adult spawning and embryo incubation conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values, with slightly lower monthly probabilities of exceedance during May, October, and November, and slightly higher probabilities of exceedance during January and April.
- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year, with slightly lower probabilities during July through October, and slightly higher probabilities of exceeding the lowest water temperature index values during December and January.
- Equivalent smolt emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be

lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of Coho salmon in the Trinity River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Spring-Run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Equivalent or slightly improved adult immigration and holding conditions, because of modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar, or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values, particularly during July through September, although slightly higher probabilities of exceedance would occur during June.
- Improved adult spawning and egg incubation conditions due to modeling results indicating: (1) equivalent or slightly higher long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during all water year types; (2) equivalent monthly flow exceedance probabilities during all months of evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, from August through October at most water temperature indices.
- Equivalent or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during July through September.
- Equivalent smolt emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly lower average monthly flows during most water year types, particularly during wet water years when average monthly flows would be slightly lower more frequently, and during above normal and below

normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during June and July.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Trinity River, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

Fall-Run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork, in addition to model results for early life stage mortality (Appendix 12J).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar, or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values, particularly during August and September.

- Equivalent or slightly improved adult spawning conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during June and October, although slightly higher probabilities of exceedance would occur during April.

- Improved embryo incubation conditions due to modeling results indicating reduced total annual early life stage mortality, and equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during June and October, although slightly higher probabilities of exceedance would occur during April.

- Equivalent or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the evaluation period, with lower probabilities of exceedance during June through September.

- Equivalent smolt emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during June and July.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Trinity River, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

Steelhead (Winter-run and Summer-run)

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Equivalent adult immigration and holding conditions for winter-run steelhead, because of modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar, or slightly lower (particularly during August through October) average monthly probabilities of exceeding specified water temperature index values, although higher probabilities of exceedance would occur during March and April.

- Equivalent adult immigration and holding conditions for summer-run steelhead due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or similar average monthly flows during all water year types; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during July and August.

- Equivalent adult spawning and egg incubation conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout the evaluation period.

- Equivalent or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during July through September.
- Equivalent smolt emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or lower average monthly flows, particularly during wet water years when average monthly flows would be lower more frequently, and during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of steelhead (winter-run and summer-run) in the Trinity River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Green Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam and at North Fork.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent or lower average monthly flows, particularly during wet water years when average monthly flows would be lower more frequently, and during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar, or slightly lower (particularly during June, July and September) average monthly probabilities of exceeding specified water temperature index values, although slightly higher probabilities of exceedance would occur during August.

- Equivalent or improved adult spawning conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent or lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperature conditions during July.
- Equivalent or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with slightly lower probabilities of exceedance during June and September.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Trinity River, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

White Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam and at North Fork.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Equivalent adult immigration and holding conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.
- Equivalent adult spawning conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.

- Equivalent or improved juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during June and September.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Trinity River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult immigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; and (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period.
- Similar adult spawning and egg incubation conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of remaining within the specified water temperature range, with slightly higher probabilities of exceedance during May and June and slightly lower probabilities of exceedance during March, April and August.
- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) equivalent or slightly lower long-term average monthly flows over the entire year, and equivalent or slightly higher average monthly flows during most water year types, except for wet water years when average monthly flows would be lower more frequently, and particularly during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of

the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Trinity River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Klamath River downstream of the Trinity River

Because potential changes within the Trinity River were considered to be less than significant under all Alternative C, it is expected that any potential changes in the Klamath River downstream of the Trinity River also would be less than significant.

Lewiston Lake, Whiskeytown Lake, Keswick Reservoir, Lake Natoma, and the Thermalito Complex

Modeling was not conducted for Lewiston Lake, Keswick Reservoir, Lake Natoma, or the Thermalito Complex. However, modeling conducted on the reservoirs upstream of these regulating reservoirs indicates that Alternative C, when compared to Existing Conditions, would result in either no change or insignificant changes to storage and water surface elevation fluctuations. Because these reservoirs would continue to operate as regulating reservoirs, it is assumed that there would not be substantial changes in storage or water surface elevations, resulting in less-than-significant impacts to fish species of primary management concern.

Because flows released from Whiskeytown Lake would not experience significant changes, storage and water surface elevations would not be expected to substantially change under Alternatives C. Therefore, potential changes in storage and water surface elevation in Whiskeytown Lake are anticipated to result in less than significant impacts to coldwater and warmwater fish species, respectively.

Spring Creek

It is not anticipated that operations of Spring Creek Reservoir or flows in Spring Creek would be substantially affected under implementation of Alternative C. It is anticipated that Spring Creek Reservoir would continue to operate for flood control purposes, and to manage the release of contaminated water from Iron Mountain Mine.

Shasta Lake

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Shasta Lake during April through November.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Improved coldwater pool storage conditions, because of modeling results indicating: (1) generally higher long-term average monthly storage during most of the evaluation period, and generally higher average monthly storage by water year type during most water years; (2) equivalent or higher monthly storage exceedance probabilities during all months of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase occurring during all months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Shasta Lake, Alternative C would result in more suitable and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Shasta Lake during March through June.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Improved warmwater fish spawning and early life stage conditions, because of modeling results indicating similar or decreased frequencies of monthly water surface elevation reductions of six feet or more during the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Shasta Lake, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

Sacramento River

Winter-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for spawning habitat availability (WUA) (Appendix 12N), early life stage mortality (SacSalMort) (Appendix 12J), overall population mortality and production potential (SALMOD) (Appendix 12K), and lifecycle modeling (IOS) (Appendix 12L).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) lower or similar long-term average and average by water year type monthly flows more often, but with higher average monthly flows during June and July in the lower Sacramento River; (2) lower monthly flow exceedance probabilities more often; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring more often at most locations, and lower flow exceedance probabilities below Red Bluff Diversion Dam; (4) equivalent monthly probabilities of exceeding specified water temperature index values, but with higher probabilities of exceeding specified water temperature index values during April, and slightly lower probabilities of exceeding specified water temperatures during June and July.

- Improved spawning conditions due to modeling results indicating increased spawning habitat availability during all months of the spawning period, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during months with relatively warm water temperature conditions (i.e., July and August).

- Similar or improved embryo incubation conditions due to modeling results indicating reduced mean total annual early life stage mortality, but with increased average annual mortality during below normal water years, reduced annual early life stage mortality over approximately 50 percent of the entire cumulative frequency distribution, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during months with relatively warm water temperature conditions (i.e., July and August).

- Improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type occurring more often in the upper Sacramento River, and higher average monthly flows in the lower Sacramento River; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below Keswick Dam and in the lower Sacramento River, and lower monthly flow exceedance probabilities below Red Bluff Diversion Dam; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at most locations evaluated, but lower flow exceedance probabilities below Red Bluff Diversion Dam; and (4) equivalent or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values during July through September, and equivalent or higher probabilities of exceeding specified water temperature index values during April.

- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by 16 percent), and average annual mortality by water year type would be reduced during all water year types (by five percent during wet water years, 24 percent during above normal water years, seven percent during below normal water years, 23 percent during dry water years, and 24 percent during critical water years); (2) a decrease in total annual mortality exceedance probabilities over more than 90 percent of the distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction, with 10 percent or more exceedance probability reductions occurring over 17 percent of the entire distribution; and (4) long-term average total annual winter-run Chinook salmon production would increase by two percent, while average total annual production would decrease during wet water years by less than one percent, and would increase during above normal water years by six percent, during below normal water years by one percent, during dry water years by three percent, and during critical water years by four percent.

- Improved conditions pertaining to early life stage survival and abundance of spawners (IOS) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual egg to fry survival would increase by four percent, and average annual egg to fry survival by water year type would decrease during wet and above normal water years by one percent and less than one percent, respectively, and would increase during below normal water years by two percent, dry water years by five percent, and during critical water years by 39 percent; (2) long-term average annual fry to smolt survival would increase by one percent, and average annual fry to smolt survival by water year type would increase during wet water years by one percent and during critical water years by 14 percent, and would decrease during above normal water years by one percent, during below normal water years by three percent, and during dry water years by two percent; (3) long-term average annual female spawner abundance would increase by 11 percent, and average annual female spawner abundance by water year type would increase during wet water years by 11 percent, during above normal water years by 20 percent, during below normal water years by five percent, during dry water years by seven percent and during critical water years by 12 percent; (4) an increase in annual egg to fry survival exceedance probabilities over approximately 65 percent of the entire distribution, particularly at lower survival rates; (5) an increase in annual fry to smolt survival exceedance probabilities over more than 50 percent of the entire distribution, particularly at lower survival rates;

and (6) an increase in annual female spawner abundance exceedance probabilities over more than 95 percent of the entire distribution.

In conclusion, in consideration of potential impacts to all life stages of winter-run Chinook salmon in the Sacramento River, Alternative C would result in beneficial and less-than-significant impacts, relative to Existing Conditions.

Spring-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J) and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type more often in the upper Sacramento River, and higher and lower long-term average monthly and average monthly flows by water year type occurring with similar monthly frequencies in the lower Sacramento River; (2) lower monthly flow exceedance probabilities more often in the upper Sacramento River, and higher monthly flow exceedance probabilities more often in the lower Sacramento River; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at most locations evaluated, with lower average monthly flows more often below Red Bluff Diversion Dam; (4) equivalent or lower (particularly during July through September) and equivalent or higher (particularly during April) monthly probabilities of exceeding specified water temperature index values.

- Improved spawning conditions due to modeling results indicating higher average monthly flows and flow exceedance probabilities more often below Keswick Dam and at Bend Bridge, lower average monthly flows and flow exceedance probabilities more often below Red Bluff Diversion Dam, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during months with warm water temperature conditions (i.e., September and October).

- Improved embryo incubation conditions due to modeling results indicating reduced average total annual early life stage mortality and reduced early life stage mortality over most of the cumulative frequency distribution, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures.

- Similar juvenile rearing conditions due to modeling results indicating: (1) lower long-term average monthly flows during more than half of the evaluation period in the upper Sacramento River; (2) lower monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often below Keswick Dam and lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam; and (4) equivalent or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values.

- Similar smolt emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type more often; (2) lower monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at most locations evaluated, but with lower flow exceedance probabilities below Red Bluff Diversion Dam; and (4) higher monthly probabilities of exceeding specified water temperature index values during April and May, and lower monthly probabilities of exceeding specified water temperature index values during October.
- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by 26 percent), and average annual mortality by water year type would be reduced during all water year types (by 43 percent during wet water years, three percent during above normal and below normal water years, 43 percent during dry water years, and 24 percent during critical water years); (2) a decrease in total annual mortality exceedance probabilities over more than 85 percent the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction, with reductions of 10 percent or more occurring over more than 65 percent of the distribution; and (4) long-term average total annual spring-run Chinook salmon production would increase by five percent, while average total annual production increases during wet water years by two percent, during above normal water years by one percent, during below normal water years by less than one percent, and during dry and critical water years by 11 percent.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Sacramento River, Alternative C would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J), spawning habitat availability (WUA) (Appendix 12N) and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar long-term average monthly and average monthly flows by water year type during most of the evaluation period in the upper Sacramento River, and higher long-term average monthly and average monthly flows by water year type in the lower Sacramento River; (2) similar or higher monthly flow exceedance probabilities below Keswick Dam, similar or lower monthly flow exceedance probabilities below Red Bluff Diversion Dam, and higher monthly flow exceedance probabilities during most months in the lower Sacramento River; (3) during low flow conditions, similar or lower monthly flow exceedance probabilities in the upper Sacramento River and generally higher monthly flow exceedance probabilities during most months of the evaluation period in the lower Sacramento River; (4) equivalent or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values.
- Less suitable spawning conditions due to modeling results indicating reduced spawning habitat availability during November through January, and lower or equivalent probabilities of exceeding

specified water temperature index values, and therefore more suitable water temperatures, specifically during October.

- Improved embryo incubation conditions due to modeling results indicating reduced mean total annual early life stage mortality and reduced annual early life stage mortality over almost the entire cumulative frequency distribution, and lower or equivalent probabilities of exceeding specified water temperature index values during October, and therefore more suitable water temperatures.
- Similar or less suitable juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during more than half of the evaluation period at all locations evaluated; (2) lower monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at all locations evaluated, except for below Red Bluff Diversion Dam where flows would be lower with more often; and (4) similar monthly probabilities of exceeding specified water temperature index values, but with less suitable water temperatures during April and May more often.
- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by five percent), average annual mortality by water year type would increase during wet water years by five percent, and would decrease during above normal water years by five percent, during below normal water years by less than 11 percent, during dry water years by 10 percent, and during critical water years by 32 percent; (2) a decrease in total annual mortality exceedance probabilities over more than 70 percent of the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction; and (4) long-term average total annual fall-run Chinook salmon production would increase by three percent, while average total annual production decreases during wet water years by eight percent and during below normal water years by less than one percent, and increases during above normal water years by six percent, during dry water years by four percent, and during critical water years by 17 percent.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Late fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J) and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) higher long-term average monthly and average monthly flows by water year type more often below Keswick Dam, and lower long-term average monthly and average monthly flows by water year type more often below Red Bluff Diversion Dam and in the lower Sacramento River; (2) higher monthly flow exceedance probabilities more often below Keswick dam and lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam and in the lower Sacramento River;

(3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated except for below Red Bluff Diversion Dam where flow exceedance probabilities would be lower more often; (4) similar monthly probabilities of exceeding specified water temperature index values, but with more suitable water temperatures during October and less suitable water temperatures during April.

- Similar spawning conditions due to modeling results indicating higher average monthly flows and flow exceedance probabilities during January and February and lower or equivalent average monthly flows and flow exceedance probabilities during March through May, and similar probabilities of exceeding specified water temperature index values.
- Similar or less suitable embryo incubation conditions due to modeling results indicating: (1) reduced average total annual early life stage mortality but with higher annual mortality during below normal, dry and critical water years, and higher annual mortality over about 65 percent of the cumulative frequency distribution; and (2) similar probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows more often below Red Bluff Diversion Dam, and higher average monthly flows more often in the lower Sacramento River; (2) similar or lower monthly flow exceedance probabilities below Red Bluff Diversion Dam, and higher monthly flow exceedance probabilities in the lower Sacramento River; (3) under low flow conditions, similar or lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam and higher monthly flow exceedance probabilities more often in the lower Sacramento River; and (4) lower monthly probabilities of exceeding specified water temperature index values more often during June through October, but higher probabilities of exceeding specified water temperature index values more often during April and May.
- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by three percent), average annual mortality by water year type would increase during wet water years by one percent and would decrease during above normal water years by two percent, during below normal water years by 10 percent, during dry water years by four percent and during critical water years by 11 percent; (2) a decrease in total annual mortality exceedance probabilities over approximately 70 percent of the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction; (4) long-term average total annual late fall-run Chinook salmon production would increase by two percent, while average total annual production by water year type would decrease during wet water years by one percent, and would increase during above normal and below normal water years by one percent, during dry water years by less than two percent, during critical water years by nine percent.

In conclusion, in consideration of potential impacts to all life stages of late fall-run Chinook salmon in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Steelhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, and results from the SacEFT (Appendix 8B) were examined for steelhead egg mortality, spawning habitat availability, redd dewatering, redd scouring, juvenile rearing habitat availability and juvenile stranding.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies below Keswick Dam and in the lower Sacramento River, and lower average monthly flows more often below Red Bluff Diversion Dam; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies, but with higher monthly flow exceedance probabilities below Keswick Dam and lower monthly flow exceedance probabilities below Red Bluff Diversion Dam; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring during most months of the evaluation period in the lower Sacramento River and below Keswick Dam, and lower flow exceedance probabilities more often below Red Bluff Diversion Dam; (4) similar or lower monthly probabilities of exceeding specified water temperature index values more often during September and October, and higher monthly probabilities of exceeding specified water temperature index values during November and March.
- Similar spawning conditions due to modeling results indicating: (1) higher mean monthly flows and flow exceedance probabilities during December through February, and lower flows during March and April; (2) higher or equivalent flow exceedance probabilities more often during low flow conditions; and (3) similar probabilities of exceeding specified water temperature index values; and (4) SacEFT results indicating that spawning habitat availability conditions would be similar.
- Similar embryo incubation conditions due to modeling results indicating: (1) similar probabilities of exceeding specified water temperature index values; (2) SacEFT results indicating that egg mortality associated with modeled water temperatures would be equivalent; (3) SacEFT results indicating that redd dewatering conditions may be improved slightly more often; and (4) SacEFT results indicating that redd scouring conditions would be equivalent.
- Similar juvenile rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies below Keswick Dam and at Bend Bridge, and lower average monthly flows occurring more often below Red Bluff Diversion Dam; (2) lower monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often below Keswick Dam, and lower monthly flow exceedance probabilities more often at Bend Bridge and below Red Bluff Diversion Dam; (4) equivalent monthly probabilities of exceeding specified water temperature index values, but with lower probabilities of exceeding 65°F during August and September, and therefore more suitable water temperature conditions; and (5) SacEFT results indicating that juvenile rearing habitat availability may be increased slightly more often while juvenile stranding potential may be increased more often.
- Similar smolt emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type more often; (2) lower monthly flow exceedance probabilities more often; (3) under low flow conditions, lower monthly flow exceedance probabilities below Red Bluff Diversion Dam, and higher monthly flow exceedance probabilities

more often in the lower Sacramento River; and (4) slightly higher monthly probabilities of exceeding specified water temperature index values more often.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Green Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities, at Wilkins Slough, at Freeport and at Rio Vista, and egg survival results from the SacEFT (Appendix 8B) were examined.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Equivalent or improved adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type below Keswick Dam, and higher long-term average monthly and average monthly flows by water year type more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; (2) higher monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista, and lower monthly flow exceedance probabilities below Keswick Dam; (3) during low flow conditions, higher monthly flow exceedance probabilities more often at all locations evaluated; and (4) lower monthly probabilities of exceeding specified water temperature index values during June, September and October, and equivalent or higher probabilities of exceeding specified water temperature index values during April and May.
- Similar spawning conditions because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type below Keswick Dam and Red Bluff Diversion Dam, and higher and lower long-term average monthly and average monthly flows by water year type with similar monthly frequencies at Wilkins Slough; (2) lower or equivalent monthly flow exceedance probabilities more often below Keswick Dam and Red Bluff Diversion Dam, but higher monthly flow exceedance probabilities more often at Wilkins Slough; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities below Keswick Dam, lower flow exceedance probabilities more often below Red Bluff Diversion Dam and higher flow exceedance probabilities more often at Wilkins Slough; and (4) equivalent monthly probabilities of exceeding the specified water temperature index value.
- Similar egg incubation conditions because of modeling results indicating equivalent probabilities of exceeding the specified water temperature index value below Keswick Dam and Red Bluff Diversion Dam, and SacEFT results indicating reduced water temperatures more often near Hamilton City and potentially increased survival.
- Similar or improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type more often below Red Bluff Diversion Dam, and generally higher average monthly flows and average monthly flows by water year type during June through November, and lower average monthly flows during December through May below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; (2) lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam and higher monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake

Facilities and at Rio Vista; (3) under low flow conditions, higher monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista, and lower monthly flow exceedance probabilities below Red Bluff Diversion Dam; and (4) equivalent or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values at all locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Sacramento River, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

White Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River at Hamilton City, below the proposed Delevan Pipeline Intake Facilities, Wilkins Slough, Knights Landing, below the Feather River confluence, Freeport and Rio Vista.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) lower or similar long-term average monthly and average monthly flows by water year type during most of the evaluation period; (2) lower monthly flow exceedance probabilities more often; (3) during low flow conditions, lower flow exceedance probabilities more often at Hamilton City and higher monthly flow exceedance probabilities occurring more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.
- Less suitable spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows; (2) lower monthly flow exceedance probabilities more often; (3) during low flow conditions, lower flow exceedance probabilities more often at Hamilton City, and equivalent or lower flow exceedance probabilities below the proposed Delevan Pipeline Intake Facilities and at Verona; and (4) equivalent or higher probabilities of exceeding specified water temperature index values, and therefore less suitable water temperatures.
- More suitable juvenile rearing and outmigration conditions due to modeling results indicating: (1) higher long-term average monthly and average by water year type monthly flows; (2) higher monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent or lower monthly probabilities of exceeding specified water temperature index values, and therefore more suitable water temperature conditions, particularly during June through September.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Sacramento River, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

River Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly flows by water year type occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below Keswick Dam and below the proposed Delevan Pipeline Intake Facilities, and lower flow exceedance probabilities more often at Freeport; and (3) during low flow conditions, higher flow exceedance probabilities occurring more often at all locations evaluated.
- Similar spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows more often; (2) lower monthly flow exceedance probabilities more often; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities below Keswick Dam and below the proposed Delevan Pipeline Intake Facilities, and lower monthly flow exceedance probabilities below Red Bluff Diversion Dam; and (4) higher probabilities of occurring within specified water temperature ranges during most months, and therefore more suitable water temperatures.
- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values, but with lower probabilities of exceeding 72°F during July and August.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) lower long-term average and average monthly by water year type flows more often; (2) lower monthly flow exceedance probabilities more often; and (3) during low flow conditions, higher or similar flow exceedance probabilities.
- Similar spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average monthly by water year type flows more often; (2) lower monthly flow exceedance probabilities more often; (3) during low flow conditions, higher or similar flow exceedance probabilities below Keswick Dam and the proposed Delevan Pipeline Intake Facilities, and lower flow exceedance probabilities more often below Red Bluff Diversion Dam; and (4) higher probabilities of water temperatures occurring within the specified water temperature range during most months, and therefore more suitable water temperatures.

- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher and lower monthly flow exceedance probabilities with similar monthly frequencies; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values, but with lower probabilities of exceeding 72°F during July and August at Freeport.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Hardhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) lower probabilities of water temperatures occurring within the specified range slightly more often, and therefore, potentially less suitable water temperatures.
- Similar spawning conditions, because of modeling results indicating: (1) similar or slightly higher or lower long-term average and average by water year type monthly flows below the proposed Delevan Pipeline Intake Facilities and at Freeport, and lower average monthly flows below Keswick Dam more often; (2) lower monthly flow exceedance probabilities more often below Keswick Dam and the proposed Delevan Pipeline Intake Facilities and similar monthly flow exceedance probabilities at Freeport; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities; and (4) higher probabilities of water temperatures occurring within the specified water temperature range during April through June below the proposed Delevan Pipeline Intake Facilities, and slightly lower probabilities of water temperatures occurring within the specified range during April and May at Freeport.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to the Existing Conditions.

California Roach

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or improved adult and other life stage conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent probabilities of water temperatures occurring within the specified range.

- Similar spawning conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows more often; (2) lower monthly flow exceedance probabilities more often; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities below Keswick Dam, higher and lower flow exceedance probabilities with the same monthly frequency below the proposed Delevan Pipeline Intake Facilities, and equivalent or lower flow exceedance probabilities at Freeport; and (4) similar probabilities of exceeding the specified water temperature index value, but a higher probability of exceedance during April below the proposed Delevan Pipeline Intake Facilities, and therefore slightly more suitable water temperatures (California roach initiate spawning at water temperatures of approximately 60°F or higher).

In conclusion, in consideration of potential impacts to all life stages of California roach in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Sacramento Splittail

Evaluation of water temperatures (Appendix 12E) for splittail in the Sacramento River (i.e., 45-75° F) indicate that water temperature conditions would be essentially equivalent or similar under Alternative C relative to Existing Conditions, resulting in a less than significant impact.

American Shad

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities, below the Feather River Confluence (Verona) and at Freeport.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult spawning and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type more often below Red Bluff Diversion Dam, and similar or slightly higher or lower long-term average and average by water year type monthly flows at Verona and Freeport; (2) lower monthly flow exceedance probabilities more often; (3) during low flow conditions, lower flow exceedance probabilities below Red Bluff Diversion Dam and equivalent or slightly higher flow exceedance probabilities at Verona and Freeport; and (4) similar but slightly higher probabilities of water temperatures occurring within the specified water temperature range below the Feather River Confluence, and slightly lower probabilities of water temperatures occurring within the specified range below Red Bluff Diversion Dam and at Freeport.
- Similar or improved larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) higher long-term average and average by water year type monthly flows more often; (2) higher monthly flow exceedance probabilities more often; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar or lower probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of American shad in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Striped Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below the proposed Delevan Pipeline Intake Facilities and below the Feather River confluence (Verona).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult spawning and other life stage conditions, because of modeling results indicating: (1) similar or slightly higher or lower long-term average monthly and average monthly flows by water year type; (2) lower monthly flow exceedance probabilities more often during April and May, but higher flow exceedance probabilities during June; (3) during low flow conditions, equivalent or higher flow exceedance probabilities; and (4) slightly higher probabilities of water temperatures occurring within the specified water temperature range.
- Similar or improved larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) higher and lower long-term average and average by water year type monthly flows with similar monthly frequencies; (2) higher monthly flow exceedance probabilities more often; (3) during low flow conditions, higher monthly flow exceedance probabilities more often; and (4) higher probabilities of water temperatures occurring within the specified water temperature range more often.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Largemouth Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and Freeport.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Equivalent or improved adult and other life stage conditions, because of modeling results indicating: (1) lower and higher long-term average monthly and average by water year type monthly flows occurring with similar monthly frequencies; (2) lower monthly flow exceedance probabilities during most months of the evaluation period below Keswick Dam, generally higher monthly flow exceedance probabilities more often below proposed Delevan Pipeline Intake Facilities, and higher and lower monthly flow exceedance probabilities occurring with the same monthly frequency at Freeport; and (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated.
- Equivalent spawning conditions, because of modeling results indicating similar or higher monthly probabilities of water temperatures occurring within the specified water temperature range at all locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Clear Creek

Potential impacts to fisheries and aquatic resources in Clear Creek under Alternative C relative to Existing Conditions would be similar to those discussed under Alternative A relative to Existing Conditions, above.

Lake Oroville

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Lake Oroville during April through November.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage during most of the evaluation period, and higher and lower average monthly storage by water year type occurring with the same frequency during most water years of the evaluation period; (2) equivalent or lower monthly storage exceedance probabilities during more than half of the evaluation period; and (3) a slightly net 10 percent or more monthly storage exceedance increase occurring during more than half of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Lake Oroville, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Lake Oroville during March through June.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar warmwater fish spawning and early life stage conditions, because of modeling results indicating slightly increased and decreased frequencies of monthly water surface elevation reductions of six feet or more during the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Lake Oroville, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Feather River

Flows in the Low Flow Channel below the Fish Barrier Dam were modeled consistent with the terms of the FERC Settlement Agreement. As shown in Appendix 12F, modeled results for long-term average flows, average flows by water year type, and flow exceedance probabilities of 10 percent or more during all years and during low flow conditions were equivalent for Alternative C, relative to Existing Conditions. Although these results are not repeated for the discussions below, the model results for the Low Flow Channel below the Fish Barrier Dam were considered along with the information presented below and are incorporated into the impact determinations for the following species: spring-run Chinook salmon, fall-run Chinook salmon, steelhead, green sturgeon, white sturgeon, river lamprey, Pacific lamprey, hardhead, and California roach.

Spring-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N) and early life stage mortality (Appendix 12J).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) higher and lower long-term average monthly flows occurring with similar monthly frequency during the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and higher and lower average monthly flows by water year type occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) during low flow conditions, higher monthly flow exceedance probabilities would occur more often; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values during most months, but with more suitable water temperatures during August and September.

- Improved spawning conditions due to modeling results indicating greater spawning habitat availability during most of the adult spawning period, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, during most of the evaluation period.

- Less suitable embryo incubation conditions due to modeling results indicating reduced total annual average early life stage mortality during critical water years and increased total annual early life stage mortality during wet, above normal, below normal and dry water years, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures during most of the evaluation period.

- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet, and higher and lower average monthly flows occurring with similar monthly frequencies during most water years, but with lower flows occurring more often during dry water years; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet, although higher probabilities of exceedance would occur during February and June through September; (3) under low flow conditions, higher and lower flow exceedance probabilities occurring with similar monthly frequencies, but with substantially higher flow exceedance probabilities occurring during June through September; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values during most of the evaluation period.

- Similar or less suitable smolt emigration conditions, because of modeling results indicating: (1) lower long-term average monthly flows during most of the evaluation period below the Thermalito Afterbay outlet and at the mouth of the Feather River, and lower average monthly flows by water year type occurring more often than higher average monthly flows; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance would occur more often during June; (3) during low flow conditions, similar or lower monthly flow exceedance probabilities below the Thermalito Afterbay outlet and at the mouth of the Feather River, although higher probabilities of exceedance would occur during June; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Feather River, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N) and early life stage mortality (Appendix 12J).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) higher and lower long-term average monthly flows and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below the Thermalito Afterbay, and higher flow exceedance probabilities occurring more often at the mouth of the Feather River; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values, with slightly lower monthly probabilities of exceedance during August and September, and slightly higher probabilities during July and October.
- Improved spawning conditions due to modeling results indicating higher spawning habitat availability during the entire adult spawning period, and equivalent or slightly lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures during most of the evaluation period.
- Less suitable embryo incubation conditions due to modeling results indicating reduced total annual average early life stage mortality during critical water years and increased total annual early life stage mortality during wet, above normal, below normal and dry water years, and equivalent or slightly lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures during most of the evaluation period.
- Similar or less suitable juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows occurring more often; (2) lower monthly flow exceedance probabilities occurring more often, but with higher flow exceedance probabilities occurring more often during June; (3) under low flow conditions, lower monthly flow exceedance probabilities occurring more often, but with higher flow exceedance probabilities during June; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Feather River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Steelhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or less suitable adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly flows occurring more often, and lower average monthly flows by water year type occurring more often; (2) lower monthly flow exceedance probabilities occurring more often, but with higher flow exceedance probabilities during August and September; (3) during low flow conditions, lower monthly flow exceedance probabilities occurring more often, but with higher flow exceedance probabilities during August and September; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.
- Improved spawning conditions due to modeling results indicating higher monthly spawning habitat availability during most of the adult spawning period, and equivalent or slightly lower probabilities of exceeding specified water temperature index values during most of the evaluation period at all Feather River locations evaluated.
- Similar embryo incubation conditions due to modeling results indicating: (1) lower long-term average monthly and average monthly by water year type flows occurring more often; (2) lower monthly flow exceedance probabilities occurring more often; (3) during low flow conditions, lower monthly flow exceedance probabilities occurring more often; and (4) equivalent or slightly higher or lower monthly probabilities of exceeding specified water temperature index values occurring more often.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet, and higher and lower average monthly flows occurring with similar monthly frequencies during most water years, but with lower flows occurring more often during dry water years; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet, although higher probabilities of exceedance would occur during February and June through September; (3) under low flow conditions, higher and lower flow exceedance probabilities occurring with similar monthly frequencies, but with substantially higher flow exceedance probabilities during June through September; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values during most of the evaluation period.
- Similar smolt emigration conditions due to modeling results indicating: (1) lower long-term average monthly and average monthly by water year type flows occurring more often; (2) generally lower monthly flow exceedance probabilities occurring more often; (3) under low flow conditions, lower monthly flow exceedance probabilities occurring more often; and (4) equivalent or slightly lower

monthly probabilities of exceeding specified water temperature index values during most months, but with less suitable water temperatures during October.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the Feather River, Alternative C would result in similar or less-than-significant impacts, relative to Existing Conditions.

Green Sturgeon

Flow model results (Appendix 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, at Shanghai Bend, and at the mouth of the Feather River. Water temperature results (Appendix 12E) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies, but with lower mean monthly flows more often during dry water years; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies at Shanghai Bend and higher monthly flow exceedance probabilities occurring more often at the mouth of the Feather River; and (4) generally equivalent or similar monthly probabilities of exceeding specified water temperature index values, but with more suitable water temperatures during September.
- Similar or less suitable adult spawning and embryo incubation conditions because of modeling results indicating: (1) similar or slightly higher long-term average monthly and average monthly by water year type flows; (2) higher and lower flow exceedance probabilities occurring with the same monthly frequency; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring more often; and (4) slightly higher monthly probabilities of exceeding specified water temperature index values more often.
- Similar suitable juvenile rearing conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar frequency; (3) under low flow conditions, higher monthly flow exceedance probabilities occurring more often; and (4) similar monthly probabilities of exceeding specified water temperature index values.
- Improved juvenile emigration conditions due to modeling results indicating: (1) higher long-term average monthly and average monthly by water year type flows occurring more often; (2) higher monthly flow exceedance probabilities during most months; (3) under low flow conditions, higher monthly flow exceedance probabilities during most months; and (4) similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Feather River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

White Sturgeon

Flow model results (Appendix 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, at Shanghai Bend, and at the mouth of the Feather River. Water temperature results (Appendix 12E) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or less suitable adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly by water year type flows occurring more often; (2) lower monthly flow exceedance probabilities occurring more often; (3) during low flow conditions, lower monthly flow exceedance probabilities occurring more often; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.
- Similar or less suitable adult spawning and embryo incubation conditions because of modeling results indicating: (1) lower long-term average monthly and average monthly by water year type flows occurring more often; (2) lower flow exceedance probabilities occurring more often; (3) during low flow conditions, lower monthly flow exceedance probabilities occurring more often; and (4) similar monthly probabilities of exceeding specified water temperature index values.
- Similar or less suitable juvenile rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) lower monthly flow exceedance probabilities occurring more often; (3) under low flow conditions, lower monthly flow exceedance probabilities occurring more often; and (4) similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Sacramento River, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

River Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or less suitable adult immigration conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly by water year type flows occurring more often; (2) lower monthly flow exceedance probabilities occurring more often; and (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies.
- Similar or less suitable spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly by water year type flows occurring more often; (2) lower monthly flow exceedance probabilities occurring more often; (3) during low flow conditions, lower monthly flow exceedance probabilities occurring more often;

and (4) equivalent or lower probabilities of water temperatures occurring within the specified water temperature range.

- Similar ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies ; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; and (4) similar probabilities of exceeding specified water temperatures, except for during June through September when probabilities of exceeding specified water temperatures would be slightly lower.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the Feather River, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or less suitable adult immigration conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type occurring more often; (2) lower monthly flow exceedance probabilities occurring more often; and (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies.
- Similar or less suitable spawning and egg incubation conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring more often; and (4) equivalent or lower probabilities of water temperatures occurring within the specified water temperature range.
- Similar ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities with similar monthly frequencies; and (4) similar probabilities of exceeding specified water temperatures, except for during June through September when probabilities of exceeding specified water temperatures would be slightly lower.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Feather River, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Hardhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult and juvenile life stage conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; and (4) similar probabilities of exceeding specified water temperatures.
- Similar or less suitable adult spawning conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly by water year type flows during April and May and higher long-term average monthly and average monthly by water year type flows during June; (2) lower monthly flow exceedance probabilities flows during April and May and higher monthly flow exceedance probabilities during June; (3) during low flow conditions, lower monthly flow exceedance probabilities during April and May, and higher monthly flow exceedance probabilities during June; and (4) similar or slightly lower probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the Feather River, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

California Roach

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult and juvenile life stage conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; and (4) equivalent probabilities of exceeding the specified water temperature index value.
- Similar adult spawning conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly by water year type flows during March through May, with higher long-term average monthly and average monthly by water year type flows during June; (2) similar or slightly lower monthly flow exceedance probabilities during March through May, and higher monthly flow exceedance probabilities during June; (3) during low flow conditions, similar or slightly lower monthly flow exceedance probabilities during March through May, and higher monthly

flow exceedance probabilities during June; and (4) similar probabilities of exceeding the specified water temperature index value.

In conclusion, in consideration of potential impacts to all life stages of California roach in the Feather River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Splittail

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the mouth.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or less suitable spawning conditions, because of modeling results indicating: (1) similar or slightly lower long-term average monthly and average monthly by water year type flows; (2) lower monthly flow exceedance probabilities during most of the evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities during April and May and a higher flow exceedance probability during February; (4) similar or lower usable flooded area (UFA) exceedance probabilities of 10 percent or more; and (5) equivalent monthly probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of splittail in the Feather River, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Striped Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River below the Thermalito Afterbay outlet and at the mouth of the Feather River.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Less suitable adult spawning and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly flows during April and May and higher long-term average monthly and average monthly by water year type flows during June; (2) lower monthly flow exceedance probabilities flows during April and May and higher monthly flow exceedance probabilities during June; (3) during low flow conditions, lower monthly flow exceedance probabilities flows during April and May and higher monthly flow exceedance probabilities during June; and (4) similar monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar or less suitable larvae, fry, and juvenile rearing emigration conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; and (4) similar or slightly higher probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the Feather River, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

American Shad

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River below the Thermalito Afterbay outlet and at the mouth of the Feather River.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Less suitable adult spawning and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly flows during April and May and higher long-term average monthly and average monthly by water year type flows during June; (2) lower monthly flow exceedance probabilities flows during April and May and higher monthly flow exceedance probabilities during June; (3) during low flow conditions, lower monthly flow exceedance probabilities flows during April and May and higher monthly flow exceedance probabilities during June; and (4) similar monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar or improved larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) higher and lower long-term average and average monthly flows by water year type occurring with similar monthly frequencies; (2) higher monthly flow exceedance probabilities during June through September and lower monthly flow exceedance probabilities during October and November; (3) during low flow conditions, higher monthly flow exceedance probabilities during June through September and lower monthly flow exceedance probabilities during October and November; and (4) similar probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of American shad in the Feather River, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Largemouth Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River below Thermalito Afterbay Outlet and at the mouth of the Feather River.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult and other life stage conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; and (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies.
- Similar spawning conditions, because of modeling results indicating similar monthly probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the Feather River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Sutter Bypass

Potential impacts to fisheries and aquatic resources in the Sutter Bypass under Alternative C relative to Existing Conditions would be similar to those discussed under Alternative A relative to Existing Conditions, above.

Folsom Lake

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Folsom Lake during April through November.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Equivalent or improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage during most of the evaluation period, and higher average monthly storage by water year type during most water years of the evaluation period; (2) higher, lower or equivalent monthly storage exceedance probabilities occurring with the same frequency during the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during most months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Folsom Lake, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to Existing Conditions.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Folsom Lake during March through June.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar warmwater fish spawning and early life stage conditions, because of modeling results indicating similar frequencies of monthly water surface elevation reductions of six feet or more during the March through June evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Folsom Lake, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

American River

Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River, in addition to model results for spawning habitat availability (WUA) (Appendix 12N) at Sailor Bar through Rossmoor and early life stage mortality (Appendix 12J).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Less suitable adult immigration and holding conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities, and substantially lower flows during September, during the evaluation period at all locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated, except for during September, when probabilities of exceedance would be higher; and (4) equivalent or higher monthly probabilities of exceeding specified water temperature index values.
- Less suitable adult spawning conditions due to modeling results indicating lower flow exceedance probabilities during all months of the evaluation period and lower spawning habitat availability during the October and December, although higher spawning habitat availability would occur during November, and higher monthly probabilities of exceeding specified water temperature index values during October and November.
- Similar or less suitable embryo incubation conditions due to modeling results indicating slightly higher total annual early life stage mortality, and similar or slightly higher monthly probabilities of exceeding specified water temperature index values.
- Equivalent or less suitable juvenile rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during most of the evaluation period, although slightly higher probabilities of exceedance would occur during April and May; (3) during low flow conditions, substantially lower monthly flow exceedance probabilities during March and June, although slightly higher probabilities of exceedance would occur during the remainder of the evaluation period; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values, although lower probabilities of exceedance would occur during April.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the American River, Alternative C would result in potentially adverse and potentially significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative C (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative C would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative C.

Spring-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined at the mouth of the American River.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or less suitable non-natal juvenile rearing conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type; (2) lower or equivalent monthly flow exceedance probabilities during the entire evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities during most months of the evaluation period, although slightly higher probabilities of exceedance would occur during January and February; and (4) similar probabilities of exceeding specified water temperature index values throughout the evaluation period.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the American River, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Steelhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River, in addition to model results for spawning habitat availability (WUA) (Appendix 12N) at Sailor Bar through Rossmoor.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or less suitable adult immigration and holding conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated; (3) during low flow conditions, lower monthly flow exceedance probabilities, although higher probabilities of exceedance would occur during January, February, and April; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during February.
- Similar or improved spawning conditions due to modeling results indicating improved spawning habitat availability during January, February, and April, and similar monthly probabilities of exceeding specified water temperature index values, although slightly higher probabilities of exceedance would occur during March.
- Similar embryo incubation conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated; (3) during low flow conditions, higher monthly flow exceedance probabilities, although lower probabilities of exceedance would occur during March; and (4) similar monthly probabilities of exceeding specified water temperature index values, although slightly higher probabilities of exceedance would occur during March.
- Similar or less suitable juvenile rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during most months of the evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during June through August at all evaluated locations, although higher probabilities of exceedance would occur during January and February, with substantially higher probabilities during April, May, and September; and (4) similar probabilities of exceeding

specified water temperature index values during November through April, with lower probabilities of exceedance during May through October.

- Similar or less suitable smolt emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during most of the evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during March and June at all evaluated locations, although higher probabilities of exceedance would occur during January, February, April, and May; and (4) similar probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during February, and slightly higher probabilities of exceedance during March.

In conclusion, in consideration of potential impacts to all life stages of steelhead in American River, Alternative C would result in potentially adverse, but less-than-significant impacts, relative to Existing Conditions.

Green Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined at the mouth of the American River.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or less suitable adult immigration and holding conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities during the entire evaluation period, with significantly lower flows during June through September; (3) during low flow conditions, lower monthly flow exceedance probabilities, with significantly lower probabilities of exceedance during June through August, although higher probabilities of exceedance would occur during February, May, and September; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values.
- Similar or less suitable spawning and egg incubation conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities during the entire evaluation period, with significantly lower flows during May through August; (3) during low flow conditions, lower monthly flow exceedance probabilities during all months of the evaluation period, with significantly lower probabilities of exceedance during most months, although higher probabilities of exceedance would occur during May; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values, particularly during June through August.
- Similar or less suitable juvenile rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities during the entire evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during June through August, although higher probabilities of exceedance would occur during January, February, May, and

September; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the American River, Alternative C would result in potentially adverse and potentially significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative C (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative C would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative C.

River Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or less suitable adult immigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River, except for during April, when flows would be higher during dry and critical water years at all evaluated locations; (2) lower monthly flow exceedance probabilities during most of the evaluation period, although slightly higher probabilities of exceedance would occur during April and May; and (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during October, March, and June, although higher probabilities of exceedance would occur during January and February, with substantially higher probabilities during April, May, and September.
- Similar or less suitable spawning and egg incubation conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during most of the evaluation period, although equivalent or higher probabilities would occur during April and May; (3) during low flow conditions, substantially lower monthly flow exceedance probabilities during March, June, and July at all evaluated locations, although higher probabilities of exceedance would occur during February, April, and May; and (4) similar or slightly lower monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar or less suitable ammocoete rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during most of the evaluation period, although equivalent or higher probabilities would occur during April and May; (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during October, March, and June through August, although higher probabilities of exceedance would occur during January and February, with substantially higher probabilities during

April, May, and September; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values, particularly during May through August.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the American River, Alternative C would result in potentially adverse and potentially significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative C (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative C would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative C.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or slightly less suitable adult immigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River, except for during April, when flows would be higher during dry and critical water years at all evaluated locations; (2) lower monthly flow exceedance probabilities during most of the evaluation period, although slightly higher probabilities of exceedance would occur during April and May; and (3) during low flow conditions, generally lower monthly flow exceedance probabilities during March and June, although higher probabilities of exceedance would occur during January and February, with substantially higher probabilities during April, May, and September.

- Similar or less suitable spawning and egg incubation conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during most of the evaluation period, although equivalent or higher probabilities would occur during April and May; (3) during low flow conditions, substantially lower monthly flow exceedance probabilities during March and June through August at all evaluated locations, although higher probabilities of exceedance would occur during February, April, and May; and (4) similar or slightly lower monthly probabilities of water temperatures occurring within the specified water temperature range.

- Less suitable ammocoete rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during most of the evaluation period, although equivalent or higher probabilities would occur during April and May; (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during October, March, and June through August, although higher probabilities of exceedance would occur during January and February, with substantially higher probabilities during April, May, and September; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values, particularly during May through August.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the American River, Alternative C would result in potentially adverse and potentially significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative C (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative C would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative C.

Hardhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or slightly improved adult and other life stage conditions due to modeling results indicating: (1) lower long-term average monthly flows the evaluation period, and lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities during most of the evaluation period, with significantly lower probabilities of exceedance during June through September; (3) during low flow conditions, lower monthly flow exceedance probabilities during seven out of 12 months of the evaluation period, although substantially higher probabilities of exceedance would occur during the remaining months; and (4) similar or slightly higher probabilities of remaining within specified water temperature ranges.
- Similar or slightly improved spawning conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types, except for during April, when flows would be higher during dry and critical water years; (2) substantially lower monthly flow exceedance probabilities during June, and equivalent or slightly higher probabilities of exceedance during the remainder of the evaluation period; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period, with lower probabilities of exceedance during June; and (4) similar or slightly higher probabilities of remaining within specified water temperature ranges.

In conclusion, in consideration of potential impacts to all life stages of hardhead in American River, Alternative C would result in similar and less-than-significant beneficial impacts, relative to Existing Conditions.

California Roach

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or slightly less suitable adult and other life stage conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities during most of the evaluation period, with significantly lower probabilities of exceedance during June through September, although equivalent or higher probabilities would occur during April and May; (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during October, March, and June through August, although higher probabilities of exceedance would occur during January and February, with substantially higher probabilities during April, May, and September; and (4) equivalent probabilities of exceeding specified water temperature index values.

- Similar or improved spawning conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities during March and June, with equivalent or slightly higher probabilities during the remainder of the evaluation period; (3) during low flow conditions, substantially lower monthly flow exceedance probabilities during March and June, with substantially higher probabilities of exceedance during April and May; and (4) equivalent or slightly lower probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of California roach in the American River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Splittail

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at the mouth of the American River.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar spawning conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types; (2) lower or equivalent monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, substantially lower monthly flow exceedance probabilities during March, and equivalent or higher probabilities of exceedance during the remainder of the evaluation period; (4) lower usable flooded area (UFA) exceedance probabilities of 10 percent or more; and (5) equivalent probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of splittail in the American River, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions.

Striped Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam and the mouth of the American River.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult spawning, embryo incubation, and initial rearing conditions due to modeling results indicating: (1) lower long-term average monthly flows during most of the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River, except for during April, when flows would be higher during dry and critical water years at all evaluated locations; (2) lower monthly flow exceedance probabilities, and particularly lower probabilities during June, although equivalent or higher flows would occur during the remainder of the evaluation period at the locations evaluated; (3) during low flow conditions, substantially lower monthly flow exceedance probabilities during June, although equivalent or higher flows would occur during the remainder of the evaluation period at the locations evaluated; and (4) similar probabilities of remaining within the specified water temperature range during the evaluation period, with higher probabilities during April and May, and lower probabilities during June.

- Similar or slightly less suitable larvae, fry, and juvenile rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types; (2) lower monthly flow exceedance probabilities during most months of the evaluation period; (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during June through August at all evaluated locations, although higher probabilities of exceedance would occur during January and February, with substantially higher probabilities during April, May, and September; and (4) similar probabilities of remaining within the specified water temperature range throughout the year, with a slightly higher probability of the temperatures occurring within the specified range during October, May, and September, and slightly lower probabilities during April and June through September.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the American River, Alternative C would result in potentially adverse, but less-than-significant impacts, relative to Existing Conditions.

American Shad

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue and the mouth of the American River.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult spawning, embryo incubation, and initial rearing conditions due to modeling results indicating: (1) lower long-term average monthly flows during most of the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River, except for during April, when flows would be higher during dry and critical water years at all evaluated locations; (2) lower monthly flow exceedance probabilities, and particularly lower probabilities during June, although equivalent or higher flows would occur during the remainder of the evaluation period at the locations evaluated; (3) during low flow conditions, substantially lower monthly flow exceedance probabilities during June, although equivalent or higher flows would occur during the remainder of the evaluation period at the locations evaluated; and (4) similar probabilities of remaining within the specified water temperature range during the evaluation period, although slightly higher probabilities of remaining within the temperature range would occur during April, and slightly lower probabilities occur during June.
- Similar larvae, fry, and juvenile rearing and emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows occurring during most of the evaluation period, and lower average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) lower monthly flow exceedance probabilities during the evaluation period at all locations evaluated, with substantially lower probabilities of exceedance during July through September; (3) during low flow conditions, substantially lower monthly flow exceedance

probabilities during most months of the evaluation period at all locations evaluated, although substantially higher probabilities would occur during September; and (4) equivalent or slightly higher monthly probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of American shad in the American River, Alternative C would result in potentially adverse and potentially significant impacts, relative to Existing Conditions. However, these impacts would occur with or without implementation of Alternative C (i.e., impacts would occur under the No Project/No Action Alternative). Further, examination of CALSIM II (Appendix 6B) and Reclamation Temperature Model (Appendix 7E) results indicates that implementation of Alternative C would not exacerbate the impacts identified under the No Project/No Action Alternative. Therefore, these potential impacts are not considered to be attributable to implementation of Alternative C.

Largemouth Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue.

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or less suitable adult and other life stage conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and lower average monthly flows by water year type during most water year types, except for during April, when flows would be higher during dry and critical water years at all evaluated locations; (2) lower monthly flow exceedance probabilities during most of the evaluation period, although slightly higher probabilities of exceedance would occur during April and May; and (3) during low flow conditions, lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during October, March, and June through August, although higher probabilities of exceedance would occur during February, in addition to substantially higher probabilities during January, April, May, and September.
- Similar or improved spawning conditions due to modeling results indicating equivalent or slightly higher probabilities of remaining within specified water temperature ranges.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the American River, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Sacramento-San Joaquin Delta and Yolo Bypass

Delta Smelt in the Delta Region

Model results were examined for water temperatures (Appendix 12E) in the Sacramento River at Freeport, OMR flows (Appendix 12E), Delta outflow (Appendix 12E), salvage at the SWP and CVP export facilities (Appendix 12I), and X2 location (Appendix 12E).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult conditions, because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range (December through May); (2) similar overall normalized mean monthly salvage at the SWP and CVP export facilities (December through April); and (3) similar or slightly higher monthly probabilities of OMR flows being more negative than -5,000 cfs (December through February)

- Less suitable spawning conditions in the Yolo Bypass (December through May), because of modeling results indicating: (1) lower long-term average Yolo Bypass flows; (2) similar or lower Yolo Bypass flow exceedance probabilities; and (3) during low flow conditions, lower flow exceedance probabilities (of 10 percent or more) during December and February, and higher flow exceedance probabilities during January and March, albeit similar simulated flows throughout the period
- Similar egg and embryo conditions (February through May), because of modeling results indicating similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range
- Similar larvae conditions (March through June), because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range; (2) during March through June of dry and critical water years, slightly higher (less negative) mean monthly OMR flows when flows would be equal to or more negative than -1,500 cfs, but with lower OMR flows (more negative) during March of critical water years; and (3) during the latter portion of the larval delta smelt downstream migration period (i.e., May and June), long-term average and average by water year type monthly Delta outflow would be slightly decreased during May but would be slightly increased during June, while monthly Delta outflow exceedance probabilities would be lower more often during May, but would be higher more often during June.
- Similar or improved juvenile conditions (May through July), because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range; (2) slightly higher overall normalized mean monthly salvage at the SWP export facility and similar overall normalized mean monthly salvage at the CVP export facility; (3) Between RKm 65 and 80, long-term average and average by water year type X2 location would move slightly upstream during May (by less than 0.5 RKm), move slightly downstream during June (by 0.5 RKm or less), and move downstream during July (by 1.2, 1.7 and 1.9 RKm during wet, above normal and below normal water years, respectively) ; and (4) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to all life stages of delta smelt in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Longfin Smelt in the Delta Region

Model results were examined for OMR flows (Appendix 12E and 12F), salvage at the SWP and CVP export facilities (Appendix 12I), and X2 location (Appendix 12E).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar adult conditions because of modeling results indicating slightly higher (during December) and equivalent (during January through March) monthly probabilities of OMR flows being more negative than -5,000 cfs during December through March
- Generally similar larvae and juvenile conditions because of: (1) slightly higher (during December) and equivalent (during January through March) monthly probabilities of OMR flows being more negative than -5,000 cfs during December through March; (2) during April and May of dry and

critical water years, mean monthly OMR flows would be lower during April of dry and critical water years (by 9.1 and 6.1 percent, respectively) would be higher during May of dry water years (by 2.3 percent) and would be equivalent during May of critical water years; (3) similar or slightly lower overall mean monthly salvage at the SWP and CVP export facilities; (4) slightly lower (during January through May) and higher (during June) monthly exceedance probabilities of X2 location occurring at or downstream of 75 RKm during January through June; and (5) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to all life stages of longfin smelt in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Splittail in the Delta Region

Model results were examined for Yolo Bypass outflow (Appendix 12E) and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Less suitable egg and larval conditions (February through May) because of modeling results indicating: (1) slightly reduced mean monthly Yolo Bypass outflow during most months of wet water years and reduced mean monthly flows during February through April of above normal and below normal water years, during February and March of dry water years and during March of critical water years, with mean monthly reductions of 10 percent or more during March through April of above normal water years and during March of below normal, dry and critical water years; and (2) lower flow exceedance probabilities (of 10 percent or more) more often during February through May
- Similar juvenile rearing and emigration conditions (April through July) because of modeling results indicating: (1) lower (during April) or similar mean monthly Yolo Bypass outflow during most water year types; (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; (3) lower (during April and May) or similar flow exceedance probabilities (of 10 percent or more); and (4) slightly higher overall simulated mean monthly salvage at the SWP export facility and similar mean monthly salvage at the CVP export facility
- Less suitable adult spawning and upstream migration conditions, because of modeling results indicating: (1) reduced mean monthly Yolo Bypass outflow during February and March, as discussed above for egg and larval conditions; and (2) similar overall simulated mean monthly salvage at the SWP and CVP export facilities during December through March

In conclusion, in consideration of potential impacts to all life stages of splittail in the Delta Region including the Yolo Bypass, Alternative C would result in less suitable and potentially significant impacts, relative to Existing Conditions. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Winter-run Chinook Salmon in the Delta Region

Model results were examined for through-Delta juvenile survival (Appendix 12M).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar juvenile conditions, because of modeling results indicating: (1) slightly higher monthly Delta survival exceedance probabilities more often; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile winter-run Chinook salmon in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Spring-run Chinook Salmon in the Delta Region

Model results were examined for through-Delta juvenile survival (Appendix 12M).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar juvenile conditions, because of modeling results indicating: (1) slightly higher and lower monthly Delta survival exceedance probabilities occurring with similar probabilities over the entire distribution; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile spring-run Chinook salmon in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Fall-run and Late Fall-run Chinook Salmon in the Delta Region

Model results were examined for OMR flows (Appendix 12E) and through-Delta juvenile survival (Appendix 12M).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar San Joaquin River adult straying conditions because of modeling results indicating: (1) similar or slightly higher monthly probabilities of OMR flows being more negative than -5,000 cfs during December through February; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta
- Similar or improved juvenile conditions because of modeling results indicating: (1) slightly higher monthly Delta survival exceedance probabilities more often

In conclusion, in consideration of potential impacts to juvenile and San Joaquin River adult fall and late fall-run Chinook salmon in the Delta, Alternative C would result in similar or beneficial and less-than-significant impacts, relative to Existing Conditions.

Steelhead in the Delta Region

Model results were examined for Sacramento River flows at Rio Vista (Appendix 12F), Yolo Bypass outflow (Appendix 12E), Delta outflow (Appendix 12E), OMR flows (Appendix 12E), and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar juvenile rearing and emigration conditions in the Delta (October through July) because of modeling results indicating: (1) higher long-term average and average by water year type monthly flows at Rio Vista during October, November, June and July, and lower average monthly flows during December through May; (2) higher monthly flow exceedance probabilities at Rio Vista during

October November, April, June and July, and lower flow exceedance probabilities during December through March and May, with higher flow exceedance probabilities during all months except for during March during low flow conditions; (3) lower or similar mean monthly Yolo Bypass outflow and lower or similar flow exceedance probabilities during most of the evaluation period; (4) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; (5) lower long-term average and average by water year type monthly Delta outflow during most months of most water year types, but with higher Delta outflow during June and July of all water year types, during November of below normal water years, during October and November of dry water years and during October and December of critical water years; (6) lower or similar long-term average and average by water year type monthly OMR flows; and (7) similar overall simulated mean monthly salvage at the SWP and CVP export facilities, but with higher mean monthly salvage during critical water years at the SWP export facility

In conclusion, in consideration of potential impacts to all life stages of Central Valley steelhead in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions. Alternative C impacts on steelhead in the Yolo Bypass are considered potentially significant, relative to Existing Conditions. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Green Sturgeon in the Delta Region

Model results were examined for Yolo Bypass outflow (Appendix 12E) and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar or less suitable juvenile rearing and emigration conditions (year-round) because of modeling results indicating: (1) lower or similar mean monthly Yolo Bypass outflow and lower flow exceedance probabilities during most months; (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; and (3) similar simulated mean monthly salvage at the SWP and CVP export facilities

In conclusion, in consideration of potential impacts to green sturgeon in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions. Alternative C impacts on green sturgeon in the Yolo Bypass are considered potentially significant, relative to Existing Conditions. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

White Sturgeon in the Delta Region

Model results were examined for Yolo Bypass outflow (Appendix 12E) and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar juvenile rearing and emigration conditions (year-round) because of modeling results indicating: (1) lower or similar mean monthly Yolo Bypass outflow and lower flow exceedance probabilities; (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; and (3) similar simulated mean monthly salvage at the SWP and CVP export facilities

In conclusion, in consideration of potential impacts to white sturgeon in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions. Alternative C impacts on white sturgeon in the Yolo Bypass are considered potentially significant, relative to Existing Conditions. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Pacific and River Lamprey in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar macropthalmia emigration conditions (year-round) because of modeling results indicating similar simulated mean monthly salvage at the SWP and CVP export facilities, but with higher mean monthly salvage at the SWP export facility during critical water years

In conclusion, in consideration of potential impacts to Pacific and river lamprey in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

American Shad in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I) and X2 location (Appendix 12E).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar egg and larval conditions in the Delta because of modeling results indicating: (1) slightly lower (during April and May) and slightly higher (during June) exceedance probabilities of X2 location being located at or downstream of 75 RKm during April through June; (2) slightly higher overall normalized mean monthly salvage at the SWP and CVP export facilities; and (3) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to American shad in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Striped Bass in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I) and X2 location (Appendix 12E).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Similar egg and larval conditions in the Delta because of modeling results indicating: (1) slight upstream mean monthly movements in X2 location during April and May of all water year types and slight downstream mean monthly movements in X2 location during June of all water year types during April through June; (2) slightly higher overall normalized mean monthly salvage at the SWP export facility and similar overall normalized mean monthly salvage at the CVP export facility; and (3) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to striped bass in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to Existing Conditions.

Largemouth Bass in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I) and X2 location (Appendix 12E).

Relative to Existing Conditions, Alternative C would generally be expected to provide:

- Less suitable juvenile rearing conditions in the Yolo Bypass because of modeling results indicating: (1) lower mean monthly Yolo Bypass outflow during most months, in addition to similar or lower flow exceedance probabilities (of 10 percent or more); and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta
- Similar juvenile and adult conditions in the Delta because of modeling results indicating: (1) upstream mean monthly movements in X2 location of 0.5 RKm or more during December and January of wet water years, during December through April of above normal water years, during January through May of below normal and dry water years and during February and March of critical water years, and downstream mean monthly movements in X2 location of 0.5 RKm or more during July and August of wet water years, during July through September of above normal water years, during June through December of below normal water years, during July through December of dry water years and during July through October and January of critical water years; and (2) slightly higher overall simulated mean monthly salvage at the SWP export facility and similar mean monthly salvage at the CVP export facility

In conclusion, in consideration of potential impacts to largemouth bass in the Delta, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to Existing Conditions. Alternative C impacts on largemouth bass in the Yolo Bypass are considered potentially significant, relative to Existing Conditions. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Suisun, San Pablo, and San Francisco Bays

Fish species of primary management concern, including Chinook salmon, steelhead, river lamprey, Pacific lamprey, green sturgeon, white sturgeon, and splittail, utilize the bays as a migration corridor and/or for juvenile rearing. Potential increases in Delta outflow during the summer and fall and reductions in Delta outflow during the spring would not result in substantial changes to migration or rearing habitat for these fish species in the bays. Striped bass and American shad also utilize the bays for migration and rearing, however, changes in X2 location were evaluated during the striped bass and American shad spawning and initial rearing period to evaluate potential changes in larval transport and rearing habitat in the Bay-Delta (see the Delta Region, above). Potential effects on delta smelt and longfin smelt migration and rearing in the Bay-Delta also were analyzed through evaluation of changes in X2 location (see the Delta Region, above).

12C.8.3 Primary Study Area – Alternative C Relative to Existing Conditions

12C.8.3.1 Construction, Operation, and Maintenance Impacts

For a discussion of impacts to fisheries and aquatic resources under Alternative C relative to Existing Conditions in the Primary Study Area, refer to the Environmental Consequences section of Chapter 12 Aquatic Biological Resources.

12C.9 Impacts Associated with Alternative C Relative to the No Project/No Action Alternative

12C.9.1 Extended Study Area – Alternative C Relative to the No Project/No Action Alternative

12C.9.1.1 SWP and CVP Operations

Agricultural Water Use

Potential impacts to fisheries and aquatic resources associated with agricultural water use are discussed under Alternative A relative to Existing Conditions, above, and are applicable to Alternative C relative to the No Project/No Action Alternative.

Municipal and Industrial Water Use

Potential impacts to fisheries and aquatic resources associated with municipal and industrial water use are discussed under Alternative A relative to Existing Conditions, above, and are applicable to Alternative C relative to the No Project/No Action Alternative.

Wildlife Refuge Water Use

Potential impacts to fisheries and aquatic resources associated with wildlife refuge water use are discussed under Alternative A relative to Existing Conditions, above, and are applicable to Alternative C relative to the No Project/No Action Alternative.

San Luis Reservoir

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for San Luis Reservoir during April through November.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Less suitable coldwater pool storage conditions, because of modeling results indicating: (1) lower long-term average monthly storage during most months of the evaluation period, and higher average monthly storage by water year type occurring more often during most water years of the evaluation period; (2) lower monthly storage exceedance probabilities during most months of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance decrease occurring during most months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in San Luis Reservoir, Alternative C would result in potentially less suitable and potentially significant impacts, relative to the No Project/No Action Alternative. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for San Luis Reservoir during March through June.

Relative to the No Project/No Action Alternative, Alternative C would be expected to provide:

- Similar or slightly less suitable warmwater fish spawning and early life stage conditions, because of modeling results indicating similar or slightly increased frequencies of monthly water surface elevation reductions of six feet or more during most months of the evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in San Luis Reservoir, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Export Service Area Reservoirs

Export Service Area Reservoir Fisheries

Changes in modeled total SWP and CVP Delta exports (Appendix 12E) under Alternative C relative to the No Project/No Action Alternative were analyzed to evaluate potential changes in storage and water surface elevations and associated impacts on fisheries in export service area reservoirs, including Anderson Reservoir, Diamond Valley Lake, Castaic Lake, Lake Mathews, and Lake Perris.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Equivalent or improved export service area reservoir fisheries habitat conditions, because of: (1) long-term average and average monthly by water year type Delta exports would be higher during most months of all water year types, and would be higher by 10 percent or more during September through November of wet and below normal water years, during August, September and November of dry water years, and during January, February, August and November of critical water years; (2) higher monthly export exceedance probabilities during January, February and July through November, and lower export exceedance probabilities during December and March through June; and (3) a net 10 percent or more export probability of exceedance increase during most months of the year.

In conclusion, in consideration of potential impacts to SWP and CVP export service area reservoir fisheries, Alternative C would result in potentially beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

12C.9.2 Secondary Study Area – Alternative C Relative to the No Project/No Action Alternative

12C.9.2.1 Construction, Operation, and Maintenance Impacts

Construction, operation, and maintenance-related impacts to fisheries and aquatic resources in the Secondary Study Area under Alternative C relative to the No Project/No Action Alternative would be identical to those discussed under Alternative C relative to Existing Conditions, above.

12C.9.2.2 SWP and CVP Operations

Trinity Lake

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Trinity Lake during April through November.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Equivalent or improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage during most of the evaluation period, and higher average monthly storage by water year type during most water years of the evaluation period; (2) equivalent or higher monthly storage exceedance probabilities during all months the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during all months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Trinity Lake, Alternative C would result in potentially beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Trinity Lake during March through June.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Improved warmwater fish spawning and early life stage conditions, because of slightly decreased frequencies of monthly water surface elevation reductions of six feet or more occurring more often during the March through June evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Trinity Lake, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Trinity River

Coho Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Equivalent or more suitable adult immigration and holding conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar average monthly probabilities of exceeding specified water temperature index values, with lower probabilities of exceedance during September and October, although slightly higher probabilities of exceedance would occur during January.

- Equivalent adult spawning and embryo incubation conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values, with slightly lower probabilities of exceedance during April, May, October and November, although slightly higher probabilities of exceedance would occur during January.
- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows over the entire year, and similar monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the year; and (4) equivalent or lower probabilities of exceeding specified water temperature index values throughout most of the year, particularly during August through October, although higher probabilities of exceedance occur during December, January, and June.
- Equivalent or slightly improved smolt emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for wet water years when flows would be slightly higher, and above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values during the evaluation period.

In conclusion, in consideration of potential impacts to all life stages of Coho salmon in the Trinity River, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Spring-Run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Equivalent or slightly improved adult immigration and holding conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent average monthly flows during most water year types, except for wet water years when average monthly flows would be slightly higher more frequently; (2) similar or slightly higher monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar or slightly lower monthly probabilities of exceeding specified water temperature index values, particularly during July through September.

- Equivalent or slightly improved adult spawning and egg incubation conditions due to modeling results indicating: (1) equivalent or slightly higher long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during all water year types; (2) equivalent or slightly higher monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar or lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during August through October.
- Equivalent or slightly improved juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows over the entire year, and similar monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values, particularly during June through September.
- Equivalent smolt emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for wet water years when flows would be slightly higher, and above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values, particularly during June and July.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Trinity River, Alternative C would result in slightly beneficial, although similar, less-than-significant impacts, relative to the No Project/No Action Alternative.

Fall-Run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork, in addition to model results for early life stage mortality (Appendix 12J).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Equivalent or slightly improved adult immigration and holding conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and equivalent or slightly higher average monthly flows during most water year types; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent or lower (particularly during August and September), and therefore more suitable, average monthly probabilities of exceeding specified water temperature index values.

- Equivalent adult spawning conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values, with lower probabilities, and therefore more suitable water temperatures, during October.
- Slightly improved embryo incubation conditions due to modeling results indicating reduced total annual early life stage mortality, and equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with lower probabilities of exceedance during October.
- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities over the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during the evaluation period; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values during the evaluation period, particularly during June through September.
- Equivalent smolt emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values, particularly during June and July.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Trinity River, Alternative C would result in slightly beneficial, although similar, less-than-significant impacts, relative to the No Project/No Action Alternative.

Steelhead (Winter-run and Summer-run)

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Equivalent or slightly improved adult immigration and holding conditions for winter-run steelhead due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during the evaluation period; and (4) similar, or slightly lower (particularly during April, and August through October) average monthly probabilities of exceeding specified water temperature index values, although slightly higher probabilities of exceedance would occur during March.

- Equivalent or slightly improved adult immigration and holding conditions for summer-run steelhead due to modeling results indicating: (1) equivalent long-term average monthly flows during the evaluation period, and equivalent average monthly flows during all water year types; (2) equivalent monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values during the evaluation period, with slightly lower probabilities of exceedance during July and August, and higher probabilities during June.
- Equivalent adult spawning and egg incubation conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values throughout the evaluation period, with slightly higher probabilities of exceedance during March and June, although slightly lower probabilities would occur during April and May.
- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows over the entire year, and similar monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent probabilities of exceeding specified water temperature index values throughout most of the year, with slightly lower probabilities of exceedance during June through September.
- Equivalent smolt emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows, except for during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values during the evaluation period.

In conclusion, in consideration of potential impacts to all life stages of steelhead (winter-run and summer-run) in the Trinity River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Green Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam and at North Fork.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Equivalent adult immigration and holding conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) equivalent or slightly higher monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar average monthly probabilities of exceeding specified water temperature index values.
- Equivalent or slightly improved adult spawning conditions due to modeling results indicating: (1) equivalent long-term average monthly flows during the evaluation period, and equivalent average monthly flows during all water year types; (2) equivalent monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent or slightly lower probabilities of exceeding specified water temperature index values, particularly during July.
- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows over the entire year, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values during the year.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Trinity River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

White Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam and at North Fork.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Equivalent adult immigration and holding conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.
- Equivalent adult spawning conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for wet water years when flows would be slightly higher, and above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the

evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.

- Equivalent rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows over the entire year, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of exceeding specified water temperature index values during the year.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Trinity River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Trinity River below Lewiston Dam, at Douglas City, and at North Fork.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Equivalent adult immigration conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities during the evaluation period; and (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period.
- Equivalent adult spawning and egg incubation conditions due to modeling results indicating: (1) similar long-term average monthly flows during the evaluation period, and similar average monthly flows during most water year types, except for above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) similar probabilities of water temperatures remaining within the specified water temperature range, with lower probabilities of exceedance during July and August, and slightly higher probabilities during April.
- Equivalent juvenile rearing and emigration conditions due to modeling results indicating: (1) similar long-term average monthly flows over the entire year, and similar average monthly flows during most water year types, except for during above normal and below normal water years, when flows would be substantially lower during March and February, respectively; (2) similar or slightly lower monthly flow exceedance probabilities over the entire year; (3) during low flow conditions, equivalent flow exceedance probabilities during all months of the evaluation period; and (4) equivalent average monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Trinity River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Klamath River downstream of the Trinity River

Because potential changes within the Trinity River were considered to be less than significant under Alternative C, it is expected that any potential changes in the Klamath River downstream of the Trinity River also would be less than significant.

Lewiston Lake, Whiskeytown Lake, Keswick Reservoir, Lake Natoma, and the Thermalito Complex

Refer to Alternative A relative to Existing Conditions for a discussion of Lewiston Lake, Whiskeytown Lake, Keswick Reservoir, Lake Natoma, and the Thermalito Complex.

Spring Creek

It is not anticipated that operations of Spring Creek Reservoir or flows in Spring Creek would be substantially affected under implementation of Alternative C. It is anticipated that Spring Creek Reservoir would continue to operate for flood control purposes, and to manage the release of contaminated water from Iron Mountain Mine.

Shasta Lake

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Shasta Lake during April through November.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Equivalent or improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage during most of the evaluation period, and higher average monthly storage by water year type during most water years of the evaluation period; (2) equivalent or higher monthly storage exceedance probabilities during all months of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during all months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Shasta Lake, Alternative C would result in potentially beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Shasta Lake during March through June.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Improved warmwater fish spawning and early life stage conditions, because of modeling results indicating decreased frequencies of monthly water surface elevation reductions of six feet or more occurring more often during the March through June evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Shasta Lake, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Sacramento River

Winter-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for spawning habitat availability (WUA) (Appendix 12N), early life stage mortality (SacSalMort) (Appendix 12J), overall population mortality and production potential (SALMOD) (Appendix 12K), and lifecycle modeling (IOS) (Appendix 12L).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) lower or similar long-term average and average by water year type monthly flows more often, but with higher average monthly flows during June and July in the lower Sacramento River; (2) lower monthly flow exceedance probabilities more often; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring more often at most locations, and lower flow exceedance probabilities below Red Bluff Diversion Dam; (4) equivalent monthly probabilities of exceeding specified water temperature index values, but with higher probabilities of exceeding specified water temperature index values during April, and slightly lower probabilities of exceeding specified water temperatures during June and July.
- Improved spawning conditions due to modeling results indicating increased spawning habitat availability during all months of the spawning period, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during months with relatively warm water temperature conditions (i.e., July and August).
- Similar or improved embryo incubation conditions due to modeling results indicating reduced mean total annual early life stage mortality, but with increased average annual mortality during above normal and below normal water years, reduced annual early life stage mortality over approximately 50 percent of the entire cumulative frequency distribution, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during months with relatively warm water temperature conditions (i.e., July and August).
- Improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type occurring more often in the upper Sacramento River, and higher average monthly flows in the lower Sacramento River; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below Keswick Dam and in the lower Sacramento River, and lower monthly flow exceedance probabilities below Red Bluff Diversion Dam; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at most locations evaluated, but lower flow exceedance probabilities below Red Bluff Diversion Dam; and (4) equivalent or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values during July through September, and equivalent or higher probabilities of exceeding specified water temperature index values during April.
- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by 15 percent), and average annual mortality by water year type would

be reduced during all water year types (by eight percent during wet water years, 28 percent during above normal water years, six percent during below normal water years, 17 percent during dry water years, and 21 percent during critical water years); (2) a decrease in total annual mortality exceedance probabilities over more than 90 percent of the distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction, with 10 percent or more exceedance probability reductions occurring over 16 percent of the entire distribution; and (4) long-term average total annual winter-run Chinook salmon production would increase by two percent, while average total annual production would increase during wet water years by less than one percent, during above normal water years by eight percent, during below normal water years by one percent, during dry water years by two percent and during critical water years by three percent.

- Improved conditions pertaining to early life stage survival and abundance of spawners (IOS) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual egg to fry survival would increase by four percent, and average annual egg to fry survival by water year type would decrease during wet and above normal water years by one percent, and would increase during below normal water years by two percent, dry water years by seven percent, and during critical water years by 33 percent; (2) long-term average annual fry to smolt survival would increase by two percent, and average annual fry to smolt survival by water year type would increase during wet water years by two percent and during critical water years by 13 percent, would decrease during below normal and dry water years by one percent, and would be equivalent during above normal water years; (3) long-term average annual female spawner abundance would increase by eight percent, and average annual female spawner abundance by water year type would increase during wet water years by 10 percent, during above normal water years by nine percent, during below normal water years by two percent, during dry water years by six percent and during critical water years by nine percent; (4) an increase in annual egg to fry survival exceedance probabilities over approximately 65 percent of the entire distribution, particularly at lower survival rates; (5) an increase in annual fry to smolt survival exceedance probabilities over approximately 75 percent of the entire distribution, particularly at lower survival rates; and (6) an increase in annual female spawner abundance exceedance probabilities over approximately 90 percent of the entire distribution.

In conclusion, in consideration of potential impacts to all life stages of winter-run Chinook salmon in the Sacramento River, Alternative C would result in beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Spring-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J) and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type more often in the upper Sacramento River, and higher and lower long-term average monthly and average monthly flows by water year type occurring with similar monthly frequencies in the lower Sacramento River; (2) lower monthly flow exceedance probabilities more often in the upper Sacramento River, and higher monthly flow exceedance probabilities more often in the lower Sacramento River; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at most locations evaluated, with lower average monthly flows more often below Red Bluff Diversion Dam; (4) equivalent or lower (particularly during July through September) and equivalent or higher (particularly during April) monthly probabilities of exceeding specified water temperature index values.

- Improved spawning conditions due to modeling results indicating higher average monthly flows and flow exceedance probabilities more often below Keswick Dam and at Bend Bridge, lower average monthly flows and flow exceedance probabilities more often below Red Bluff Diversion Dam, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, particularly during months with warm water temperature conditions (i.e., September and October).
- Improved embryo incubation conditions due to modeling results indicating reduced average total annual early life stage mortality and reduced early life stage mortality over most of the cumulative frequency distribution, and lower probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures.
- Similar juvenile rearing conditions due to modeling results indicating: (1) lower long-term average monthly flows during more than half of the evaluation period in the upper Sacramento River; (2) lower monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often below Keswick Dam and lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam; and (4) equivalent or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values.
- Similar smolt emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type more often; (2) lower monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at most locations evaluated, but with lower flow exceedance probabilities below Red Bluff Diversion Dam; and (4) higher monthly probabilities of exceeding specified water temperature index values during April and May, and lower monthly probabilities of exceeding specified water temperature index values during October.
- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by 23 percent), and average annual mortality by water year type would be reduced during all water year types (by 45 percent during wet water years, three percent during above normal water years, one percent during below normal water years, 37 percent during dry water years, and 20 percent during critical water years); (2) a decrease in total annual mortality exceedance probabilities over more than 95 percent the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction, with reductions of 10 percent or more occurring over more than 80 percent of the distribution; and (4) long-term average total annual spring-run Chinook salmon production would increase by four percent, while average total annual production would increase during wet water years by three percent, during above normal water years by

one percent, during dry water years by nine percent, and during critical water years by eight percent, and decreases during below normal water years by less than one percent.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Sacramento River, Alternative C would result in similar or beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J), spawning habitat availability (WUA) (Appendix 12N), and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) similar or lower long-term average monthly and average monthly flows by water year type during most of the evaluation period in the upper Sacramento River, and higher long-term average monthly and average monthly flows by water year type in the lower Sacramento River; (2) similar or higher monthly flow exceedance probabilities below Keswick Dam, similar monthly flow exceedance probabilities below Red Bluff Diversion Dam, and higher monthly flow exceedance probabilities during most months in the lower Sacramento River; (3) during low flow conditions, similar or lower monthly flow exceedance probabilities below Red Bluff Diversion Dam and higher monthly flow exceedance probabilities more often below Keswick Dam and in the lower Sacramento River; (4) equivalent or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values.

- Less suitable spawning conditions due to modeling results indicating reduced spawning habitat availability during November through January, and lower or equivalent probabilities of exceeding specified water temperature index values, and therefore more suitable water temperatures, specifically during October.

- Improved embryo incubation conditions due to modeling results indicating reduced mean total annual early life stage mortality and reduced annual early life stage mortality over almost the entire cumulative frequency distribution, and lower or equivalent probabilities of exceeding specified water temperature index values during October, and therefore more suitable water temperatures.

- Similar or less suitable juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows during more than half of the evaluation period at all locations evaluated; (2) lower monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often at all locations evaluated, except for below Red Bluff Diversion Dam where flows would be lower with more often; and (4) similar monthly probabilities of exceeding specified water temperature index values, but with less suitable water temperatures during April and May more often and more suitable water temperatures during June more often.

- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by three percent), average annual mortality by water year type would increase during wet water years by five percent and during below normal water years by one percent, and would decrease during above normal water years by five percent, during dry water years by nine percent, and during critical water years by 26 percent; (2) a decrease in total annual mortality exceedance probabilities over approximately 60 percent of the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction; and (4) long-term average total annual fall-run Chinook salmon production would increase by two percent, while average total annual production would decrease during wet water years by eight percent and during below normal water years by less than one percent, and would increase during above normal water years by six percent, during dry water years by three percent, and during critical water years by 12 percent.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Late Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, in addition to model results for early life stage mortality (SacSalMort) (Appendix 12J) and overall population mortality and production potential (SALMOD) (Appendix 12K).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) higher long-term average monthly and average monthly flows by water year type more often below Keswick Dam, and lower long-term average monthly and average monthly flows by water year type more often below Red Bluff Diversion Dam and in the lower Sacramento River; (2) higher monthly flow exceedance probabilities more often below Keswick dam, lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam, and higher and lower monthly flow exceedance probabilities with similar monthly frequencies in the lower Sacramento River; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated except for below Red Bluff Diversion Dam where flow exceedance probabilities would be lower more often; (4) similar monthly probabilities of exceeding specified water temperature index values, but with more suitable water temperatures during October and less suitable water temperatures during April.
- Similar spawning conditions due to modeling results indicating higher average monthly flows and flow exceedance probabilities during January and February and lower or equivalent average monthly flows and flow exceedance probabilities during March through May, and similar probabilities of exceeding specified water temperature index values.
- Similar or less suitable embryo incubation conditions due to modeling results indicating: (1) reduced average total annual early life stage mortality but with higher annual mortality during above normal, below normal, dry and critical water years, and higher annual mortality over about 65 percent of the cumulative frequency distribution; and (2) similar probabilities of exceeding specified water temperature index values.

- Similar or improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows more often below Red Bluff Diversion Dam, and higher average monthly flows more often in the lower Sacramento River; (2) similar or lower monthly flow exceedance probabilities below Red Bluff Diversion Dam, and higher monthly flow exceedance probabilities in the lower Sacramento River; (3) under low flow conditions, similar or lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam and higher monthly flow exceedance probabilities more often in the lower Sacramento River; and (4) lower monthly probabilities of exceeding specified water temperature index values more often during June through October, but higher probabilities of exceeding specified water temperature index values more often during April and May.
- Improved conditions pertaining to population mortality and production potential (SALMOD) because of modeling results indicating: (1) over the 81-year evaluation period, long-term average annual mortality would be reduced (by three percent), average annual mortality by water year type would increase during wet water years by one percent and would decrease during above normal water years by two percent, during below normal water years by 11 percent, during dry water years by two percent and during critical water years by 12 percent; (2) a decrease in total annual mortality exceedance probabilities over approximately 75 percent of the entire distribution; (3) a net 10 percent or more total annual mortality exceedance probability reduction; (4) long-term average total annual late fall-run Chinook salmon production would increase by two percent, while average total annual production by water year type would decrease during wet water years by less than one percent, and would increase during above normal water years by one percent, during below normal water years by two percent, during dry water years by one percent, and during critical water years by nine percent.

In conclusion, in consideration of potential impacts to all life stages of late fall-run Chinook salmon in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Steelhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, Ball's Ferry, Jelly's Ferry, Bend Bridge, below Red Bluff Diversion Dam, below the Feather River confluence, Freeport and Rio Vista, and results from the SacEFT (Appendix 8B) were examined for steelhead egg mortality, spawning habitat availability, redd dewatering, redd scouring, juvenile rearing habitat availability and juvenile stranding.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies below Keswick Dam and in the lower Sacramento River, and lower average monthly flows more often below Red Bluff Diversion Dam; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies, but with higher monthly flow exceedance probabilities below Keswick Dam and lower monthly flow exceedance probabilities below Red Bluff Diversion Dam; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period in the lower Sacramento River and below Keswick Dam, and lower flow exceedance probabilities more often below Red Bluff Diversion Dam; (4) similar or lower monthly probabilities of exceeding specified water temperature index values more often during September and October, and higher monthly probabilities of exceeding specified water temperature index values during November and March.

- Similar spawning conditions due to modeling results indicating: (1) higher mean monthly flows and flow exceedance probabilities during December through February, and lower flows during March and April; (2) higher or equivalent flow exceedance probabilities more often during low flow conditions; (3) similar probabilities of exceeding specified water temperature index values; and (4) SacEFT results indicating that spawning habitat availability conditions would be similar.
- Similar embryo incubation conditions due to modeling results indicating: (1) similar probabilities of exceeding specified water temperature index values; (2) SacEFT results indicating that egg mortality associated with modeled water temperatures would be equivalent; (3) SacEFT results indicating that redd dewatering conditions may be improved slightly more often; and (4) SacEFT results indicating that redd scouring conditions would be equivalent.
- Similar juvenile rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies below Keswick Dam and at Bend Bridge, and lower average monthly flows occurring more often below Red Bluff Diversion Dam; (2) lower monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often below Keswick Dam, and lower monthly flow exceedance probabilities more often at Bend Bridge and below Red Bluff Diversion Dam; (4) equivalent monthly probabilities of exceeding specified water temperature index values, but with lower probabilities of exceeding 65°F during August and September, and therefore more suitable water temperature conditions; and (5) SacEFT results indicating that juvenile rearing habitat availability may be increased slightly more often while juvenile stranding potential may be increased more often.
- Similar smolt emigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type more often; (2) lower monthly flow exceedance probabilities more often; (3) under low flow conditions, lower monthly flow exceedance probabilities below Red Bluff Diversion Dam, and higher monthly flow exceedance probabilities more often in the lower Sacramento River; and (4) higher monthly probabilities of exceeding specified water temperature index values during March and April, and lower monthly probabilities of exceeding specified water temperature index values during October.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Green Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities, at Wilkins Slough, at Freeport and at Rio Vista, and egg survival results from the SacEFT (Appendix 8B) were examined.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar or improved adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type below

Keswick Dam, and higher long-term average monthly and average monthly flows by water year type more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; (2) higher monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista, and lower monthly flow exceedance probabilities below Keswick Dam; (3) during low flow conditions, higher monthly flow exceedance probabilities more often at all locations evaluated; and (4) lower monthly probabilities of exceeding specified water temperature index values during June, September and October, and equivalent or higher probabilities of exceeding specified water temperature index values during April and May.

- Similar spawning conditions because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type below Keswick Dam and Red Bluff Diversion Dam, and higher and lower long-term average monthly and average monthly flows by water year type with similar monthly frequencies at Wilkins Slough; (2) lower or equivalent monthly flow exceedance probabilities more often below Keswick Dam and Red Bluff Diversion Dam, but higher monthly flow exceedance probabilities more often at Wilkins Slough; (3) during low flow conditions, equivalent or slightly higher monthly flow exceedance probabilities below Keswick Dam, lower flow exceedance probabilities more often below Red Bluff Diversion Dam and higher flow exceedance probabilities more often at Wilkins Slough; and (4) equivalent monthly probabilities of exceeding the specified water temperature index value.
- Similar egg incubation conditions because of modeling results indicating equivalent probabilities of exceeding the specified water temperature index value below Keswick Dam and Red Bluff Diversion Dam, and SacEFT results indicating reduced water temperatures more often near Hamilton City and potentially increased survival.
- Similar or improved juvenile rearing and outmigration conditions due to modeling results indicating: (1) lower long-term average monthly flows and average monthly flows by water year type more often below Red Bluff Diversion Dam, and higher average monthly flows and average monthly flows by water year type during June through November, and lower average monthly flows during December through May below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; (2) lower monthly flow exceedance probabilities more often below Red Bluff Diversion Dam and higher monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; (3) under low flow conditions, higher monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista, and lower monthly flow exceedance probabilities below Red Bluff Diversion Dam; and (4) equivalent or lower, and therefore more suitable, monthly probabilities of exceeding specified water temperature index values at all locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Sacramento River, Alternative C would result in similar or beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

White Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River at Hamilton City, below the proposed Delevan Pipeline Intake Facilities, Wilkins Slough, Knights Landing, below the Feather River confluence, Freeport and Rio Vista.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) lower or similar long-term average monthly and average monthly flows by water year type during most of the evaluation period; (2) lower monthly flow exceedance probabilities more often; (3) during low flow conditions, lower flow exceedance probabilities more often at Hamilton City and higher monthly flow exceedance probabilities occurring more often below the proposed Delevan Pipeline Intake Facilities and at Rio Vista; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.
- Less suitable spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows; (2) lower monthly flow exceedance probabilities more often; (3) during low flow conditions, lower flow exceedance probabilities more often at Hamilton City, equivalent or lower flow exceedance probabilities below the proposed Delevan Pipeline Intake Facilities, and equivalent or higher and lower flow exceedance probabilities at Verona; and (4) equivalent or higher probabilities of exceeding specified water temperature index values, and therefore less suitable water temperatures during April and May.
- More suitable juvenile rearing and outmigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows, but with higher average monthly flows during drier water year types; (2) higher monthly flow exceedance probabilities more often; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent or lower monthly probabilities of exceeding specified water temperature index values, and therefore more suitable water temperature conditions, particularly during June through September.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

River Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly flows by water year type occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; and (3) during low flow conditions, higher flow exceedance probabilities occurring more often at all locations evaluated.
- Similar spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows more often; (2) lower monthly flow exceedance probabilities more often; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities below Keswick Dam and below the proposed Delevan Pipeline Intake Facilities, and lower monthly flow exceedance probabilities below Red Bluff Diversion Dam; and

(4) higher probabilities of occurring within specified water temperature ranges during most months, and therefore more suitable water temperatures.

- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below Keswick Dam, and higher monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities and at Freeport; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values, but with lower probabilities of exceeding 72°F during July and August.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) lower long-term average and average monthly by water year type flows more often; (2) lower monthly flow exceedance probabilities more often; and (3) during low flow conditions, higher or similar flow exceedance probabilities.
- Similar spawning and egg incubation conditions, because of modeling results indicating: (1) lower long-term average and average monthly by water year type flows more often; (2) lower monthly flow exceedance probabilities more often; (3) during low flow conditions, higher or similar flow exceedance probabilities below Keswick Dam and the proposed Delevan Pipeline Intake Facilities, and lower flow exceedance probabilities more often below Red Bluff Diversion Dam; and (4) higher probabilities of water temperatures occurring within the specified water temperature range during most months, and therefore more suitable water temperatures.
- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities with similar monthly frequencies below Keswick Dam, and higher monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities and at Freeport; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values, but with lower probabilities of exceeding 72°F during July and August at Freeport.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Hardhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult and other life stage conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below Keswick Dam, and higher monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities and at Freeport; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) lower probabilities of water temperatures occurring within the specified range slightly more often, and therefore, potentially less suitable water temperatures.
- Similar spawning conditions, because of modeling results indicating: (1) similar or slightly higher or lower long-term average and average by water year type monthly flows below the proposed Delevan Pipeline Intake Facilities and at Freeport, and lower average monthly flows below Keswick Dam more often; (2) lower monthly flow exceedance probabilities more often below Keswick Dam, similar monthly flow exceedance probabilities below the proposed Delevan Pipeline Intake Facilities, and equivalent monthly flow exceedance probabilities at Freeport; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities; and (4) higher probabilities of water temperatures occurring within the specified water temperature range during April through June below the proposed Delevan Pipeline Intake Facilities, and slightly lower probabilities of water temperatures occurring within the specified range during April at Freeport.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

California Roach

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities and at Freeport.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar or improved adult and other life stage conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average by water year type monthly flows occurring with similar frequencies during most water years; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below Keswick Dam, and higher monthly flow exceedance probabilities more often below the proposed Delevan Pipeline Intake Facilities and at Freeport; (3) under low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent probabilities of water temperatures occurring within the specified range.
- Similar spawning conditions, because of modeling results indicating: (1) lower long-term average and average by water year type monthly flows more often; (2) lower monthly flow exceedance probabilities more often; (3) during low flow conditions, equivalent or higher monthly flow

exceedance probabilities below Keswick Dam, higher and lower flow exceedance probabilities with the same monthly frequency below the proposed Delevan Pipeline Intake Facilities, and equivalent flow exceedance probabilities at Freeport; and (4) similar probabilities of exceeding the specified water temperature index value, but a higher probability of exceedance during April below the proposed Delevan Pipeline Intake Facilities, and therefore slightly more suitable water temperatures (California roach initiate spawning at water temperatures of approximately 60°F or higher).

In conclusion, in consideration of potential impacts to all life stages of California roach in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Sacramento Splittail

Evaluation of water temperatures (Appendix 12E) for splittail in the Sacramento River (i.e., 45-75° F) indicate that water temperature conditions would be essentially equivalent or similar under Alternative C relative to the No Project/No Action Alternative, resulting in a less than significant impact.

American Shad

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Red Bluff Diversion Dam, below the proposed Delevan Pipeline Intake Facilities, below the Feather River Confluence (Verona) and at Freeport.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult spawning and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type more often below Red Bluff Diversion Dam, and similar or slightly higher or lower long-term average and average by water year type monthly flows at Verona and Freeport; (2) lower or equivalent monthly flow exceedance probabilities more often; (3) during low flow conditions, lower flow exceedance probabilities below Red Bluff Diversion Dam and equivalent or slightly higher flow exceedance probabilities at Verona and Freeport; and (4) similar but slightly higher probabilities of water temperatures occurring within the specified water temperature range below the Feather River Confluence and at Freeport, and slightly lower probabilities of water temperatures occurring within the specified range below Red Bluff Diversion Dam.
- Similar or improved larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) higher long-term average and average by water year type monthly flows more often; (2) higher monthly flow exceedance probabilities more often; (3) during low flow conditions, higher monthly flow exceedance probabilities; and (4) similar or lower probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of American shad in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Striped Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below the proposed Delevan Pipeline Intake Facilities and below the Feather River confluence (Verona).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult spawning and other life stage conditions, because of modeling results indicating: (1) similar or slightly higher or lower long-term average monthly and average monthly flows by water year type; (2) lower monthly flow exceedance probabilities more often during April and May, but higher flow exceedance probabilities during June; (3) during low flow conditions, equivalent or higher flow exceedance probabilities; and (4) slightly higher probabilities of water temperatures occurring within the specified water temperature range.
- Similar or improved larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) higher and lower long-term average and average by water year type monthly flows with similar monthly frequencies; (2) higher monthly flow exceedance probabilities more often; (3) during low flow conditions, higher monthly flow exceedance probabilities more often; and (4) higher probabilities of water temperatures occurring within the specified water temperature range more often.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Largemouth Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Sacramento River below Keswick Dam, below the proposed Delevan Pipeline Intake Facilities, and Freeport.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Equivalent or improved adult and other life stage conditions, because of modeling results indicating: (1) lower and higher long-term average monthly flows occurring with similar monthly frequencies below the proposed Delevan Pipeline Intake Facilities and at Freeport, with lower long-term average monthly flows below Keswick Dam, and lower and higher average monthly flows by water year type occurring with similar monthly frequencies below the proposed Delevan Pipeline Intake Facilities and at Freeport, lower monthly flows during dry and critical water years, and generally higher average monthly flows during wet and below normal water years below Keswick Dam; (2) lower monthly flow exceedance probabilities during most months of the evaluation period below Keswick Dam, and higher monthly flow exceedance probabilities occurring most months of the evaluation period below proposed Delevan Pipeline Intake Facilities and at Freeport; and (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated.
- Similar spawning conditions, because of modeling results indicating similar monthly probabilities of water temperatures occurring within the specified water temperature range at all locations evaluated.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the Sacramento River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Clear Creek

Potential impacts to fisheries and aquatic resources in Clear Creek under Alternative C relative to the No Project/No Action Alternative would be similar to those discussed under Alternative A relative to the No Project/No Action Alternative, above.

Lake Oroville

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Lake Oroville during April through November.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Equivalent or improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage during most of the evaluation period, and higher average monthly storage by water year type during most water years of the evaluation period; (2) equivalent or higher monthly storage exceedance probabilities during all months of the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during most months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Lake Oroville, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Lake Oroville during March through June.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar warmwater fish spawning and early life stage conditions, because of slightly decreased and increased frequencies of monthly water surface elevation reductions of six feet or more during the March through June evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Lake Oroville, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Feather River

Flows in the Low Flow Channel below the Fish Barrier Dam were modeled consistent with the terms of the FERC Settlement Agreement. As shown in Appendix 12F, modeled results for long-term average flows, average flows by water year type, and flow exceedance probabilities of 10 percent or more during all years and during low flow conditions were equivalent for Alternative C, relative to the No Project/No Action Alternative. Although these results are not repeated for the discussions below, the model results for the Low Flow Channel below the Fish Barrier Dam were considered along with the information presented below and are incorporated into the impact determinations for the following species: spring-run Chinook salmon, fall-run Chinook salmon, steelhead, green sturgeon, white sturgeon, river lamprey, Pacific lamprey, hardhead, and California roach.

Spring-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N) and early life stage mortality.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; and (4) similar monthly probabilities of exceeding specified water temperature index values.
- Similar or improved spawning conditions due to modeling results indicating higher spawning habitat availability during October and December, lower spawning habitat availability during September, and slightly lower spawning habitat availability during November, and equivalent or lower probabilities of exceeding specified water temperature index values.
- Less suitable embryo incubation conditions due to modeling results indicating reduced total average early life stage mortality during critical water years and increased total early life stage mortality during wet, above normal, below normal and dry water years, and equivalent or lower probabilities of exceeding specified water temperature index values.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) under low flow conditions, higher and lower flow exceedance probabilities occurring with similar monthly frequencies; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values during most of the evaluation period.
- Similar or less suitable smolt emigration conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly by water year type flows during most of the evaluation period; (2) lower monthly flow exceedance probabilities occurring more often; (3) during low flow conditions, similar or lower monthly flow exceedance probabilities more often; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in the Feather River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N) and early life stage mortality (Appendix 12J).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) higher and lower long-term average monthly flows and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below the Thermalito Afterbay, and higher flow exceedance probabilities occurring more often at the mouth of the Feather River; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.
- Improved spawning conditions due to modeling results indicating higher spawning habitat availability during most of the adult spawning period, and equivalent or slightly lower probabilities of exceeding specified water temperature index values.
- Less suitable embryo incubation conditions due to modeling results indicating reduced total average early life stage mortality during critical water years and increased total early life stage mortality during wet, above normal, below normal and dry water years, and equivalent or slightly lower probabilities of exceeding specified water temperature index values.
- Similar or less suitable juvenile rearing and outmigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) lower monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay outlet and similar flow exceedance probabilities at the mouth of the Feather River, but with lower flower exceedance probabilities during December; (3) under low flow conditions, lower monthly flow exceedance probabilities occurring more often; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in the Feather River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Steelhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River in addition to model results for spawning habitat availability (WUA) (Appendix 12N).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly by water year type flows occurring more often; (2) lower monthly flow exceedance probabilities occurring more often, but with higher flow exceedance probabilities during February, March, August and September; (3) during low flow conditions, lower monthly flow exceedance probabilities occurring more often, but with higher flow exceedance probabilities during August and September; and (4) equivalent or slightly lower monthly probabilities of exceeding specified water temperature index values.

- Similar or more suitable spawning conditions due to modeling results indicating higher monthly spawning habitat availability during most of the adult spawning period, but with lower spawning habitat availability during February and March, and higher and lower probabilities of exceeding specified water temperature index values with similar monthly frequencies.
- Similar embryo incubation conditions due to modeling results indicating: (1) lower long-term average monthly and average monthly by water year type flows occurring more often; (2) lower monthly flow exceedance probabilities occurring more often; (3) during low flow conditions, lower monthly flow exceedance probabilities occurring more often; and (4) equivalent or slightly lower monthly probabilities of exceeding specified water temperature index values occurring more often.
- Similar juvenile rearing and outmigration conditions due to modeling results indicating: (1) similar or slightly lower long-term average monthly flows occurring more often during the evaluation period below the Thermalito Afterbay outlet, and higher and lower average monthly flows occurring with similar monthly frequencies during most water years, but with lower flows occurring more often during dry water years; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) under low flow conditions, higher and lower flow exceedance probabilities occurring with similar monthly frequencies; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values during most of the evaluation period.
- Similar smolt emigration conditions due to modeling results indicating: (1) lower long-term average monthly and average monthly by water year type flows occurring more often; (2) lower monthly flow exceedance probabilities occurring more often; (3) under low flow conditions, lower monthly flow exceedance probabilities occurring more often; and (4) equivalent or slightly lower monthly probabilities of exceeding specified water temperature index values during most months, but with less suitable water temperatures during October.

In conclusion, in consideration of potential impacts to all life stages of steelhead in the Feather River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Green Sturgeon

Flow model results (Appendix 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, at Shanghai Bend, and at the mouth of the Feather River. Water temperature results (Appendix 12E) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies, but with lower mean monthly flows more often during dry water years; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.

- Similar adult spawning and embryo incubation conditions because of modeling results indicating: (1) similar or slightly higher long-term average monthly and average monthly by water year type flows; (2) higher and lower flow exceedance probabilities occurring with similar monthly frequencies; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring more often; and (4) higher and lower monthly probabilities of exceeding specified water temperature index values occurring with similar monthly frequencies.
- Similar juvenile rearing conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) under low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; and (4) similar monthly probabilities of exceeding specified water temperature index values.
- Similar or improved juvenile emigration conditions due to modeling results indicating: (1) higher long-term average monthly and average monthly by water year type flows occurring more often; (2) higher monthly flow exceedance probabilities during most months; (3) under low flow conditions, higher monthly flow exceedance probabilities during most months; and (4) similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in the Feather River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

White Sturgeon

Flow model results (Appendix 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, at Shanghai Bend, and at the mouth of the Feather River. Water temperature results (Appendix 12E) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult immigration and holding conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly by water year type flows occurring more often; (2) similar or lower monthly flow exceedance probabilities occurring more often; (3) during low flow conditions, lower monthly flow exceedance probabilities occurring more often; and (4) equivalent monthly probabilities of exceeding specified water temperature index values.
- Similar or less suitable adult spawning and embryo incubation conditions because of modeling results indicating: (1) similar long-term average monthly and average monthly by water year type flows, but with lower flows during dry and critical water years; (2) similar flow exceedance probabilities; (3) during low flow conditions, lower monthly flow exceedance probabilities occurring more often; and (4) equivalent or similar monthly probabilities of exceeding specified water temperature index values.
- Similar juvenile rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) under low flow conditions, higher and lower monthly flow

exceedance probabilities occurring with similar monthly frequencies; and (4) similar monthly probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of white sturgeon in the Sacramento River, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

River Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar or less suitable adult immigration conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly flows by water year type occurring more often; (2) lower monthly flow exceedance probabilities occurring more often; and (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies.
- Similar or less suitable spawning and egg incubation conditions, because of modeling results indicating: (1) higher long-term average monthly and average monthly by water year type flows occurring more often; (2) higher monthly flow exceedance probabilities occurring more often; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring more often below the Thermalito Afterbay and lower monthly flow exceedance probabilities occurring more often at the mouth of the Feather River; and (4) equivalent or lower probabilities of water temperatures occurring within the specified water temperature range.
- Similar ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies ; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; and (4) similar probabilities of exceeding specified water temperatures.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in the Feather River, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult immigration conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly flows by water year type occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; and (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies.

- Similar or less suitable spawning and egg incubation conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) during low flow conditions, higher monthly flow exceedance probabilities occurring more often; and (4) equivalent or lower probabilities of water temperatures occurring within the specified water temperature range.
- Similar ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below the Thermalito Afterbay outlet and similar or higher flow exceedance probabilities at the mouth of the Feather River; (3) during low flow conditions, higher monthly flow exceedance probabilities more often; and (4) equivalent or similar probabilities of water temperatures exceeding the specified water temperature index value.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in the Feather River, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Hardhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult and juvenile life stage conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; and (4) similar probabilities of water temperatures occurring within the specified water temperature range.
- Similar or less suitable adult spawning conditions, because of modeling results indicating: (1) lower long-term average monthly and average monthly by water year type flows during April and May and higher long-term average monthly and average monthly by water year type flows during June; (2) lower monthly flow exceedance probabilities flows during April and May and higher monthly flow exceedance probabilities during June; (3) during low flow conditions, lower monthly flow exceedance probabilities more often; and (4) similar or slightly lower probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of hardhead in the Feather River, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

California Roach

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay outlet, and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult and juvenile life stage conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; and (4) equivalent probabilities of exceeding specified water temperatures.
- Similar adult spawning conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies below the Thermalito Afterbay and lower flow exceedance probabilities more often at the mouth of the Feather River; and (4) similar probabilities of exceeding the specified water temperature index value.

In conclusion, in consideration of potential impacts to all life stages of roach in the Feather River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Splittail

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar spawning conditions, because of modeling results indicating: (1) similar or slightly higher or lower long-term average monthly and average monthly by water year type flows, but with lower flows during dry water years; (2) similar monthly flow exceedance probabilities; (3) during low flow conditions, lower monthly flow exceedance probabilities occurring during April and May and a higher flow exceedance probability during March; (4) similar changes in usable flooded area (UFA) exceedance probabilities of 10 percent or more; and (5) equivalent monthly probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of splittail in the Feather River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Striped Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River below the Thermalito Afterbay outlet and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Less suitable adult spawning and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly flows during April and May and higher long-term average monthly and average monthly by water year type flows during June; (2) lower monthly flow exceedance probabilities flows during April and May and higher monthly flow exceedance probabilities during June; (3) during low flow conditions, lower monthly flow exceedance probabilities more often; and (4) similar monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar larvae, fry, and juvenile rearing emigration conditions, because of modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; (3) during low flow conditions, higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; and (4) similar probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the Feather River, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

American Shad

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River below the Thermalito Afterbay outlet and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Less suitable adult spawning and other life stage conditions, because of modeling results indicating: (1) lower long-term average monthly flows during April and May and higher long-term average monthly and average monthly by water year type flows during June; (2) lower monthly flow exceedance probabilities flows during April and May and higher monthly flow exceedance probabilities during June; (3) during low flow conditions, lower monthly flow exceedance probabilities more often; and (4) similar monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar larvae, fry, and juvenile emigration conditions, because of modeling results indicating: (1) higher and lower long-term average and average monthly flows by water year type occurring with similar monthly frequencies; (2) higher monthly flow exceedance probabilities occurring during June through September and lower monthly flow exceedance probabilities occurring during October and November; (3) during low flow conditions, similar or higher monthly flow exceedance probabilities occurring during June through September and similar or lower monthly flow exceedance probabilities occurring during October and November; and (4) similar or lower probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of American shad in the Feather River, Alternative C would result in similar or less suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Largemouth Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the Feather River below Thermalito Afterbay Outlet and at the mouth of the Feather River.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult and other life stage conditions due to modeling results indicating: (1) higher and lower long-term average monthly and average monthly by water year type flows occurring with similar monthly frequencies; (2) higher and lower monthly flow exceedance probabilities occurring with similar monthly frequencies; and (3) during low flow conditions, higher and lower monthly flow exceedance probabilities with similar monthly frequencies.
- Similar spawning conditions, because of similar monthly probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of largemouth bass in the Feather River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Sutter Bypass

Potential impacts to fisheries and aquatic resources in the Sutter Bypass under Alternative A relative to the No Project/No Action Alternative would be similar to those discussed under Alternative A relative to Existing Conditions, above.

Folsom Lake

Coldwater Fish Species

Reservoir storage model results (Appendix 12H) were examined for Folsom Lake during April through November.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Equivalent or improved coldwater pool storage conditions, because of modeling results indicating: (1) higher long-term average monthly storage occurring during most of the evaluation period, and higher average monthly storage by water year type during most water years of the evaluation period; (2) equivalent or higher monthly storage exceedance probabilities during all months the evaluation period; and (3) a net 10 percent or more monthly storage exceedance increase during all months of the evaluation period.

In conclusion, in consideration of potential impacts to coldwater fish species in Folsom Lake, the Alternative C would result in potentially beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Warmwater Fish Species

Reservoir water surface elevation model results (Appendix 12H) were examined for Folsom Lake during March through June.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar warmwater fish spawning and early life stage conditions, because of modeling results indicating slightly decreased and increased frequencies of monthly water surface elevation reductions of six feet or more occurring during the March through June evaluation period.

In conclusion, in consideration of potential impacts to warmwater fish species in Folsom Lake, Alternative C would result in similar less-than-significant impacts, relative to the No Project/No Action Alternative.

American River

Fall-run Chinook Salmon

Flow and water temperature model results (Appendix 12H) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River, in addition to model results for spawning habitat availability (WUA) (Appendix 12N) at Sailor Bar through Rossmoor and early life stage mortality (Appendix 12J).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar or improved adult immigration and holding conditions due to modeling results indicating: (1) higher long-term average monthly flows during most months of the evaluation period, and higher average monthly flows by water year type during most water year types at the locations evaluated in the American River; (2) higher monthly flow exceedance probabilities during the evaluation period at all locations evaluated; (3) during low flow conditions, higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated, except for during October, when probabilities of exceedance would be equivalent or slightly lower; and (4) equivalent or slightly lower monthly probabilities of exceeding specified water temperature index values, although slightly higher probabilities of exceedance would occur during November.
- Improved adult spawning conditions due to modeling results indicating higher spawning habitat availability during the evaluation period, and similar or slightly lower monthly probabilities of exceeding specified water temperature index values, although slightly higher probabilities of exceedance would occur during November.
- Similar embryo incubation conditions due to modeling results indicating slightly higher total annual early life stage mortality, and similar or slightly lower monthly probabilities of exceeding specified water temperature index values, although slightly higher probabilities of exceedance would occur during November and March.
- Similar juvenile rearing and emigration conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50 percent of the time) across all water year types at all locations evaluated in the American River; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although slightly lower probabilities of exceedance would occur during June; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities during most months, with significantly higher probabilities of exceedance during May and June; and (4) similar or slightly

higher probabilities of exceeding specified water temperature index values, although slightly lower probabilities of exceedance would occur during May.

In conclusion, in consideration of potential impacts to all life stages of fall-run Chinook salmon in American River, Alternative C would result in beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Spring-run Chinook Salmon

Flow and water temperature model results (Appendix 12E and 12F) were examined at the mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar or improved non-natal juvenile rearing conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type; (2) higher monthly flow exceedance probabilities during the entire evaluation period; (3) during low flow conditions, equivalent or higher flow exceedance probabilities during the evaluation period; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values throughout the evaluation period.

In conclusion, in consideration of potential impacts to all life stages of spring-run Chinook salmon in American River, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Steelhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River, in addition to model results for spawning habitat availability (WUA) (Appendix 12N) at Sailor Bar through Rossmoor.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult immigration and holding conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during most water year types at all locations evaluated in the American River; (2) higher monthly flow exceedance probabilities during most months of the evaluation period at all locations evaluated; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values.
- Similar or improved spawning conditions due to modeling results indicating improved spawning habitat availability during January, February, and April, and similar or slightly higher monthly probabilities of exceeding specified water temperature index values.
- Similar embryo incubation conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during most water year types; (2) higher monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities; and (4) similar or slightly higher monthly probabilities of exceeding specified water temperature index values.

- Similar or more suitable juvenile rearing and emigration conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50% of the time) across all water year types at all locations evaluated in the American River; (2) higher monthly flow exceedance probabilities during most months of the evaluation period, although lower probabilities of exceedance would occur during June and July at all evaluated locations; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities, with substantially higher probabilities of exceedance during May through September at all evaluated locations, although equivalent or slightly lower probabilities of exceedance would occur during October and March; and (4) similar probabilities of exceeding specified water temperature index values.
- Similar or more suitable smolt emigration conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50% of the time) across all water year types at all locations evaluated in the American River; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during June at all evaluated locations; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities, with substantially higher probabilities of exceedance during May and June at all evaluated locations; and (4) similar probabilities of exceeding specified water temperature index values during most of the evaluation period, with slightly higher probabilities of exceedance during February and March.

In conclusion, in consideration of potential impacts to all life stages of steelhead in American River, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Green Sturgeon

Flow and water temperature model results (Appendix 12E and 12F) were examined at the mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar or improved adult immigration and holding conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50% of the time) across all water year types; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during June and July; (3) during low flow conditions, similar or higher monthly flow exceedance probabilities, with substantially higher probabilities of exceedance during May, August, and September; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values.
- Similar spawning and egg incubation conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50% of the time) across all water year types; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would

occur during June and July; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities during all months of the evaluation period; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values, particularly during June through August.

- Similar or more suitable juvenile rearing and emigration conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50% of the time) across all water year types; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during June and July; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities, with substantially higher probabilities of exceedance during May through September at all evaluated locations, although equivalent or slightly lower probabilities of exceedance would occur during October and March; and (4) similar or slightly higher probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of green sturgeon in American River, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

River Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Improved adult immigration conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50% of the time) across all water year types at all evaluated locations; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during June; and (3) during low flow conditions, higher monthly flow exceedance probabilities, with substantially higher probabilities of exceedance during May and September, although equivalent or slightly lower probabilities of exceedance would occur during October and March.
- Similar or improved spawning and egg incubation conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50% of the time) across all water year types at all evaluated locations; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during June and July; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities, with substantially higher probabilities of exceedance during May; and (4) similar or slightly higher monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring

approximately 50% of the time) across all water year types at all locations evaluated in the American River; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during June and July; (3) during low flow conditions, higher monthly flow exceedance probabilities, with substantially higher probabilities of exceedance during May and September, although equivalent or slightly lower probabilities of exceedance would occur during October and March; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of river lamprey in American River, Alternative C would result in potentially beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Pacific Lamprey

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam, Watt Avenue, and mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar or improved adult immigration conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50% of the time) across all water year types at all evaluated locations; (2) equivalent or higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during June; and (3) during low flow conditions, higher monthly flow exceedance probabilities, with substantially higher probabilities of exceedance during May, although equivalent probabilities of exceedance would occur during March.
- Similar or improved spawning and egg incubation conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50% of the time) across all water year types at all locations evaluated in the American River; (2) equivalent or higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during June and July; (3) during low flow conditions, higher monthly flow exceedance probabilities, with substantially higher probabilities of exceedance during May, although equivalent probabilities of exceedance would occur during March; and (4) similar or slightly higher monthly probabilities of water temperatures occurring within the specified water temperature range.
- Similar or improved ammocoete rearing and emigration conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50% of the time) across all water year types at all locations evaluated in the American River; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during June and July; (3) during low flow conditions, higher monthly flow exceedance probabilities, with substantially higher probabilities of exceedance during May and September, although equivalent or slightly lower probabilities of exceedance would occur during October and March; and (4) similar or slightly lower probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of Pacific lamprey in American River, Alternative C would result in beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Hardhead

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar or improved adult and other life stage conditions due to modeling results indicating: (1) higher long-term average monthly flows the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50% of the time) across all water year types; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during June and July; (3) during low flow conditions, higher monthly flow exceedance probabilities, with substantially higher probabilities of exceedance during May through September, although equivalent or slightly lower probabilities of exceedance would occur during October and March; and (4) similar or slightly higher probabilities of remaining within specified water temperature ranges.
- Similar or improved spawning conditions due to modeling results indicating: (1) lower long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50% of the time) across all water year types; (2) higher monthly flow exceedance probabilities during April and May, and lower probabilities or exceedance during June; (3) during low flow conditions, substantially higher monthly flow exceedance probabilities during the entire evaluation period; and (4) similar or slightly higher probabilities of remaining within specified water temperature ranges.

In conclusion, in consideration of potential impacts to all life stages of hardhead in American River, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

California Roach

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult and other life stage conditions due to modeling results indicating: (1) higher long-term average monthly flows the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50% of the time) across all water year types; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during June and July; (3) during low flow conditions, higher monthly flow exceedance probabilities, with substantially higher probabilities of exceedance during May through September, although equivalent probabilities of exceedance would occur during October and March; and (4) equivalent probabilities of exceeding specified water temperature index values.

- Similar or improved spawning conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50% of the time) across all water year types; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during June; (3) during low flow conditions, equivalent or lower monthly flow exceedance probabilities, with substantially lower probabilities of exceedance during May; and (4) equivalent or slightly lower probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of California roach in American River, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Splittail

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at the mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar spawning conditions due to: (1) lower long-term average monthly flows during the evaluation period, and similar or slightly higher average monthly flows by water year type across all water year types, although lower flows would occur within the evaluation period; (2) higher monthly flow exceedance probabilities during the evaluation period; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities during the evaluation period, with substantially higher probabilities of exceedance during May; (4) similar or slightly lower usable flooded area (UFA) exceedance probabilities of 10 percent or more; and (5) equivalent probabilities of exceeding specified water temperature index values.

In conclusion, in consideration of potential impacts to all life stages of splittail in the American River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Striped Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Nimbus Dam and the mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar or more suitable adult spawning, embryo incubation, and initial rearing conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50 percent of the time) across all water year types; (2) higher monthly flow exceedance probabilities during April and May, and lower probabilities or exceedance during June; (3) during low flow conditions, substantially higher monthly flow exceedance probabilities during the entire evaluation period; and (4) similar or slightly lower probabilities of remaining within the specified water temperature range during the evaluation period.
- Similar larvae, fry, and juvenile rearing and emigration conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly

flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50% of the time) across all water year types; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during June and July; (3) during low flow conditions, equivalent or higher monthly flow exceedance probabilities, with substantially higher probabilities of exceedance during May through September, although equivalent or slightly lower probabilities of exceedance would occur during October and March; and (4) similar or slightly higher probabilities of remaining within the specified water temperature range throughout the year, with a slightly lower probability of the temperatures occurring within the specified range during October and April.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the American River, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

American Shad

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue and the mouth of the American River.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar or more suitable adult spawning, embryo incubation, and initial rearing conditions due to modeling results indicating: (1) similar or slightly higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50% of the time) across all water year types; (2) higher monthly flow exceedance probabilities during April and May, and lower probabilities or exceedance during June; (3) during low flow conditions, substantially higher monthly flow exceedance probabilities during the entire evaluation period; and (4) similar or slightly lower probabilities of remaining within the specified water temperature range during the evaluation period, although slightly higher probabilities of remaining within the temperature range would occur during April.
- Similar larvae, fry, and juvenile rearing and emigration conditions due to modeling results indicating: (1) higher long-term average monthly flows during the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50 percent of the time) across all water year types; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during July; (3) during low flow conditions, higher monthly flow exceedance probabilities, with substantially higher probabilities of exceedance during August and September, although equivalent or slightly lower probabilities of exceedance would occur during October; and (4) equivalent or slightly higher monthly probabilities of water temperatures occurring within the specified water temperature range.

In conclusion, in consideration of potential impacts to all life stages of American shad in the American River, Alternative C would result in similar or more suitable and less-than-significant impacts, relative to the No Project/No Action Alternative.

Largemouth Bass

Flow and water temperature model results (Appendix 12E and 12F) were examined for the American River at Watt Avenue.

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult and other life stage conditions due to modeling results indicating: (1) higher long-term average monthly flows the evaluation period, and higher average monthly flows by water year type during approximately 50 percent of the time (with lower flows occurring approximately 50 percent of the time) across all water year types; (2) higher monthly flow exceedance probabilities during most of the evaluation period, although lower probabilities of exceedance would occur during June and July; and (3) during low flow conditions, higher monthly flow exceedance probabilities, with substantially higher probabilities of exceedance during May through September, although equivalent probabilities of exceedance would occur during October and March.
- Similar or slightly improved spawning conditions due to modeling results indicating equivalent or slightly higher probabilities of remaining within specified water temperature ranges.

In conclusion, in consideration of potential impacts to all life stages of striped bass in the American River, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Sacramento-San Joaquin Delta and Yolo Bypass

Delta Smelt in the Delta Region

Model results were examined for water temperatures (Appendix 12E) in the Sacramento River at Freeport, OMR flows (Appendix 12E), Delta outflow (Appendix 12E), salvage at the SWP and CVP export facilities (Appendix 12I), and X2 location (Appendix 12E).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult conditions, because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range (December through May); (2) similar overall normalized mean monthly salvage at the SWP and CVP export facilities (December through April); and (3) generally similar monthly probabilities of OMR flows being more negative than -5,000 cfs (December through February)
- Less suitable spawning conditions in the Yolo Bypass (December through May), because of modeling results indicating: (1) lower long-term average Yolo Bypass outflow; (2) lower flow exceedance probabilities during December through April; and (3) during low flow conditions, higher flow exceedance probabilities during January, and lower flow exceedance probabilities during December, February and March, albeit similar flows during low flow conditions.
- Similar egg and embryo conditions (February through May), because of modeling results indicating similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range
- Similar larvae conditions (March through June), because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range; (2) during March through June of dry and critical water years, slightly higher (less

negative) mean monthly OMR flows when flows would be equal to or more negative than -1,500 cfs; and (3) during the latter portion of the larval delta smelt downstream migration period (i.e., May and June), long-term average and average by water year type monthly Delta outflow would be slightly decreased during May but slightly increased during June, while monthly Delta outflow exceedance probabilities would be lower more often during May, but higher more often during June.

- Similar or improved juvenile conditions (May through July), because of modeling results indicating: (1) similar monthly probabilities of water temperatures at Freeport occurring within the specified water temperature range; (2) similar overall normalized mean monthly salvage at the SWP and CVP export facilities; (3) Between RKm 65 and 80, long-term average and average by water year type X2 location would move slightly upstream during May (by less than 0.5 RKm), move slightly downstream during June (by 0.6 RKm or less), and move downstream during July (by 1.3, 1.6 and 1.5 RKm during wet, above normal and below normal water years, respectively); and (4) lower Yolo Bypass outflow and potentially reduced productivity in the Delta.

In conclusion, in consideration of potential impacts to all life stages of delta smelt, Alternative C would result in similar or beneficial and less-than-significant impacts, relative to the No Project/No Action Alternative.

Longfin Smelt in the Delta Region

Model results were examined for OMR flows (Appendix 12E), salvage at the SWP and CVP export facilities (Appendix 12I), and X2 location (Appendix 12E).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar adult conditions because of modeling results indicating similar monthly probabilities of OMR flows being more negative than -5,000 cfs during December through March
- Similar larvae and juvenile conditions because of modeling results indicating: (1) similar monthly probabilities of OMR flows being more negative than -5,000 cfs during December through March; (2) during April and May of dry and critical water years, mean monthly OMR flows would be lower during April and May of critical water years (by 8.7 and 14.5%, respectively) and would be higher during April and May of dry water years (by 2.0 and 6.4%, respectively); (3) similar or slightly lower overall mean monthly salvage at the SWP and CVP export facilities; (4) slightly lower (during January through April), equivalent (during May) and slightly higher (during June) monthly exceedance probabilities of X2 location occurring at or downstream of 75 RKm during January through June; and (5) lower Yolo Bypass outflow and potentially reduced productivity in the Delta.

In conclusion, in consideration of potential impacts to all life stages of longfin smelt, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Splittail in the Delta Region

Model results were examined for Yolo Bypass outflow (Appendix 12E) and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Less suitable egg and larval conditions (February through May) because of modeling results indicating: (1) slightly reduced mean monthly Yolo Bypass outflow during most months of wet water years and reduced mean monthly flows during February through April of above normal and below normal water years, during February and March of dry water years and during March of critical water years, with mean monthly reductions of 10 percent or more during March and April of above normal water years, during February through April of below normal water years, and during March of dry and critical water years; and (2) lower flow exceedance probabilities (of 10% or more) more often during February through May

- Similar juvenile rearing and emigration conditions (April through July) because of modeling results indicating: (1) lower (during April) or similar mean monthly Yolo Bypass outflow during most water year types; (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; (3) lower (during April) or similar flow exceedance probabilities (of 10% or more); and (3) similar overall simulated mean monthly salvage at the SWP and CVP export facilities during April through July
- Less suitable adult spawning and upstream migration conditions, because of modeling results indicating: (1) reduced mean monthly Yolo Bypass outflow during February and March, as discussed above for egg and larval conditions; and (2) similar overall simulated mean monthly salvage at the SWP and CVP export facilities during December through March

In conclusion, in consideration of potential impacts to all life stages of splittail in the Delta Region including the Yolo Bypass, Alternative C would result in adverse and potentially significant impacts, relative to the No Project/No Action Alternative. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Winter-run Chinook Salmon in the Delta Region

Model results were examined for through-Delta juvenile survival (Appendix 12M).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar juvenile conditions, because of modeling results indicating: (1) slightly lower monthly Delta survival exceedance probabilities more often; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile winter-run Chinook salmon in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Spring-run Chinook Salmon in the Delta Region

Model results were examined for through-Delta juvenile survival (Appendix 12M).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar juvenile conditions, because of modeling results indicating: (1) slightly lower monthly Delta survival exceedance probabilities more often; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile spring-run Chinook salmon in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Fall-run and Late Fall-run Chinook Salmon in the Delta Region

Model results were examined for OMR flows (Appendix 12E) and through-Delta juvenile survival (Appendix 12M).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar San Joaquin River adult straying conditions because of modeling results indicating similar monthly probabilities of OMR flows being more negative than -5,000 cfs during December through February
- Similar juvenile conditions because of modeling results indicating: (1) slightly lower monthly Delta survival exceedance probabilities over most of the distribution; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to juvenile and San Joaquin River adult fall and late fall-run Chinook salmon in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Steelhead in the Delta Region

Model results were examined for Sacramento River flows (Appendix 12F) at Rio Vista, Yolo Bypass outflow (Appendix 12E), Delta outflow (Appendix 12E), OMR flows (Appendix 12E), and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar juvenile rearing and emigration conditions in the Delta (October through July) because of modeling results indicating: (1) higher long-term average and average by water year type monthly flows at Rio Vista during October, November, June and July, and lower average monthly flows during December through May; (2) higher monthly flow exceedance probabilities at Rio Vista during October, November, June and July, and lower flow exceedance probabilities during December through March, with higher flow exceedance probabilities during all months except for during March through May during low flow conditions; (3) lower or similar mean monthly Yolo Bypass outflow and lower or similar flow exceedance probabilities during most of the evaluation period; (4) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; (5) lower long-term average and average by water year type monthly Delta outflow during most months of most water year types, but with higher Delta outflow during June and July of all water year types, during October and November of below normal water years, during November of dry water years and during October and December of critical water years; (6) lower long-term average and average by water year type monthly OMR flows; and (7) similar overall simulated mean monthly salvage at the SWP export facility and slightly higher mean monthly salvage at the CVP export facility

In conclusion, in consideration of potential impacts to all life stages of Central Valley steelhead in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative. Alternative C impacts on steelhead in the Yolo Bypass are considered potentially significant, relative to the No Project/No Action Alternative. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Green Sturgeon in the Delta Region

Model results were examined for Yolo Bypass outflow (Appendix 12E) and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar or less suitable juvenile rearing and emigration conditions (year-round) because of modeling results indicating: (1) lower or similar mean monthly Yolo Bypass outflow and flow exceedance probabilities during most months; (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; and (3) similar simulated mean monthly salvage at the SWP and CVP export facilities

In conclusion, in consideration of potential impacts to green sturgeon in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative. Alternative C impacts on green sturgeon in the Yolo Bypass are considered potentially significant, relative to the No Project/No Action Alternative. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

White Sturgeon in the Delta Region

Model results were examined for Yolo Bypass outflow (Appendix 12E) and salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar juvenile rearing and emigration conditions (year-round) because of modeling results indicating: (1) lower or similar mean monthly Yolo Bypass outflow and flow exceedance probabilities; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta; (3) similar simulated mean monthly salvage at the SWP and CVP export facilities

In conclusion, in consideration of potential impacts to white sturgeon in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative. Alternative C impacts on white sturgeon in the Yolo Bypass are considered potentially significant, relative to the No Project/No Action Alternative. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Pacific and River Lamprey in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar macropthalmia emigration conditions (year-round) because of similar simulated mean monthly salvage at the SWP export facility, but with higher mean monthly salvage during critical water years, and slightly higher mean monthly salvage at the CVP export facility during most water years, but with higher salvage during critical water years

In conclusion, in consideration of potential impacts to Pacific and river lamprey in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

American Shad in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I) and X2 location (Appendix 12E).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar egg and larval conditions in the Delta because of modeling results indicating: (1) slightly lower (during April), equivalent (during May) and slightly higher (during June) exceedance probabilities of X2 location being located at or downstream of 75 Rkm during April through June; (2) slightly higher overall normalized mean monthly salvage at the SWP and CVP export facilities; and (3) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to American shad in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Striped Bass in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I) and X2 location (Appendix 12E).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Similar egg and larval conditions in the Delta because of modeling results indicating: (1) slight upstream mean monthly movements in X2 location during April and May of all water year types and slight downstream mean monthly movements in X2 location during June of all water year types during April through June; (2) similar or slightly higher overall normalized mean monthly salvage at the SWP and CVP export facilities; and (3) lower Yolo Bypass outflow and potentially reduced productivity in the Delta

In conclusion, in consideration of potential impacts to striped bass in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative.

Largemouth Bass in the Delta Region

Model results were examined for salvage at the SWP and CVP export facilities (Appendix 12I) and X2 location (Appendix 12E).

Relative to the No Project/No Action Alternative, Alternative C would generally be expected to provide:

- Less suitable juvenile rearing conditions in the Yolo Bypass because of modeling results indicating: (1) lower mean monthly Yolo Bypass outflow, in addition to lower flow exceedance probabilities; and (2) lower Yolo Bypass outflow and potentially reduced productivity in the Delta
- Similar juvenile and adult conditions in the Delta because of modeling results indicating: (1) upstream mean monthly movements in X2 location of 0.5 RKm or more during December and January of wet water years, during December through April of above normal water years, during January through April of below normal and below normal water years, during January through March

of critical water years, and downstream mean monthly movements in X2 location of 0.5 RKm or more during July and August of wet water years, during July through September of above normal water years, during June through December of below normal water years, during July through November of dry water years and during July through October of critical water years; and (2) similar overall simulated mean monthly salvage at the SWP and CVP export facilities

In conclusion, in consideration of potential impacts to largemouth bass in the Delta, Alternative C would result in similar and less-than-significant impacts, relative to the No Project/No Action Alternative. Alternative C impacts on largemouth bass in the Yolo Bypass are considered potentially significant, relative to the No Project/No Action Alternative. However, implementation of impact avoidance and mitigation measures (see Section 12.4 in Chapter 12 Aquatic Biological Resources) is anticipated to reduce these impacts to less than significant levels.

Suisun, San Pablo and San Francisco Bays

Fish species of primary management concern, including Chinook salmon, steelhead, river lamprey, Pacific lamprey, green sturgeon, white sturgeon, and splittail utilize the bays as a migration corridor and/or for juvenile rearing. Potential increases in Delta outflow during the summer and fall and reductions in Delta outflow during the spring would not result in substantial changes to migration or rearing habitat for these fish species in the bays. Striped bass and American shad also utilize the bays for migration and rearing, however, changes in X2 location were evaluated during the striped bass and American shad spawning and initial rearing period to evaluate potential changes in larval transport and rearing habitat in the Bay-Delta (see the Delta Region, above). Potential effects on delta smelt and longfin smelt migration and rearing in the Bay-Delta also were analyzed through evaluation of changes in X2 location (see the Delta Region, above).

12C.9.3 Primary Study Area – Alternative C Relative to the No Project/No Action Alternative

12C.9.3.1 Construction, Operation, and Maintenance Impacts

For a discussion of impacts to fisheries and aquatic resources under Alternative C relative to the No Project/No Action Alternative in the Primary Study Area, refer to the Environmental Consequences section of Chapter 12 Aquatic Biological Resources.

12C.10 References

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Appendix 12D
Water Temperature Index Value Selection Rationale

APPENDIX 12D
Water Temperature Index Value Selection Rationale

12D.1 Introduction

Water temperature is one of the most important environmental parameters affecting the distribution, growth, and survival of fish populations. Lethal water temperatures control fish populations by directly reducing population size, while sub-lethal water temperatures affect fish populations via indirect physiologic influences. Water temperatures may particularly regulate fish populations that are near their latitudinal distributional extremes, because environmental conditions (e.g., water temperature) at distributional extremes also may be near the boundaries of conditions that allow the populations to persist. For example, California's Central Valley is at the southern limit of Chinook salmon distribution, and studies have demonstrated that direct effects of high water temperatures are an important source of juvenile Chinook salmon mortality in the Central Valley (Baker et al., 1995).

Myrick and Cech (2001) suggested that the primary cause for declines in Central Valley salmon and steelhead populations is the extensive construction of dams on rivers and streams used by salmonids for spawning and freshwater rearing. Dam construction has restricted Central Valley salmonids to less than 80 percent of their historical spawning habitat (Moyle, 2002), and has altered the natural flow and water temperature regimes in the river sections that remain available to spawning and rearing salmonids.

Technical evaluation guidelines have been developed to assess potential impacts of water diversion and water use projects in a consistent and effective manner. In order to successfully evaluate the effects of water temperature regimes on a given salmonid life stage or the entire life cycle, it is necessary to gain a broad understanding of how salmonids respond to water temperature regimes. This appendix presents the results of a literature review that was conducted to: (1) interpret the available literature on the effects of water temperature on the various life stages of Chinook salmon and steelhead; (2) consider the effects of short-term and long-term exposure to constant or fluctuating temperatures; and (3) establish biologically defensible water temperature index values to be used as guidelines for impact assessment.

12D.2 Methodology

To the extent that literature describing thermal tolerances for each species was available, water temperature index values were established from a comprehensive literature review to reflect an evenly spaced range of water temperatures, from reported "optimal" to "lethal" water temperatures. Types of literature examined include scientific journals, Master's theses and Ph.D. dissertations, literature reviews, and agency publications. With respect to water temperature, the primary concern in the Central Valley relates to water temperatures that may exceed upper salmonid tolerance limits rather than lower limits; therefore, index values were only established for water temperatures at and above the warmer tolerance zone for salmonids. For non-salmonid and warmwater species, it was assumed that sufficient warmwater habitat is available in Central Valley water bodies such that impacts resulting from exposure to cold water likely would not occur (e.g., warmwater game fishes do not typically occur in the uppermost reaches of Central Valley rivers where cold water is released from terminal dams, but instead, tend to occur farther downstream where water temperatures are generally warmer).

In the 2001 USEPA document, *Summary of Technical Literature Examining the Physiological Effects of Temperature on Salmonids*, the case is made that there is not enough significant genetic variation among stocks or among species of salmonids to warrant geographically specific water temperature standards (Carter, 2008). However, because this DEIR/EIS focuses on issues in Central Valley watersheds where large bodies of literature are available for some species (e.g., Chinook salmon), water temperature index values were determined by placing emphasis on the results of laboratory experiments that examined how water temperature affects fishes in Central Valley watersheds being evaluated, as well as by considering field studies documenting habitat use and regulatory documents such as biological opinions from the National Marine Fisheries Service (NMFS). Studies on fish from outside the Central Valley were used to establish index values when local studies were unavailable. To avoid unwarranted specificity, only whole integers were selected as index values, thus support for index values was, in some cases, partially derived from literature supporting a water temperature that varied from the resultant index value by several tenths of a degree. For example, Combs and Burrows (1957) reported that constant incubation temperatures between 42.5 and 57.5°F resulted in normal development of Chinook salmon eggs, and their report was referenced as support for a water temperature index value of 58°F. Rounding for the purposes of selecting index values is appropriate because the daily variation of experimental treatment temperatures is often high. For example, temperature treatments in Marine (1997) consisted of control (55.4 to 60.8°F), intermediate (62.6 to 68.0°F), and extreme (69.8 to 75.2°F) treatments that varied daily by whole degrees.

Inspection of the available literature on the effects of water temperature on salmonids revealed the need to interpret each document with caution and to verify the appropriateness of statements supported by references to other literature. Often source studies are cited incorrectly, and sometimes repeatedly.

Most of the literature on salmonid water temperature requirements refers to “stressful,” “tolerable,” “preferred,” or “optimal” water temperatures or water temperature ranges. Spence et al. (1996) defined the tolerable water temperature range as the range at which fish can survive indefinitely. Thermal stress to fish is defined as any water temperature change that alters the biological functions of the fish and which decreases probability of survival (McCullough, 1999). Optimal water temperatures are defined as those that provide for feeding activity, normal physiological response, and behavior void of thermal stress symptoms (McCullough, 1999). Preferred water temperature ranges are defined as those that are most frequently selected by fish when allowed to freely choose locations along a thermal gradient (McCullough, 1999).

Finally, as a comparative tool, life stage-specific water temperature impact indicator values have been developed for the species evaluated in this DEIR/EIS to be used as evaluation guidelines, the basis of which are described herein. The water temperature index values are not meant to serve as significance thresholds, but instead serve as a mechanism by which to compare the proposed Project action alternatives (alternatives) to the baseline[1]. Thus, water temperature index values represent a gradation of potential effects, from reported optimal water temperatures increasing through the range of represented index values for each life stage. Differences in the frequency of exceeding a particular water temperature index value between an alternative and the baseline do not necessarily constitute an impact. Impact determinations are based on consideration of all evaluated impact indicators for all life stages for a particular species.

[1] For the purposes of comparison, the baseline includes both Existing Conditions and the No Project/No Action Alternative.

12D.3 Results

12D.3.1 Chinook Salmon

It has been suggested that separate water temperatures standards should be developed for each run-type of Chinook salmon. For example, McCullough (1999) states that spring-run Chinook salmon immigrate in spring and spawn in 3rd to 5th order streams and, therefore, face different migration and adult holding temperature regimes than do summer- or fall-run Chinook salmon, which spawn in streams of 5th order or greater. However, to meet the objectives of the current literature review, run-types were not separated because: (1) there is a paucity of literature specific to each life stage of each run-type; (2) there is an insufficient amount of data available in the literature suggesting that Chinook salmon run-types respond to water temperatures differently; (3) the water temperature index values derived from all the literature pertaining to Chinook salmon that provide suitable habitat conditions for a particular life stage will be sufficiently protective of that life stage for each run-type; and (4) all run-types overlap in timing of adult immigration, and holding and in some cases, are not easily distinguished (Healey, 1991).

12D.3.1.1 Adult Immigration and Holding

The adult immigration and adult holding life stages are evaluated together because it is difficult to determine the thermal regime to which Chinook salmon have been exposed in the river prior to spawning, and in order to be sufficiently protective of pre-spawning fish, water temperatures that provide high adult survival and high egg viability must be available throughout the entire pre-spawning freshwater period. Although studies examining the effects of thermal stress on immigrating Chinook salmon are generally lacking, it has been demonstrated that thermal stress during the upstream spawning migration of sockeye salmon negatively affected the secretion of hormones controlling sexual maturation, causing numerous reproductive impairment problems (McCullough et al., 2001).

The water temperature index values are evenly spaced across the range of conditions from those reported as “optimal” to those reported as “lethal” for adult Chinook salmon during upstream spawning migrations and holding. The water temperature index values established to evaluate the Chinook salmon adult immigration and holding life stage are 60, 64, and 68°F (Table 12D-1). Although 56°F is referenced in the literature frequently as the upper “optimal” water temperature limit for upstream migration and holding, the references are not foundational studies and often are inappropriate citations. Because 56°F is not strongly supported in the literature for adult Chinook salmon immigration and holding, it was not established as an index value.

The lowest water temperature index value established was 60°F because in the NMFS biological opinion for the proposed operation of the Central Valley Project (CVP) and State Water Project (SWP), 59°F to 60°F is reported as…”*The upper limit of the optimal temperature range for adults holding while eggs are maturing*” (NMFS, 2000). Also, NMFS (1997b) states…”*Generally, the maximum temperature of adults holding, while eggs are maturing, is about 59°F to 60°F*” …and… “*Acceptable range for adults migrating upstream range from 57°F to 67°F.*” The Oregon Department of Environmental Quality (ODEQ, 1995) reports that “*…many of the diseases that commonly affect Chinook become highly infectious and virulent above 60°F.*” Study summaries in USEPA (2003) indicate disease risk is high at 62.6°F. Additionally, Ward and Kier (1999) designated temperatures <60.8°F as an “optimum” water temperature threshold for holding Battle Creek spring-run Chinook salmon. USEPA (2003) chose a holding value of 61°F (7DADM[2]) based on laboratory data and various assumptions regarding diel temperature fluctuations. 61°F is also a holding temperature index value for steelhead (see above). The 60°F water temperature index value established for the Chinook salmon adult immigration and holding life stage is the index value generally reported in the literature as the upper limit of the optimal range, and is within the reported acceptable range. Increasing levels of thermal stress to this life stage may reportedly occur above the 60°F water temperature index value.

Table 12D-1
Chinook Salmon Adult Immigration and Holding Water Temperature Index Values and the Literature Supporting Each Value

Index Value	Supporting Literature
60°F*	Maximum water temperature for adults holding, while eggs are maturing, is approximately 59ºF to 60ºF (NMFS, 1997b). Acceptable water temperatures for adults migrating upstream range from 57ºF to 67ºF (NMFS, 1997b). Upper limit of the optimal water temperature range for adults holding while eggs are maturing is 59 to 60°F (NMFS, 2000). Many of the diseases that commonly affect Chinook salmon become highly infectious and virulent above 60ºF (ODEQ, 1995). Mature females subjected to prolonged exposure to water temperatures above 60°F have poor survival rates and produce less viable eggs than females exposed to lower water temperatures (USFWS, 1995).
64°F	Acceptable range for adults migrating upstream is from 57ºF to 67ºF (NMFS, 1997b). Disease risk becomes high at water temperatures above 64.4°F (USEPA, 2003). Latent embryonic mortalities and abnormalities associated with water temperature exposure to pre-spawning adults occur at 63.5 to 66.2°F (Berman, 1990).
68°F	Acceptable range for adults migrating upstream range from 57 to 67ºF (NMFS, 1997b). For chronic exposures, an incipient upper lethal water temperature limit for pre-spawning adult salmon probably falls within the range of 62.6 to 68.0°F (Marine, 1992). Spring-run Chinook salmon embryos from adults held at 63.5 to 66.2°F had greater numbers of pre-hatch mortalities and developmental abnormalities than embryos from adults held at 57.2 to 59.9°F (Berman, 1990). Water temperatures of 68°F resulted in nearly 100 percent mortality of Chinook salmon during Columnaris outbreaks (Ordal and Pacha, 1963).

*The 60°F water temperature index value established for the Chinook salmon adult immigration and holding life stage is the index value generally reported in the literature as the upper limit of the optimal range, and is within the reported acceptable range. Increasing levels of thermal stress to this life stage may reportedly occur above the 60°F water temperature index value.

An index value of 64°F was established because Berman (1990) suggests effects of thermal stress to pre-spawning adults are evident at water temperatures near 64°F. Berman (1990) conducted a laboratory study to determine if pre-spawning water temperatures experienced by adult Chinook salmon influenced reproductive success, and found evidence suggesting latent embryonic abnormalities associated with water temperature exposure to pre-spawning adults occurs at 63.5 to 66.2°F. Also, 64°F represents a mid-point value between the water temperature index values of 60 and 68°F. An index value of 68°F was established because the literature suggests that thermal stress at water temperatures greater than or equal to 68°F is pronounced, and severe adverse effects to immigrating and holding pre-spawning adults, including mortality, can be expected (Berman, 1990; Marine, 1992; NMFS, 1997b). Because significant impacts to immigrating and holding adult Chinook salmon reportedly occur at water temperatures greater than or equal to 68°F, index values higher than 68°F were not established.

12D.3.1.2 Spawning and Embryo Incubation

The adult spawning and embryo (i.e., eggs and alevins) incubation life stage includes redd construction, egg deposition, and embryo incubation. Potential effects to the adult spawning and embryo incubation life stages are evaluated together using one set of water temperature index values because it is difficult to

[2] 7DADM = seven day average of the daily maximum

separate the effects of water temperature between lifestages that are closely linked temporally, especially considering that studies describing how water temperature affects embryonic survival and development have included a pre-spawning or spawning adult component in the reporting of water temperature experiments conducted on fertilized eggs (Marine, 1992; McCullough, 1999; Seymour, 1956).

Water temperature index values were selected from a comprehensive literature review for Chinook salmon eggs during spawning and incubation (Table 12D-2). Relative to the large body of literature pertaining to water temperature effects on Chinook salmon embryos, few laboratory experiments specifically examine Chinook salmon embryo survival under different constant or fluctuating water temperature treatments (Combs and Burrows, 1957; Hinze, 1959; Johnson and Brice, 1953; Seymour, 1956; USFWS, 1999). In large part, supporting evidence for index value selections was derived from the aforementioned laboratory studies and from regulatory documents (NMFS, 1993; NMFS, 1997b; NMFS, 2002b). Field studies reporting river water temperatures during spawning also were considered (Dauble and Watson, 1997; Groves and Chandler, 1999).

Table 12D-2
Chinook Salmon Spawning and Embryo Incubation Water Temperature Index Values and the Literature Supporting Each Value

Index Value	Supporting Literature
56°F*	Less than 56°F results in a natural rate of mortality for fertilized Chinook salmon eggs (Reclamation Unpublished Work). Optimum water temperatures for egg development are between 43 and 56°F (NMFS, 1993). Upper value of the water temperature range (i.e., 41.0 to 56.0°F) suggested for maximum survival of eggs and yolk-sac larvae in the Central Valley of California (USFWS, 1995). Upper value of the range (i.e., 42.0 to 56.0°F) given for the preferred water temperature for Chinook salmon egg incubation in the Sacramento River (NMFS, 1997a). Incubation temperatures above 56°F result in significantly higher alevin mortality (USFWS, 1999). 56.0°F is the upper limit of suitable water temperatures for spring-run Chinook salmon spawning in the Sacramento River (NMFS, 2002b). Water temperatures averaged 56.5°F during the week of fall-run Chinook salmon spawning initiation on the Snake River (Groves and Chandler, 1999).
58°F	Upper value of the range given for preferred water temperatures (i.e., 53.0 to 58.0°F) for eggs and fry (NMFS, 2002b). Constant egg incubation temperatures between 42.5 and 57.5°F resulted in normal development (Combs and Burrows, 1957). The natural rate of mortality for alevins occurs at 58°F or less (Reclamation Unpublished Work).
60°F	100 percent mortality occurs during yolk-sac stage when embryos are incubated at 60°F (Seymour, 1956). An October 1 to October 31 water temperature criterion of less than or equal to 60°F in the Sacramento River from Keswick Dam to Bend Bridge has been determined for protection of late incubating larvae and newly emerged fry (NMFS, 1993). Mean weekly water temperature at first observed Chinook salmon spawning in the Columbia River was 59.5°F (Dauble and Watson, 1997). Consistently higher egg losses resulted at water temperatures above 60.0°F than at lower temperatures (Johnson and Brice, 1953).
62°F	100 percent mortality of fertilized Chinook salmon eggs after 12 days at 62°F (Reclamation Unpublished Work). Incubation temperatures of 62 to 64°F appear to be the physiological limit for embryo development resulting in 80 to 100 percent mortality prior to emergence (USFWS, 1999). 100 percent loss of eggs incubated at water temperatures above 62°F (Hinze, 1959). 100 percent mortality occurs during yolk-sac stage when embryos are incubated at 62.5°F (Seymour, 1956)

*The 56°F water temperature index value established for the Chinook salmon spawning and embryo incubation life stage is the index value generally reported in the literature as the upper limit of the optimal range for egg development and the upper limit of the range reported to provide maximum survival of eggs and yolk-sac larvae in the Central Valley of California. Increasing levels of thermal stress to this life stage may reportedly occur above the 56°F water temperature index value.

The water temperature index values selected to evaluate the Chinook salmon spawning and embryo incubation life stages are 56, 58, 60, and 62ºF. Some literature suggests that water temperatures must be less than or equal to 56°F for maximum survival of Chinook salmon embryos (i.e., eggs and alevins) during spawning and incubation. NMFS (1993) reported that optimum water temperatures for egg development are between 43 and 56°F. Similarly, Myrick and Cech (2001) reported the highest egg survival rates occur between water temperatures of 39 to 54°F. Reclamation (unpublished work) reports that water temperatures less than 56°F results in a natural rate of mortality for fertilized Chinook salmon eggs. Bell (1986) recommends water temperatures ranging between 42 to 57°F for spawning Chinook salmon, and water temperatures between 41 to 58°F for incubating embryos. USFWS (1995) reported a water temperature range of 41.0 to 56.0°F for maximum survival of eggs and yolk-sac larvae in the Central Valley of California. The preferred water temperature range for Chinook salmon egg incubation in the Sacramento River was suggested as 42.0 to 56.0°F (NMFS, 1997a). Alevin mortality is reportedly significantly higher when Chinook salmon embryos are incubated at water temperatures above 56°F (USFWS, 1999). NMFS (2002b) reported 56.0°F as the upper limit of suitable water temperatures for spring-run Chinook salmon spawning in the Sacramento River. The 56°F water temperature index value established for the Chinook salmon spawning and embryo incubation life stage is the index value generally reported in the literature as the upper limit of the optimal range for egg development and the upper limit of the range reported to provide maximum survival of eggs and yolk-sac larvae in the Central Valley of California. Increasing levels of thermal stress to this life stage may reportedly occur above the 56°F water temperature index value.

High survival of Chinook salmon embryos also has been suggested to occur at incubation temperatures at or near 58.0°F. For example, Reclamation (unpublished work) reported that the natural rate of mortality for alevins occurs at 58°F or less. Combs and Burrows (1957) concluded constant incubation temperatures between 42.5 and 57.5°F resulted in normal development of Chinook salmon eggs, and NMFS (2002b) suggests 53.0 to 58.0°F is the preferred water temperature range for Chinook salmon eggs and fry. Johnson and Brice (1953) found consistently higher Chinook salmon egg losses resulted at water temperatures above 60.0°F than at lower temperatures. In order to protect late incubating Chinook salmon embryos and newly emerged fry NMFS (1993) has determined a water temperature criterion of less than or equal to 60.0°F be maintained in the Sacramento River from Keswick Dam to Bend Bridge from October 1 to October 31. However, Seymour (1956) provides evidence that 100 percent mortality occurs to late incubating Chinook salmon embryos when held at a constant water temperature greater than or equal to 60.0°F. For Chinook salmon eggs incubated at constant temperatures, mortality increases rapidly at temperatures greater than about 59-60°F (see data plots in Myrick and Cech, 2001). Olsen and Foster (1955), however, found high survival of Chinook salmon eggs and fry (89.6%) when incubation temperatures started at 60.9°F and declined naturally for the Columbia River (about 7°F / month). Geist et al. (2006) found high (93.8%) Chinook salmon incubation survival through emergence for naturally declining temperatures (0.36°F/day) starting as high as 61.7°F; however, a significant reduction in survival occurred above this temperature.

The literature largely agrees that 100 percent mortality will result to Chinook salmon embryos incubated at water temperatures greater than or equal to 62.0°F (Hinze, 1959; Seymour, 1956; Reclamation, 2003b; USFWS, 1999), therefore, it was not necessary to select index values above 62°F. Similarly, mortality to spawning adult Chinook salmon prior to egg deposition (Berman, 1990; Marine, 1992) reportedly occurs at water temperatures above those at which embryo mortality results (i.e., 62°F) (Hinze, 1959; Seymour, 1956; Reclamation, 2003b; USFWS, 1999); therefore, an index value above 62°F was not required.

12D.3.1.3 Juvenile Rearing and Emigration

Water temperature index values were selected from a comprehensive literature review for juvenile rearing and emigration, including spring-run Chinook salmon smolt emigration (Table 12D-3). The lowest index value of 60°F was chosen because regulatory documents as well as several source studies, including ones recently conducted on Central Valley Chinook salmon fry, fingerlings, and smolts, report 60°F as an optimal water temperature for growth (Banks et al., 1971; Brett et al., 1982; Marine, 1997; NMFS, 1997b; NMFS, 2000; NMFS, 2001a; NMFS, 2002b; Rich, 1987a, b). Water temperatures below 60°F also have been reported as providing conditions optimal for fry and fingerling growth, but were not selected as index values, because the studies were conducted on fish from outside of the Central Valley (Brett, 1952; Seymour, 1956). Studies conducted using local fish may be particularly important because *Oncorhynchus* species show considerable variation in morphology, behavior, and physiology along latitudinal gradients (Myrick, 1998; Taylor, 1990b; Taylor, 1990a). More specifically, it has been suggested that salmonid populations in the Central Valley prefer higher water temperatures than those from more northern latitudes (Myrick and Cech, 2000).

Table 12D-3
Chinook Salmon Juvenile Rearing and Smolt Emigration Water Temperature Index Values and the Literature Supporting Each Value

Index Value	Supporting Literature
60°F*	Optimum water temperature for Chinook salmon fry growth is between 55.0 and 60°F (Seymour, 1956). Water temperature range that produced optimum growth in juvenile Chinook salmon was between 54.0 and 60.0°F (Rich, 1987b). Water temperature criterion of less than or equal to 60.0°F for the protection of Sacramento River winter-run Chinook salmon from Keswick Dam to Bend Bridge (NMFS, 1993). Upper optimal water temperature limit of 61°F for Sacramento River fall-run Chinook salmon juvenile rearing (Marine, 1997; Marine and Cech, 2004). Upper water temperature limit of 60.0°F preferred for growth and development of spring-run Chinook salmon fry and fingerlings (NMFS, 2000; NMFS, 2002b). To protect salmon fry and juvenile Chinook salmon in the upper Sacramento River, daily average water temperatures should not exceed 60°F after September 30 (NMFS, 1997b). A water temperature of 60°F appeared closest to the optimum for growth of fingerlings (Banks *et al.*, 1971). Optimum growth of Nechako River Chinook salmon juveniles would occur at 59°F at a feeding level that is 60 percent of that required to satiate them (Brett *et al.*, 1982). In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70 and 75°F experienced significantly decreased growth rates, impaired smoltification indices, and increased predation vulnerability compared with juveniles reared between 55 and 61°F (Marine, 1997; Marine and Cech, 2004). Indirect evidence from tagging studies suggests that the survival of fall-run Chinook salmon smolts decreases with increasing water temperatures between 59 and 75°F in the Sacramento-San Joaquin Delta (Kjelson and Brandes, 1989).
63°F	Acceleration and inhibition of Sacramento River Chinook salmon smolt development reportedly may occur at water temperatures above 63°F (Marine, 1997; Marine and Cech, 2004). Laboratory evidence suggests that survival and smoltification become compromised at water temperatures above 62.6°F (Zedonis and Newcomb, 1997). Juvenile Chinook salmon growth was highest at 62.6°F (Clarke and Shelbourn, 1985).
65°F	Water temperatures between 45 to 65°F are preferred for growth and development of fry and juvenile spring-run Chinook salmon in the Feather River (NMFS, 2002b). Recommended summer maximum water temperature of 64.4°F for migration and non-core rearing (USEPA, 2003). Water temperatures greater than 64.0°F are considered not "properly functioning" by NMFS in Amendment 14 to the Pacific Coast Salmon Plan (NMFS, 1995). Fatal infection rates caused by *C. columnaris* are high at temperatures greater than or equal to 64.0°F (USEPA, 2001). Disease mortalities diminish at water temperatures below 65.0°F (Ordal and Pacha, 1963). Fingerling Chinook salmon reared in water greater than 65.0°F contracted *C. columnaris* and exhibited high mortality (Johnson and Brice, 1953). Water temperatures greater than 64.9°F identified as being stressful in the Columbia River Ecosystem (Independent Scientific Group, 1996). Juvenile Chinook salmon have an optimum temperature for growth that appears to occur at about 66.2°F (Brett *et al.*, 1982). Juvenile Chinook salmon reached a growth maximum at 66.2°F (Cech Jr. and Myrick, 1999). Optimal range for Chinook salmon survival and growth from 53.0 to 64.0°F (USFWS, 1995). Survival of Central Valley juvenile Chinook salmon declines at temperatures greater than 64.4°F (Myrick and Cech, 2001). Increased incidence of disease, reduced appetite, and reduced growth rates at 66.2 ± 1.4 (Rich, 1987b)

Table 12D-3
Chinook Salmon Juvenile Rearing and Smolt Emigration Water Temperature Index Values and the Literature Supporting Each Value

Index Value	Supporting Literature
68°F	Sacramento River juvenile Chinook salmon reared at water temperatures greater than or equal to 68.0°F suffer reductions in appetite and growth (Marine, 1997; Marine and Cech, 2004). Significant inhibition of gill sodium ATPase activity and associated reductions of hyposmoregulatory capacity, and significant reductions in growth rates, may occur when chronic elevated temperatures exceed 68°F (Marine, 1997; Marine and Cech, 2004). Water temperatures supporting smoltification of fall-run Chinook salmon range between 50 to 68°F, the colder temperatures represent more optimal conditions (50 to 62.6°F), and the warmer conditions (62.6 to 68°F) represent marginal conditions (Zedonis and Newcomb, 1997). Juvenile spring-run Chinook salmon were not found in areas having mean weekly water temperatures between 67.1 and 71.6°F (Burck *et al.*, 1980; Zedonis and Newcomb, 1997). Results from a study on wild spring-run Chinook salmon in the John Day River system indicate that juvenile fish were not found in areas having mean weekly water temperatures between 67.1 and 72.9°F (McCullough, 1999; Zedonis and Newcomb, 1997).
70°F	No growth at all would occur for Nechako River juvenile Chinook salmon at 70.5°F (Brett et al., 1982; Zedonis and Newcomb, 1997). Juvenile spring-run Chinook salmon were not found in areas having mean weekly water temperatures between 67.1 and 71.6°F (Burck *et al.*, 1980; Zedonis and Newcomb, 1997). Results from a study on wild spring-run Chinook salmon in the John Day River system indicate that juvenile fish were not found in areas having mean weekly water temperatures between 67.1 and 72.9°F (McCullough, 1999; Zedonis and Newcomb, 1997). Increased incidence of disease, hyperactivity, reduced appetite, and reduced growth rates at 69.8 ± 1.8 (Rich, 1987a). In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70 and 75°F experienced significantly decreased growth rates, impaired smoltification indices, and increased predation vulnerability compared with juveniles reared between 55 and 61°F (Marine, 1997; Marine and Cech, 2004).
75°F	For juvenile Chinook salmon in the lower American River fed maximum rations under laboratory conditions, 75.2ºF was determined to be 100 percent lethal due to hyperactivity and disease (Rich, 1987b; Zedonis and Newcomb, 1997). Lethal temperature threshold for fall-run juvenile Chinook salmon between 74.3 and 76.1°F (NAS, 1972 *as cited in* McCullough, 1999). In a laboratory study, juvenile fall-run Chinook salmon from the Sacramento River reared in water temperatures between 70°F and 75°F experienced significantly decreased growth rates, impaired smoltification indices, and increased predation vulnerability compared with juveniles reared between 55°F and 61°F (Marine, 1997; Marine and Cech, 2004).

*The 60°F water temperature index value established for the Chinook salmon juvenile rearing and smolt emigration life stage is the index value generally reported in the literature as the upper limit of the optimal range for fry and juvenile growth and the upper limit of the preferred range for growth and development of juvenile Chinook salmon. Increasing levels of thermal stress to this life stage may reportedly occur above the 60°F water temperature index value.

The 60°F water temperature index value established for the Chinook salmon juvenile rearing and emigration life stage is the index value generally reported in the literature as the upper limit of the optimal range for fry and juvenile growth and the upper limit of the preferred range for growth and development of spring-run Chinook salmon fry and fingerlings. FERC (1993) referred to 58°F as an "optimum" water temperature for juvenile Chinook salmon in the American River. NMFS (2002a) identified 60°F as the "preferred" water temperature for juvenile spring-run Chinook salmon in the Central Valley. Increasing levels of thermal stress to this life stage may reportedly occur above the 60°F water temperature index value.

A water temperature index value of 63°F was selected because water temperatures at or below this value allow for successful transformation to the smolt stage, and water temperatures above this value may result in impaired smoltification indices, inhibition of smolt development, and decreased survival and successful smoltification of juvenile spring-run Chinook salmon. Laboratory experiments suggest that water temperatures at or below 62.6°F provide conditions that allow for successful transformation to the smolt stage (Clarke and Shelbourn, 1985; Zedonis and Newcome, 1997; Marine, 1997). The reported temperature of 62.6ºF was rounded and used to support an index value of 63ºF.

An index value of 65°F was selected because it represents an intermediate value between 64.0°F and 66.2°F, at which both adverse and beneficial effects to juvenile salmonids have been reported to occur. For example, at temperatures approaching and beyond 65°F, sub-lethal effects associated with increased incidence of disease reportedly become severe for juvenile Chinook salmon (Johnson and Brice, 1953; Ordal and Pacha, 1963; Rich, 1987b; USEPA, 2003). Conversely, numerous studies report that temperatures between 64.0 and 66.2°F provide conditions ranging from suitable to optimal for juvenile Chinook salmon growth (Brett et al., 1982; USFWS, 1995; Myrick and Cech, Jr., 2001; USEPA, 2003; NMFS, 2002b; Cech and Myrick, 1999). Maximum growth of juvenile fall-run Chinook salmon has been reported to occur in the American River at water temperatures between 56 to 59°F (Rich, 1987a) and in Nimbus Hatchery spring-run Chinook salmon at 66°F (Cech and Myrick, 1999).

An index value of 68°F was selected because, at water temperatures above 68°F, sub-lethal effects become severe such as reductions in appetite and growth of juveniles, as well as prohibiting successful smoltification (Marine, 1997; Rich, 1987a; Zedonis and Newcomb, 1997). Chronic stress associated with water temperature can be expected when conditions reach the index value of 70°F. For example, growth becomes drastically reduced at temperatures close to 70.0°F and has been reported to be completely prohibited at 70.5°F (Brett et al., 1982; Marine, 1997).

The 75°F index value was chosen as the highest water temperature index value because high levels of direct mortality to juvenile Chinook salmon reportedly result at this water temperature (Rich, 1987a). Other studies have suggested higher upper lethal water temperature levels (Brett, 1952; Orsi, 1971), but 75°F was chosen because it was derived from experiments using Central Valley Chinook salmon and it is a more rigorous index value representing a more protective upper lethal water temperature level. Furthermore, the lethal level determined in Rich (1987a) was derived using slow rates of water temperature change and, thus, is ecologically relevant. Additional support for an index value of 75°F is provided from a study conducted by Baker et al. (1995) in which a statistical model is presented that treats survival of Chinook salmon smolts fitted with coded wire tags in the Sacramento River as a logistic function of water temperature. Using data obtained from mark-recapture surveys, the statistical model suggests a 95 percent confidence interval for the upper incipient lethal water temperature for Chinook salmon smolts as 71.5 to 75.4°F. Additionally, the juvenile Chinook salmon upper incipient lethal temperature (UILT) based on numerous studies is 75-77°F (Sullivan et al., 2000; McCullough et al., 2001; Myrick and Cech, 2001).

12D.3.2 Steelhead

12D.3.2.1 Adult Immigration and Holding

Water temperatures can control the timing of adult spawning migrations and can affect the viability of eggs in holding females. Few studies have been published that examine the effects of water temperature on either steelhead immigration or holding, and none have been recent (Billard and Breton, 1977 and Billard and Gillet, 1981 *as cited in* McCullough et al., 2001; Bruin and Waldsdorf, 1975). The available studies suggest that adverse effects occur to immigrating and holding steelhead at water temperatures exceeding the mid 50°F range and that immigration will be delayed if water temperatures approach approximately 70°F (Table 12D-4). Water temperature index values of 52°F, 56°F, and 70°F were chosen because: (1) they incorporate a range of values that provide suitable habitat to conditions that are highly adverse; and (2) the available literature provided the strongest support for these values. Because of the paucity of literature pertaining to steelhead adult immigration and holding, an evenly spaced range of water temperature index values could not be achieved. A water temperature index value of 52°F was selected because it has been referred to as a “recommended” (Reclamation, 2003a), “preferred” (NMFS, 2002a), and “optimum” (Reclamation, 1997) water temperature for steelhead adult immigration. Increasing levels of thermal stress to this life stage may reportedly occur above the 52°F water temperature index value.

Table 12D-4
Steelhead Adult Immigration and Holding Water Temperature Index Values and the Literature Supporting Each Value

Index Value	Supporting Literature
52°F*	Preferred range for adult steelhead immigration of 46.0 to 52.0°F (NMFS, 2000; NMFS, 2002b; SWRCB, 2003). Optimum range for adult steelhead immigration of 46.0 to 52.1°F (Reclamation, 1997). Recommended adult steelhead immigration temperature range of 46.0 to 52.0°F (Reclamation, 2003a).
56°F	To produce rainbow trout eggs of good quality, brood fish must be held at water temperatures not exceeding 56.0°F (Leitritz and Lewis, 1980). Rainbow trout brood fish must be held at water temperatures not exceeding 56°F for a period of two to six months before spawning to produce eggs of good quality (Bruin and Waldsdorf, 1975). Holding migratory fish at constant water temperatures above 55.4 to 60.1°F may impede spawning success (McCullough *et al.*, 2001).
70°F	Migration barriers have frequently been reported for pacific salmonids when water temperatures reach 69.8 to 71.6°F (McCullough *et al.*, 2001). Snake River adult steelhead immigration was blocked when water temperatures reached 69.8 (McCullough et al., 2001). A water temperature of 68°F was found to drop egg fertility in vivo to five percent after 4.5 days (Billard and Breton, 1977 *as cited in* McCullough et al., 2001).

*The 52°F water temperature index value established for the steelhead adult immigration and holding life stage is the index value generally reported in the literature as the upper limit of either the recommended, preferred, or optimum range for steelhead immigration. Increasing levels of thermal stress to this life stage may reportedly occur above the 52°F water temperature index value.

A water temperature index value of 56°F was selected because 56°F represents a water temperature above which adverse effects to migratory and holding steelhead begin to arise (Leitritz and Lewis, 1980; McCullough et al., 2001; Smith et al., 1983). A range of 50-59°F is referred to as the “preferred” range of water temperatures for California summer steelhead holding (Moyle et al., 1995). Whereas, water temperatures greater than 61°F may result in “chronic high stress” of holding Central Valley winter-run steelhead (USFWS, 1995). The highest water temperature index value selected was 70°F because the literature suggests that water temperatures near and above 70.0°F present a thermal barrier to adult steelhead migrating upstream (McCullough et al., 2001) and are water temperatures referred to as “stressful” to upstream migrating steelhead in the Columbia River (McCullough, 1999). Further, Coutant (1972) found that the UILT for adult steelhead was 69.8°F and temperatures between 73-75°F are described as “lethal” to holding adult steelhead.

12D.3.2.2 Spawning and Embryo Incubation

Relatively few studies have been published regarding the effects of water temperature on steelhead spawning and embryo incubation (Redding and Schreck, 1979; Rombough, 1988). Because anadromous steelhead and non-anadromous rainbow trout are genetically and physiologically similar, studies on non-anadromous rainbow trout also were considered in the development of water temperature index values for steelhead spawning and embryo incubation (Moyle, 2002; McEwan, 2001). From the available literature, water temperatures in the low 50°F range appear to support high embryo survival, with substantial mortality to steelhead eggs reportedly occurring at water temperatures in the high 50°F range and above (Table 12D-5). Water temperatures in the 45 to 50°F range have been referred to as the "optimum" for spawning steelhead (FERC, 1993).

Table 12D-5
Steelhead Spawning and Embryo Incubation Water Temperature Index Values and the Literature Supporting Each Value

Index Value	Supporting Literature
52°F*	Rainbow trout from Mattighofen (Austria) had highest egg survival at 52.0°F compared to 45.0, 59.4, and 66.0°F (Humpesch, 1985). Water temperatures from 48.0 to 52.0°F are suitable for steelhead incubation and emergence in the American River and Clear Creek (NMFS, 2000; NMFS, 2001a; NMFS, 2002b). Optimum water temperature range of 46.0 to 52.0°F for steelhead spawning in the Central Valley (USFWS, 1995). Optimum water temperature range of 46.0 to 52.1°F for steelhead spawning and 48.0 to 52.1°F for steelhead egg incubation (Reclamation, 1997). Upper limit of preferred water temperature of 52.0°F for steelhead spawning and egg incubation (SWRCB, 2003).
54°F	Big Qualicum River steelhead eggs had 96.6 percent survival to hatch at 53.6°F (Rombough, 1988). Highest survival from fertilization to hatch for *Salmo gairdneri* incubated at 53.6°F (Kamler and Kato, 1983). Emergent fry were larger when North Santiam River (Oregon) winter steelhead eggs were incubated at 53.6°F than at 60.8°F (Redding and Schreck, 1979). The upper optimal water temperature regime based on constant or acclimation water temperatures necessary to achieve full protection of steelhead is 51.8 to 53.6°F (USEPA, 2001). From fertilization to hatch, rainbow trout eggs and larvae had 47.3 percent mortality (Timoshina, 1972). Survival of rainbow trout eggs declined at water temperatures between 52.0 and 59.4°F (Humpesch, 1985). The optimal constant incubation water temperature for steelhead occurs below 53.6°F (McCullough *et al.*, 2001).
57°F	From fertilization to 50 percent hatch, Big Qualicum River steelhead had 93 percent mortality at 60.8°F, 7.7 percent mortality at 57.2°F, and one percent mortality at 47.3 and 39.2°F (Velsen, 1987). A sharp decrease in survival was observed for rainbow trout embryos incubated above 57.2°F (Kamler and Kato, 1983).
60°F	From fertilization to 50 percent hatch, Big Qualicum River steelhead had 93 percent mortality at 60.8°F, 7.7 percent mortality at 57.2°F, and one percent mortality at 47.3 and 39.2°F (Velsen, 1987). From fertilization to 50 percent hatch, rainbow trout eggs from Ontario Provincial Normendale Hatchery had 56 percent survival when incubated at 59.0°F (Kwain, 1975).

*The 52°F water temperature index value established for the steelhead spawning and embryo incubation life stage is the index value generally reported in the literature as the upper limit of the optimal range for steelhead spawning, embryo incubation, and fry emergence. Increasing levels of thermal stress to this life stage may reportedly occur above the 52°F water temperature index value.

Water temperature index values of 52, 54, 57, and 60°F were selected for two reasons. First, the available literature provided the strongest support for water temperature index values at or near 52, 54, 57, and 60°F. Second, the index values reflect an evenly distributed range representing reported optimal to lethal conditions for steelhead spawning and embryo incubation. Although some literature suggests water temperatures ≤ 50°F are optimal for steelhead spawning and embryo survival (FERC, 1993; Myrick and Cech, 2001; Timoshina, 1972), a larger body of literature suggests optimal conditions occur at water temperatures ≤ 52°F (Humpesch, 1985; NMFS, 2000; NMFS, 2001a; NMFS, 2002b; SWRCB, 2003; Reclamation, 1997; USFWS, 1995). Further, water temperatures between 48 to 52°F were referred to as "optimal" (FERC, 1993; McEwan and Jackson, 1996; NMFS, 2000) and "preferred" (Bell, 1986) for steelhead embryo incubation. Therefore, 52°F was selected as the lowest water temperature index value. Increasing levels of thermal stress to the steelhead spawning and embryo incubation life stage may reportedly occur above the 52°F water temperature index value.

An index value of 54°F was selected because although most of the studies conducted at or near 54.0°F report high survival and normal development (Kamler and Kato, 1983; Redding and Schreck, 1979; Rombough, 1988), some evidence suggests that symptoms of thermal stress arise at or near 54.0°F (Timoshina, 1972; Humpesch, 1985). Thus, water temperatures near 54°F may represent an inflection point between properly functioning water temperature conditions, and conditions that cause negative effects to steelhead spawning and embryo incubation. Further, water temperatures greater than 55°F were referred to as "stressful" for incubating steelhead embryos (FERC, 1993). An index value of 57°F was selected because embryonic mortality increases sharply and development becomes retarded at incubation temperatures greater than or equal to 57.0°F. Velsen (1987) provided a compilation of data on rainbow trout and steelhead embryo mortality to 50 percent hatch under incubation temperatures ranging from 33.8 to 60.8°F that demonstrated a two-fold increase in mortality for embryos incubated at 57.2°F, compared to embryos incubated at 53.6°F. In a laboratory study using gametes from Big Qualicum River, Vancouver Island, steelhead mortality increased to 15 percent at a constant temperature of 59.0°F, compared to less than four percent mortality at constant temperatures of 42.8, 48.2, and 53.6°F (Rombough, 1988). Also, alevins hatching at 59.0°F were considerably smaller and appeared less well developed than those incubated at the lower temperature treatments. From fertilization to 50 percent hatch, Big Qualicum River steelhead had 93 percent mortality at 60.8°F, 7.7 percent mortality at 57.2°F, and one percent mortality at 47.3 and 39.2°F (Velsen, 1987). Myrick and Cech (2001) similarly described water temperatures >59°F as "lethal" to incubating steelhead embryos, although FERC (1993) suggested that water temperatures exceeding 68°F were "stressful" to spawning steelhead and "lethal" when greater than 72°F.

12D.3.2.3 Juvenile Rearing and Emigration

Water temperature index values were developed to evaluate the combined steelhead rearing (fry and juvenile) and juvenile downstream movement lifestages. Some steelhead may rear in freshwater for up to three years before emigrating as yearling smolts, whereas other individuals move downstream shortly after emergence as post-emergent fry, or rear in the river for several months and move downstream as juveniles without exhibiting the ontogenetic[3] characteristics of smolts. Presumably, these individuals continue to rear and grow in downstream areas (e.g., lower Feather River, Sacramento River, and Upper Delta) and undergo the smoltification process prior to entry into saline environments. Thus, fry and juvenile rearing occur concurrently with post-emergent fry and juvenile downstream movement and are assessed in this EIR/EIS using the fry and juvenile rearing water temperature index values.

Like other salmonids, growth, survival, and successful smoltification of juvenile steelhead are controlled largely by water temperature. The duration of freshwater residence for juvenile steelhead is long relative to that of Chinook salmon, making the juvenile life stage of steelhead more susceptible to the influences of water temperature, particularly during the over-summer rearing period. Central Valley juvenile steelhead have high growth rates at water temperatures in the mid 60°F range, but reportedly require lower water temperatures to successfully undergo the transformation to the smolt stage (Tables 12D-6 and 12D-7).

[3] Ontogeny is the origin and development of an individual organism from embryo to adult.

Table 12D-6
Steelhead Juvenile Rearing Water Temperature Index Values and the Literature Supporting Each Value

Index Value	Supporting Literature
65°F*	Upper limit of 65°F preferred for growth and development of Sacramento River and American River juvenile steelhead (NMFS, 2002b). Nimbus juvenile steelhead growth showed an increasing trend with water temperature to 66.2°F, irrespective of ration level or rearing temperature (Cech Jr. and Myrick, 1999). The final preferred water temperature for rainbow fingerlings was between 66.2 and 68°F (Cherry *et al.*, 1977). Nimbus juvenile steelhead preferred water temperatures between 62.6 and 68.0°F (Cech Jr. and Myrick, 1999). Rainbow trout fingerlings preferred or selected water temperatures in the 62.6 to 68.0°F range (McCauley and Pond, 1971).
68°F*	Nimbus juvenile steelhead preferred water temperatures between 62.6 and 68.0°F (Cech and Myrick, 1999). The final preferred water temperature for rainbow trout fingerlings was between 66.2 and 68°F (Cherry *et al.*, 1977). Rainbow trout fingerlings preferred or selected water temperatures in the 62.6 to 68.0°F range (McCauley and Pond, 1971). The upper avoidance water temperature for juvenile rainbow trout was measured at 68 to 71.6°F (Kaya *et al.*, 1977).
72°F	Increased physiological stress, increased agonistic activity, and a decrease in forage activity in juvenile steelhead occur after ambient stream temperatures exceed 71.6°F (Nielsen *et al.*, 1994). The upper avoidance water temperature for juvenile rainbow trout was measured at 68 to 71.6°F (Kaya et al., 1977). Estimates of upper thermal tolerance or avoidance limits for juvenile rainbow trout (at maximum ration) ranged from 71.6 to 79.9°F (Ebersole, 2001).
75°F	The maximum weekly average water temperature for survival of juvenile and adult rainbow trout is 75.2°F (USEPA, 2002). Rearing steelhead juveniles have an upper lethal limit of 75.0°F (NMFS, 2001b). Estimates of upper thermal tolerance or avoidance limits for juvenile rainbow trout (at maximum ration) ranged from 71.6 to 79.9°F (Ebersole, 2001).

*The 65 and 68°F water temperature index values established for the steelhead juvenile rearing life stage are the index values generally reported in the literature as the upper limits of the preferred range for juvenile steelhead. However, because 68°F also has been reported as an avoidance temperature for juvenile rainbow trout, 65°F may provide more suitable conditions for steelhead juvenile rearing than 68°F. Therefore, increasing levels of thermal stress to this life stage may reportedly occur above the 65°F water temperature index value.

Table 12D-7
Steelhead Smolt Emigration Water Temperature Index Values and the Literature Supporting Each Value

Index Value	Supporting Literature
52°F*	Steelhead successfully smolt at water temperatures in the 43.7 to 52.3°F range (Myrick and Cech, 2001). Steelhead undergo the smolt transformation when reared in water temperatures below 52.3°F, but not at higher water temperatures (Adams *et al.*, 1975). Optimum water temperature range for successful smoltification in young steelhead is 44.0 to 52.3°F (Rich, 1987a).
55°F	ATPase activity was decreased and migration reduced for steelhead at water temperatures greater than or equal to 55.4°F (Zaugg and Wagner, 1973). Water temperatures should be below 55.4°F at least 60 days prior to release of hatchery steelhead to prevent premature smolting and desmoltification (Wedemeyer et al., 1980). In winter steelhead, a temperature of 54.1°F is nearly the upper limit for smolting (McCullough *et al.*, 2001; Zaugg and Wagner, 1973). Water temperatures less than or equal to 54.5°F are suitable for emigrating juvenile steelhead (USEPA, 2003). Water temperatures greater than 55°F prevent increases in ATPase activity in steelhead juveniles (Hoar, 1988). Water temperatures greater than 56°F do not permit smoltification in summer steelhead (Zaugg *et al.*, 1972)

Table 12D-7
Steelhead Smolt Emigration Water Temperature Index Values and the Literature Supporting Each Value

Index Value	Supporting Literature
59°F	Yearling steelhead held at 43.7°F and transferred to 59°F had a substantial reduction in gill ATPase activity, indicating that physiological changes associated with smoltification were reversed (Wedemeyer *et al.*, 1980).

*The 52°F water temperature index value established for the steelhead smolt emigration life stage is the index value generally reported in the literature as the upper limit of the water temperature range that provides successful smolt transformation thermal conditions. Increasing levels of thermal stress to this life stage may reportedly occur above the 52°F water temperature index value.

Water temperature index values of 65, 68, 72, and 75°F were selected to represent an evenly distributed range of index values for steelhead juvenile rearing. The lowest water temperature index value of 63°F was established because Myrick and Cech (2001) describe 63°F as the “preferred” water temperature for wild juvenile steelhead, whereas “preferred” water temperatures for juvenile hatchery steelhead reportedly range between 64 to 66°F. A water temperature index value of 65°F was also identified because NMFS (2000; 2002a) reported 65°F as the upper limit preferred for growth and development of Sacramento River and American River juvenile steelhead. Also, 65°F was found to be within the optimum water temperature range for juvenile growth (i.e., 59 to 66°F) (Myrick and Cech, 2001), and supported high growth of Nimbus strain juvenile steelhead (Cech and Myrick, 1999). Increasing levels of thermal stress to this life stage may reportedly occur above the 65°F water temperature index value. For example, Kaya et al. (1977) reported that the upper avoidance water temperature for juvenile rainbow trout was measured at 68 to 71.6°F. Cherry et al. (1977) observed an upper preference water temperature near 68.0°F for juvenile rainbow trout, duplicating the upper preferred limit for juvenile steelhead observed in Cech and Myrick (1999) and FERC (1993). Because of the literature describing 68.0°F as both an upper preferred and an avoidance limit for juvenile *Oncorhynchus mykiss*, 68°F was established as a water temperature index value.

A water temperature index value of 72°F was established because symptoms of thermal stress in juvenile steelhead have been reported to arise at water temperatures approaching 72°F. For example, physiological stress to juvenile steelhead in northern California streams was demonstrated by increased gill flare rates, decreased foraging activity, and increased agonistic activity as stream temperatures rose above 71.6°F (Nielsen et al., 1994). Also, 72°F was selected as a water temperature index value because 71.6°F has been reported as an upper avoidance water temperature (Kaya et al., 1977) and an upper thermal tolerance water temperature (Ebersole, 2001) for juvenile rainbow trout. The highest water temperature index value of 75°F was established because NMFS and EPA report that direct mortality to rearing juvenile steelhead results when stream temperatures reach 75.0°F (USEPA, 2002; NMFS, 2001b). Water temperatures >77°F have been referred to as “lethal” to juvenile steelhead (FERC, 1993; Myrick and Cech, 2001). The UILT for juvenile rainbow trout, based on numerous studies, is between 75-79°F (Sullivan et al., 2000; McCullough, 2001).

12D.3.2.4 Smolt Emigration

Laboratory data suggest that smoltification, and therefore successful emigration of juvenile steelhead is directly controlled by water temperature (Adams et al., 1975). Water temperature index values of 52 and 55°F were selected to evaluate the steelhead smolt emigration life stage, because most literature on water temperature effects on steelhead smolting suggest that water temperatures less than 52°F (Adams et al., 1975; Myrick and Cech, 2001; Rich, 1987b); or less than 55°F (USEPA, 2003; McCullough et al., 2001;

Wedemeyer et al., 1980; Zaugg and Wagner, 1973) are required for successful smoltification to occur. Adams et al. (1973) tested the effect of water temperature (43.7, 50.0, 59.0 or 68.0°F) on the increase of gill microsomal sodium (Na+)-, potassium (K+)-stimulated ATPase activity associated with parr-smolt transformation in steelhead and found a two-fold increase in Na+-, K+-ATPase at 43.7 and 50.0°F, but no increase at 59.0 or 68.0°F. In a subsequent study, the highest water temperature where a parr-smolt transformation occurred was at 52.3°F (Adams et al. 1975). The results of Adams et al. (1975) were reviewed in Myrick and Cech (2001) and Rich (1987b), which both recommended that water temperatures below 52.3°F are required to successfully complete the parr-smolt transformation. The 52°F water temperature index value established for the steelhead smolt emigration life stage is the index value generally reported in the literature as the upper limit of the water temperature range that provides successful smolt transformation thermal conditions. Increasing levels of thermal stress to this life stage may reportedly occur above the 52°F water temperature index value.

Zaugg and Wagner (1973) examined the influence of water temperature on gill ATPase activity related to parr-smolt transformation and migration in steelhead and found ATPase activity was decreased and migration reduced when juveniles were exposed to water temperatures of 55.4°F or greater. In a technical document prepared by the Environmental Protection Agency (EPA) to provide temperature water quality standards for the protection of Northwest native salmon and trout, water temperatures less than or equal to 54.5°F were recommended for emigrating juvenile steelhead (USEPA, 2003). A water temperature index value of 59°F was chosen because water temperatures are considered “unsuitable” for steelhead smolts at >59°F (Myrick and Cech, 2001) and “lethal” at 77°F (FERC, 1993).

12D.3.3 Coho Salmon

12D.3.3.1 Adult Immigration and Holding

Like other salmonids, Coho salmon prefer cool, well-oxygenated water (Giannico and Heider, 2001). It is recommended that the seven day moving average of the daily maximum water temperature (7DADM) should not exceed 18°C (64.4°F) in waters where both adult salmonid migration and “non-core” juvenile rearing occur during the period of summer maximum temperatures (Carter, 2008). USEPA (2003) indicated that this temperature recommendation would protect against lethal conditions, prevent migration blockage, provide optimal or near optimal juvenile growth conditions, and prevent high disease risk by minimizing the exposure time to temperatures which can lead to elevated disease rates.

A 7DADM temperature of 20°C (68°F) is recommended by USEPA (2003) for water bodies that are used almost exclusively for migration during the period of summer maximum temperatures. Further, Table 1 in USEPA (2003) indicates that disease risks for juvenile rearing and adult migration associated with exposure to constant water temperatures are minimized at temperatures from 12 to 13°C (53.6 to 55.4°F), elevated from 14 to 17°C (57.2 to 62.6°F), and high at temperatures from >18 to 20°C (64.4 to 68°F).

In a study of both laboratory and field studies of temperature effects on salmonids and related species, USEPA (1999, 2001 *as cited in* Carter, 2008) concluded that temperatures of approximately 22 -24°C (71.6 to 75.2°F) limit salmonid distribution (i.e., they totally eliminate salmonids from a location). USEPA (1999*as cited in* Carter, 2008) also notes that changes in competitive interactions between fish species can lead to a transition in dominance from salmonids to other species at temperatures 2 to 4°C (3.6 to 7.2°F) lower than the range of total elimination.

Although USEPA (1999, 2001 *as cited in* Carter, 2008; 2003) provides water temperature recommendations for anadromous salmonids that were presumably developed, in part, based on studies of

Coho salmon, the recommendations are not specific to Coho salmon. Migration for Coho salmon reportedly is delayed when water temperatures reach 21.1°C (~70°F), while the preferred water temperatures for Coho salmon reportedly range from 11.7 to 14.5°C (53.1 to 58.1°F) (Bell, 1986 *as cited in* Carter, 2008). In California Coho salmon reportedly typically migrate upstream when water temperatures range from 4 to 14°C (39.2 to 57.2°F) (Carter, 2008). The Washington Department of Ecology (WDOE) reviewed various studies and concluded that to be protective of adult Coho salmon migration, maximum weekly maximum temperatures (MWMT) should not exceed 16.5°C (61.7°F) (Carter, 2008). A report prepared for The North Coast Regional Water Quality Control Board, shows acute lethal water temperature thresholds for Coho salmon based upon "best professional judgment of the literature." The threshold for adult migration and holding is reported to be 25°C (77°F) (Carter, 2008). Additionally, NMFS (2012) reported that a study of Coho salmon occurrence in tributaries of the Mattole River suggested that a maximum weekly maximum temperature (MWMT) greater than 18.1°C (64.6°F) or a maximum weekly average temperature (MWAT) greater than 16.8°C (62.2°F) would preclude the occurrence of Coho salmon.

Based on the water temperature thresholds and recommendations for the protection of anadromous salmon, and specifically Coho salmon, a range of water temperature index values was selected for evaluation purposes in this DEIR/EIS. These water temperature index values are 40, 52, 57, 60, 70, and 77°F.

12D.3.3.2 Spawning and Embryo Incubation

USEPA (2003) recommends that the 7DADM temperatures should not exceed 13°C (55.4°F) for salmonid spawning, egg incubation, and fry emergence.

Carter (2008) reviewed various literature sources and reported the results for the North Coast Regional Water Quality Control Board. As part of the review, Carter (2008) indicated that, in 2002, WDOE reported the results of several studies and literature reviews, which suggested that spawning activity in Coho salmon may typically occur in the range of 4.4 to 13.3°C (39.9 to 55.9°F). Additionally, Carter (2008) reported that according to a review by Bell (1986), preferred spawning temperatures range from 4.5 to 9.4°C (40.1 to 48.9°F). Brungs and Jones (1977 as cited in Carter, 2008) used existing data on the optimum and range of temperatures for Coho salmon spawning and embryo survival to create criteria using protocols from the National Academy of Sciences and National Academy of Engineering. The resultant criteria were that the MWAT should not exceed 10°C (50°F) and the daily maximum temperature should not exceed 13°C (55.4°F) to be protective of Coho salmon (Brungs and Jones, 1977*as cited in* Carter, 2008). Further, in a discussion paper and literature summary, WDOE reviewed studies that assessed the survival of embryos and alevin at various temperatures (Carter, 2008). Based on the findings of these studies, WDOE determined that the average daily temperature during the incubation period should be at or below 8 to 10°C (46.4 to 50°F) to fully support this Coho salmon life stage (Carter, 2008). According to a review of various literature sources by Bell (1986 as cited in Carter, 2008), the preferred emergence temperatures for Coho salmon range from 4.5 to 13.3°C (40.1 to 55.9°F). Optimum temperatures for salmonid egg survival are reported to range from 6 to 10°C (42.8 to 50°F) (USEPA, 2001 as cited in Carter, 2008). Additionally, USEPA (2001 as cited in Carter, 2008) concluded that, to fully support pre-emergent stages of Coho salmon development MWMTs should not exceed 9 to 12°C (48.2 to 53.6°F).

One study incubated five species of Pacific salmon, including Coho salmon, at five temperatures (2, 5, 8, 11, and 14°C) (35.6, 41, 46.4, 51.8, and 57.2°F) to determine embryo survival at various temperatures

(Carter, 2008). Coho salmon embryos were reported to have suffered increased mortality above 11°C (51.8°F), although survival was still high. According to Carter (2008), they concluded that the upper limit for normal Coho salmon embryo development is 14°C (57.2°F). Based on this review, Carter (2008) shows acute lethal water temperature thresholds for Coho salmon based upon “best professional judgment of the literature.” The threshold for fry emergence is reported to be 20°C (68°F) (Carter, 2008).

Based on the water temperature thresholds and recommendations for the protection of anadromous salmon, and specifically Coho salmon, for evaluation purposes in this DEIR/EIS a range of water temperature index values was selected that encompasses the range described in the literature. These water temperature index values are 40, 43, 48, 50, 56, and 68°F.

12D.3.3.3 Juvenile Rearing and Emigration

USEPA (2003) recommends a 7DADM temperature of 16°C (60.8°F) for salmon and trout “core” juvenile rearing. Core rearing areas include areas with moderate to high densities of summertime salmonid juvenile rearing. USEPA (2003) further recommends a 7DADM temperature of 16°C (60.8°F) to: (1) protect juvenile salmon and trout from lethal temperatures; (2) provide optimal to upper optimal conditions for juvenile growth under limited food conditions; (3) provide optimal growth during other conditions; (4) avoid temperatures where salmonids are at a competitive disadvantage with other fish species; (5) protect against increased disease rates caused by elevated temperatures and; (6) provide temperatures reported in various literature sources that salmon and trout prefer under high rearing densities. USEPA (2003) also indicates that disease risks for juvenile salmon and trout rearing and adult migration are minimized at temperatures from 12 to 13°C (53.6 to 55.4°F), elevated from 14 to 17°C (57.2 to 62.6°F), and high at temperatures from 18 to 20°C (64.4 to 68°F).

In a study of both laboratory and field studies of temperature effects on salmonids and related species, USEPA (1999, 2001 *as cited in* Carter, 2008) concluded that temperatures of approximately 22 to 24°C (71.6 to 75.2°F) limit salmonid distribution (i.e., they totally eliminate salmonids from a location). USEPA (1999*as cited in* Carter, 2008) also notes that changes in competitive interactions between fish species can lead to a transition in dominance from salmonids to other species at temperatures 2 to 4°C (3.6 to 7.2°F) lower than the range of total elimination.

In a study of juvenile Coho salmon presence and absence in the Mattole watershed, logistic regression was used to determine that an MWAT greater than 16.8°C (62.2°F) or a MWMT greater than 18.1°C (64.6°F) may preclude the presence of juvenile Coho salmon in the stream (Carter, 2008). The study also reported that juvenile Coho salmon were found in all streams with an MWAT less than 14.5°C (58.1°F), or a MWMT less than 16.3°C (61.3°F) (NMFS, 2012, Carter, 2008, and Giannico and Hieder, 2001). Another study found juvenile Coho salmon to be absent or rare in stream segments where temperatures exceeded 21°C (69.8°F) in the Sixes River in southern Oregon (Lestelle, 2007).

Sullivan et al. (2000 *as cited in* Carter, 2008) reviewed sub-lethal and acute temperature thresholds from a wide range of studies, incorporating information from laboratory-based research, field observations, and risk assessment approaches. Using a risk assessment approach based on “realistic food estimates”, Sullivan et al. (2000 *as cited in* Carter, 2008) suggest that MWATs ranging from 12.5 to 14.5°C (54.5 to 58.1°F) for Coho salmon will result in no more than a 10 percent reduction from maximum growth, and that a range for the MWAT of 9 to 18.5°C (48.2 to 65.3°F) will reduce growth no more than 20 percent from maximum. Sullivan et al. (2000 *as cited in* Carter, 2008) also calculated temperature ranges for MWMT (13 to 16.5°C [55.4 to 61.7°F]) and the annual maximum temperature (13 to 17.5°C [55.4 to

63.5°F]) that will result in no more than a 10 percent reduction in maximum growth. They further calculated ranges for MWMT (9 to 22.5°C [48.2 to 72.5°F]) and the annual maximum temperature (9.5 to 23°C [49.1 to 73.4°F]) that will result in no more than a 20 percent growth loss.

In an attempt to determine the water temperature that will allow for maximum growth of Coho salmon, WDOE reviewed literature on laboratory studies conducted at constant and fluctuating temperatures, as well as field studies (Carter, 2008). The two laboratory studies reviewed were conducted under satiated feeding conditions. One study found that maximum growth occurred at a constant temperature of 17°C (62.6°F), while the other tested fish at different temperatures and determined that Coho salmon had the greatest growth at the temperature test regime from 12.1 to 20.8°C (median 16.5°C) (53.8 to 69.4°F [median 61.7°F]) (Carter, 2008). WDOE also concluded that weekly average temperatures of 14 to 15°C (57.2 to 59°F) were more beneficial to growth than lower temperature regimes, while daily maximum temperatures of 21 to 26°C (69.8 to 78.8°F) were detrimental to growth (Carter, 2008).

Brett (1952 *as cited in* Giannico and Heider, 2001) found that Coho salmon showed the greatest preference for temperatures between 12 to 14°C (53.6 to 57.2°F), and showed a general avoidance of temperatures above 15°C (59°F). Carter (2008) also reviewed Brett (1952) and concurs with the characterization of Brett's results as described in Giannico and Heider (2001). Additionally, Giannico and Heider (2001) reported that although fish may survive near the extremes of the tolerance range (1.7 to 28.8°C, 35.1 to 83.8°F) (Giannico and Heider, 2001), growth is reduced at both low and high temperatures (Giannico and Heider, 2001).

One study raised two groups of juvenile Coho salmon under identical regimes to test the hypothesis that the group from a stream with lower and less variable temperature would have lower and less variable temperature preferences than the group from a stream with warmer and more variable temperatures. The study concluded that the temperature preference of juvenile Coho salmon in their study was 10 to 12°C (53.6°F) (Carter, 2008).

During the summer (between June and September) of 2001, USFWS conducted several snorkeling surveys of the Klamath River and several tributary creeks, during which juvenile Coho salmon were observed in areas with temperatures ranging from 12.8 to 24.5°C (55 to 76.1°F). However, during one survey Coho salmon were observed in tributary-influenced water that was 24.6°C (76.3°F), while the mainstem Klamath River water temperature was reported to be 20.5°C (68.9°F) (Giannico and Heider, 2001)

Using an extensive database of primarily large stream and river data, one study estimated that the maximum temperature that juvenile Coho salmon tolerate is 23.4°C (74.1°F) (Giannico and Heider, 2001 and Lestelle, 2007). Brett (1952 *as cited in* Carter, 2008) concluded that the ultimate upper lethal temperature of juvenile Coho salmon was 25.0°C (77°F) (temperature at which 50 percent of the population is dead after infinite exposure). Another study determined that upper lethal temperature for fish acclimated to a 10 to 13°C (50 to 55.4°F) cycle was 26°C (78.8°F) for presmolts (age-2 fish), and 28°C (82.4°F) for age-0 fish (Carter, 2008). One study reported that mortality increased progressively from two percent at 9.4°C (48.9°F) to 22 percent at 15.0°C (59°F) to 84 percent at 20.5°C (68.9°F). No deaths occurred in Coho salmon maintained at 3.9 and 6.7°C (39 and 44°F) (Carter, 2008). Another study reported a lethal temperature limit of 28.8°C (83.8°F) when they gradually exposed fish to increasingly warmer waters (Giannico and Heider, 2001).

Researchers performed a study on the relationship between water temperature and Columnaris in juvenile steelhead, Coho salmon, and spring-run Chinook salmon (Carter, 2008). Juvenile Coho salmon reportedly had 100 percent mortality at 20.5°C (68.9°F), 99 percent at 17.8°C (64°F), and 51 percent at 15.0°C (59°F) (Carter, 2008).

A report prepared for The North Coast Regional Water Quality Control Board that relied on much of the literature reported above shows acute lethal water temperature thresholds for Coho salmon based upon "best professional judgment of the literature." The threshold for juvenile growth and rearing reportedly is 25°C (77°F) (Carter, 2008).

One study found neither evidence of mortality nor lethargic behavior in juvenile Coho salmon when stream temperatures exceeded 24.5°C (76.1°F) during extended periods, and even when they peaked at 29.5°C (85.1°F) for three consecutive days in two Mount St. Helens streams (Washington) (Giannico and Heider, 2001 and Lestelle, 2007). Relatively similar tolerance limits were reported by another study (Giannico and Heider, 2001), which tested the critical maximum temperature for wild juvenile Coho salmon from three streams in Washington. Researchers found consistently high thermal tolerance levels that ranged from mean maximum temperatures of 28.21°C (82.8°F) for one population to 29.23°C (84.6°F) for another (Giannico and Heider, 2001)

These results suggest that juvenile Coho salmon are able to tolerate different critical maximum temperatures, depending on stream channel size, acclimation period, food abundance, competition, predation, body size, and condition (Giannico and Heider, 2001).

Based on the water temperature thresholds and recommendations for the protection of anadromous salmon, and specifically Coho salmon, for evaluation purposes in this DEIR/EIS a range of water temperature index values was selected that encompasses the range described in the literature. These water temperature index values are 41, 48, 54, 57, 60, 64, 70, and 77°F.

12D.3.3.4 Smolt Emigration

NMFS (2012) reported that, because most juveniles rear in tributaries (Lestelle, 2007 *as cited in* NMFS, 2012) the greatest potential impacts to smolts are those that could occur during emigration. Potential impacts of elevated water temperature on smolts include the inability to maintain osmoregulatory capacity potentially resulting in the inability to properly feed and avoid predators, or in smolts reverting back to parr (McCullough, 1999). Coho salmon have a low tolerance for elevated water temperatures (McCullough, 1999 *as cited in* NMFS, 2012) and this factor consequently poses a very high level of stress (NMFS, 2012).

NMFS (2012) reported that average mortality is estimated to be approximately 50 percent at 17°C (62.6°F) and approximately 12 percent at 15°C (59°F) in the Upper Klamath River watershed. The ODEQ (NMFS, 2012) limit for MWMT is 64°F (17.8°C), which is compatible with Coho salmon recovery. Laboratory tests clearly showed that a high constant temperature regime (20°C [68°F]) during the emigration period of Coho salmon caused a very restricted peak in gill ATPase activity compared to a normal (10°C [50°F]) temperature regime. Under the elevated temperature regime, ATPase activity plummeted prior to ocean entry (McCullough, 1999).

Transformation from parr to smolt during seaward migration can be blocked by temperatures in the range 15 to 20°C (59 to 68°F) (Adams et al., 1973 *as cited in* McCullough, 1999). Temperatures of >17 to 20°C (62.6 to 68°F) place smolts under either lethal or loading stresses that can impair metabolic activity, reduce swimming performance, or lead to death (McCullough, 1999). It is recommended for Chinook and Coho salmon that a maximum temperature of approximately 12°C (53.6°F) exist to maintain the migratory response and seawater adaptation in juveniles (Wedemeyer et al., 1980 *as cited in* McCullough, 1999).

Temperatures must be maintained at <12°C (53.6°F) to prevent premature smolting (Hoar, 1988, Wedemeyer et al., 1980 both *as cited in* McCullough, 1999). An apparent exception to this rule is that temperatures as high as 15°C (59°F) have been used to increase growth rate and onset of smolting in Coho salmon. However, the rate of desmoltification is also high in this temperature range (McCullough, 1999).

Sockeye salmon terminate their downstream migration if water temperature exceeds 12 to 14°C (53.6 to 57.2°F), although Coho salmon are able to withstand some further increases before impeding migration. The influence on the smoltification process, though, may be common to both species (McCullough, 1999). One study found that Coho salmon smolt size and condition factor was greater in years in which stream temperatures fluctuated annually from four to 13.5°C (39.2 to 56.3°F) than in years with temperatures of near zero to 11 to12°C (32 to 51.8 to 53.6°F) (McCullough, 1999).

Based on data taken from several studies, Table 9 in McCullough (1999) shows a dramatic decrease in survival of juvenile Coho salmon exposed to various diseases between 15 and 17.8°C (59 and 64.4°F).

Relative to other life stages of Coho salmon, there is a paucity of information that describes water temperature effects on smolt emigration. However, based on the water temperature thresholds and recommendations for the protection of anadromous salmon, and specifically Coho salmon, for juvenile growth, rearing, emigration, and smolt emigration a range of water temperature index values was selected for evaluation purposes in this DEIR/EIS that encompasses the range described in the literature. These water temperature index values are 50, 59, 62, and 70°F.

12D.3.4 North American Green Sturgeon

12D.3.4.1 Adult Immigration and Holding

The habitat requirements of North American green sturgeon are not well known. In the Klamath River, the water temperature tolerance of immigrating adult green sturgeon reportedly ranges from 44.4 to 60.8°F. Reportedly, no green sturgeon were found in areas of the river outside this surface water temperature range (USFWS, 1995). However, the critical temperature for adult mortality has been reported to be 81°F (Erickson et al., 2002, Heublein et al., 2009). Additionally, Suitable water temperatures for green sturgeon adult immigration range from 52 to 59°F, while water temperatures ranging from 61 to 66°F are reportedly tolerable (NMFS, 2009a). Therefore, water temperature index values of 61 and 66°F were chosen for evaluation purposes in this DEIR/EIS.

12D.3.4.2 Spawning and Egg Incubation

Green sturgeon reportedly tolerate spawning water temperatures ranging from 50 to 70°F (CDFG, 2001). Water temperature affects the following critical processes: 1) hatching rates, 2) rate and type of embryonic development, and 3) survival (Van Eenennaam et al., 2005, Werner et al., 2007). Water temperatures tolerances for green sturgeon during spawning and egg incubation also have been reported to range between 46° to 57°F (NMFS, 2009b), although eggs have been artificially incubated at temperatures as high as 60°F (Deng, 2000 *as cited in* NMFS, 2009b). However, suitable water temperatures for egg incubation in green sturgeon were reported by Van Eenennaam et al. (2005) to be between 52 and 63°F, with the upper limit of optimal water temperatures ranging from 63 to 64°F. Further, Van Eenennaam et al. (2005) reported that water temperatures greater than approximately 73°F led to complete mortality of embryos prior to hatching. Suitable water temperatures for green sturgeon spawning and egg incubation reportedly range from 46 to 57°F, while water temperatures ranging from 57 to 65°F are reported as tolerable (NMFS, 2009a).

Water temperatures not exceeding 62.6°F have been reported to permit normal North American green sturgeon larval development (Van Eenennaam et al., 2005 *as cited in* Heublein et al., 2009). Werner et al. (2007) suggests temperatures remain below 68°F for larval development. Temperatures of about 59°F are believed to be optimal for larval growth, whereas temperatures below about 52°F or above about 66°F may be detrimental for growth (Cech et al., 2000). Water temperatures above 68°F are reportedly lethal to North American green sturgeon embryos (Cech et al., 2000; Beamesderfer and Webb, 2002).

In addition to available literature evaluating empirical studies, the Sacramento River Ecological Flow Tool (SacEFT) Record of Design (v.2.00) (ESSA Technologies Ltd., 2011) was reviewed to identify water temperature thresholds used by DWR, The Nature Conservancy, and others for evaluating effects on green sturgeon eggs in the Sacramento River. The SacEFT Record of Design states, *"The best information we were able to use is based on in vitro studies (Cech et al., 2000) of larval development, which we adapted to create a quasi-mortality model in which larvae experience no mortality at temperatures below 17°C and complete mortality at temperatures at and above 20°C."* These temperatures correspond to 62.6 and 68°F, respectively.

Because available literature is not entirely in agreement regarding appropriate thermal tolerances for North American green sturgeon a bulk of evidence approach was utilized to identify an appropriate index value to be used for evaluating water temperature effects on green sturgeon spawning and embryo incubation. Based on Werner et al. (2007), Cech et al. (2000), Beamesderfer and Webb (2002), and the use of the SacEFT, an index value of 68°F was selected for evaluation purposes in this DEIR/EIS analysis.

12D.3.4.3 Juvenile Rearing and Emigration

NMFS (2009b) reports optimal water temperatures for the development of green sturgeon egg, larval, and juvenile life stages ranging between 52 and 66°F. Growth of juvenile green sturgeon is reportedly optimal at 59°F and reduced at both 51.8 and 66.2°F (Cech et al., 2000). According to NMFS (2009b) suitable water temperatures for juvenile green sturgeon should be below about 75°F. At temperatures above about 75°F, juvenile green sturgeon exhibit decreased swimming performance (Mayfield and Cech, 2004) and increased cellular stress (Allen et al., 2006). Optimum water temperatures for green sturgeon larvae reportedly are less than approximately 63°F (Israel and Klimley, 2008). Reproductive success and young-of-year recruitment may be negatively impacted when larvae are exposed to water temperatures greater than 68°F (Israel and Klimley, 2008). Optimal juvenile green sturgeon water temperatures reportedly range from 59 to 66°F (Israel and Klimley, 2008). Because several sources report that optimal green sturgeon larvae and juvenile growth occurs below approximately 66°F, it was selected as a water temperature index value for evaluation of juvenile rearing and emigration for evaluation purposes in this DEIR/EIS analysis.

12D.3.5 White Sturgeon

12D.3.5.1 Adult Immigration and Holding

Similar to North American green sturgeon, little detailed information exists regarding white sturgeon thermal tolerances. In fact, very little is known about adult white sturgeon habitat in the Sacramento River or Sacramento-San Joaquin Delta, though they are present throughout the river and Delta during the spring, fall, and winter (Israel et al., 2011). However, publication of the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) conceptual model for white sturgeon indicated that although adult white sturgeon begin to show signs of stress at temperatures above 68°F (20°C), the upper limit of suitable water temperatures for adult white sturgeon is reportedly 25°C (77°F) (Israel et al., 2011). Therefore, an index value of 77°F was used for evaluation purposes in this DEIR/EIS analysis.

12D.3.5.2 Spawning and Egg Incubation

White sturgeon spawning occurs from mid-February to late May when water temperatures are between 46 and 72°F, with peak spawning activity occurring during March and April (Israel et al., 2011).

Incubation length and success in white sturgeon is largely temperature dependent. Field studies have found eggs when water temperatures appear optimal for egg incubation on the Sacramento River (14°-16°C, (Israel et al., 2011). Additionally, white sturgeon egg incubation occurs between 11 and 20°C (~52 to 68°F), with optimal egg incubation occurring at water temperatures ranging from 14 to 16°C (~57 to 61°F) (Israel et al., 2011). Incubation water temperatures above 17°C (~63°F) reportedly result in premature hatching and higher mortality (Israel et al., 2011). Experiments showed the size of a white sturgeon larva was inversely related to water temperature during egg incubation (Israel et al., 2011). In experiments, incubation temperatures above 17°C resulted in premature hatching with higher mortality and no hatching at temperatures above 20°C (Israel et al., 2011).

An index value of 68°F was selected for this life stage for evaluation purposes in this DEIR/EIS analysis because white sturgeon embryo hatching reportedly does not occur above 68°F (20°C) (Israel et al., 2011).

12D.3.5.3 Juvenile Rearing and Emigration

White sturgeon are sensitive to temperature at early life stages. Slow growth and some mortality in juvenile white sturgeon kept in water temperatures above 20°C (68°F) has been observed, while larger juveniles were reported to show signs of stress above 19°C (~66°F). Additionally, young juvenile white sturgeon (0.5 to 0.6 g) grew significantly greater at 20 than 15°C. However, no growth difference was observed between 20 and 25°C, though increased temperatures led to increased activity in juvenile white sturgeon. Temperatures higher than 25°C are not tolerated by juvenile white sturgeon, and stress is observed near 20°C (Israel et al., 2011).

Because stress is observed in white sturgeon juveniles above approximately 66°F (19°C), it was selected as an index value for evaluation purposes in this DEIR/EIS.

12D.3.6 Pacific Lamprey and River Lamprey

Generally, lamprey biology is less well studied and understood than that of other fishes in the Central Valley and other California rivers (i.e., the Trinity River system). However, where literature is available, and specifically is available for California streams and rivers, the majority of information available seems to discuss Pacific lamprey. Specifically, Moyle (2002) stated that the biology of river lamprey has not been studied in California. However, Pacific and river lamprey overlap in habitat utilization for spawning and ammocoete rearing in the Sacramento River system with life history periodicity overlapping partially for spawning and completely for ammocoete rearing, indicating that habitat requirements likely are similar. Therefore, for purposes of evaluating potential water temperature effects on Pacific and river lamprey, one set of water temperature index values were used.

12D.3.6.1 Adult Spawning and Egg Incubation

River lamprey are reported to spawn at water temperatures ranging from 55.4 to 56.3°F (Wang, 1986). However, it is not likely that the species requires a water temperature range of 1.1°F. Therefore, these water temperatures were not relied upon for evaluation in this DEIR/EIS.

Pacific lamprey reportedly spawn where water temperatures are typically 12 to 18°C (53.6 to 64.4°F) (Moyle, 2002). Additionally, Moyle (2002) reported that Pacific lamprey embryos hatch in approximately 19 days at 15°C (59°F). Pacific lamprey laboratory studies and analyses in the Columbia River basin suggest that consistently high survival and low occurrence of embryonic developmental abnormalities occur as water temperatures increase from 10 to 18°C (50 to 64.4°F), with a significant decrease in survival and increase in developmental abnormalities at 22°C (~72 °F) (Meeuwig et al., 2002, Meeuwig et al., 2005).

Therefore, for purposes of evaluating potential water temperature impacts in this DEIR/EIS, a range of 50 to 64°F was utilized.

12D.3.6.2 Ammocoete Rearing and Emigration

Meeuwig et al. (2002) and Meeuwig et al. (2005) found a significant decrease in survival and increase in developmental abnormalities of Pacific lamprey larvae at 22°C (71.6°F) in a laboratory setting.

Laboratory studies and analyses suggest that consistently high survival and low occurrence of embryonic developmental abnormalities occur in Pacific lamprey and western brook lamprey at water temperatures ranging from 50 to 64.4°F, with a significant decrease in survival and increase in developmental abnormalities at 71.6°F (Meeuwig et al., 2002, Meeuwig et al., 2005), potentially indicating similar water temperature effects on river lamprey. Meeuwig et al. (2002) Meeuwig et al. (2005) identified 64.4 °F as the most beneficial temperature for survival of Pacific and western brook lampreys, which is similar to the thermal optima reported for survival of sea lampreys (Meeuwig et al., 2002, Meeuwig et. al, 2005).

Moyle et al. (1995) indicate that river lamprey eggs and ammocoetes may require water temperatures that do not exceed 25°C (77°F). However, the effect of temperatures exceeding this threshold on river lamprey eggs is unknown. The effects on this species are likely similar to and, for purposes of evaluation in this DEIR/EIS, are assumed to be similar to those for Pacific lamprey when water temperatures exceed 22°C (71.6°F) as described by Meeuwig et al. (2002); Meeuwig et al. (2005).

Therefore, in consideration of available information, an index value of 72°F was utilized to evaluate potential effects on Pacific and river lamprey.

12D.3.7 Hardhead

12D.3.7.1 Adult Spawning

Little is known about life stage-specific water temperature requirements of hardhead. Hardhead spawning has not been documented, and documentation regarding water temperatures associated with hardhead spawning is not widely available. However, Wang (1986) reported that temperatures for hardhead spawning range from 59 to 64.4°F.

Therefore, for purposes of this DEIR/EIS, a range of 59 to 64°F was utilized to evaluate hardhead spawning.

12D.3.7.2 Adults and Other Life Stages

Using samples of hardhead taken at 10 locations within water bodies of the San Joaquin drainage, it was determined that adults prefer water temperatures of 68°F (Moyle, 2002). Hardhead are reportedly found in streams with summer water temperatures above 20°C (68°F) (Moyle, 2002), while water temperatures ranging from 65°F (~18°C) to 75°F (~24°C) are believed to be suitable (Cech et al., 1990). Preliminary work suggests that adult hardhead acclimated to water temperatures below 20°C (68°F) prefer water temperatures at or above 20°C (68°F) (Southern California Edison Company, 2007). Under laboratory conditions, juvenile hardhead preferred water temperatures ranging from 75.2 to 82.4°F (24 to 28°C) (Moyle, 2002). Research indicates that hardhead generally selected water temperatures of 17 to 21°C (62.6 to 69.8°F) in a thermal plume in the Pit River (Moyle, 2002).

Based on the lowest and highest water temperatures reported in the body of literature related to hardhead, a water temperature range of 65 to 82°F was used to evaluate hardhead adults and other life stages.

12D.3.8 California Roach

12D.3.8.1 Adult Spawning

The California roach is generally found in small, warm intermittent streams throughout the Sacramento River drainage, and are most abundant in mid-elevation streams in the Sierra foothills (Moyle, 2002). However, they are habitat generalists, also being found in cold, well-aerated clear streams (Taylor et al., 1982 *as cited in* Moyle, 2002), in human-modified habitats and in the main channels of rivers (Moyle, 2002). The wide range of habitat conditions in which the California roach is found, as well as its widespread distribution in Central Valley tributaries, indicates a wide tolerance range for habitat variables including water temperature. However, little is known about life stage-specific water temperature requirements of California roach.

Research shows that California roach spawning is determined by water temperature, which must be approximately 60°F (16°C) for spawning to be initiated (Moyle et al., 1995). Additionally, reproduction generally occurs from March to June, usually when temperatures exceed 60.8°F, but may be extended through late July (Moyle, 2002). Therefore, 60°F was utilized as a water temperature index value for evaluation purposes in this DEIR/EIS.

12D.3.8.2 Adults and Other Life Stages

As described above, little information regarding water temperature tolerances for roach are available. However, Taylor et al. (1982 as cited in Moyle, 2002) indicated that California roach are tolerant of relatively high temperatures 30 to 35°C (86 to 95°F). Because it is unlikely that a water temperature index value of 95°F would provide meaningful information for impact assessment purposes, a water temperature index value of 86°F was used in this DEIR/EIS to evaluate California roach adults and other life stages.

12D.3.9 Sacramento Splittail

12D.3.9.1 Adult Spawning

Floodplain inundation during March and April appears to be the primary factor contributing to Sacramento splittail abundance (DWR, 2004). Moyle et al. (2003) reports that moderate to strong year classes of Sacramento splittail develop when floodplains are inundated for six to ten weeks between late February and late April.

Although floodplain inundation is the dominant factor in Sacramento splittail spawning success, a literature review of thermal tolerance studies and field observations conducted by DWR (2004), water temperatures between 45 and 75°F were considered to constitute the range of suitable Sacramento splittail spawning water temperatures.

Thus, for purposes of evaluation in this DEIR/EIS, the range of water temperatures from 45 to 75°F was used as an index of potential impact on Sacramento splittail.

12D.3.10 American Shad

12D.3.10.1 Adult Spawning, Embryo Incubation, and Initial Rearing

Water temperature is an important factor influencing the timing of spawning. American shad are reported to spawn at water temperatures ranging from approximately 46 to 79°F (7.8 to 26.1°C) (USFWS, 1967), although optimal spawning temperatures are reported to range from about 60 to 70°F (15.6 to 21.1°C) (Bell, 1986; CDFG, 1980; Leggett and Whitney, 1972; Painter et al., 1979; Rich, 1987a). The optimal water temperature for egg development is reported to occur at 62°F (16.7°C). At this temperature, eggs hatch in six to eight days; at water temperatures near 75°F (23.9°C), eggs would hatch in three days (Moyle, 2002).

Based on available information, a water temperature range of 60 to 70°F was utilized in this DEIR/EIS to evaluate potential effects on American shad adult spawning, embryo incubation, and initial rearing.

12D.3.10.2 Larvae, Fry, and Juvenile Rearing and Emigration

American shad migration into the Sacramento River occurs when water temperatures exceed 14°C. Peak American shad runs in the Sacramento River are reported to occur when water temperatures are between 17 and 24°C (62.6 and 75.2°F) (Moyle, 2002). Although these water temperature ranges are reported for American shad upmigrating adults, they are indicative of water temperatures suitable for larvae, fry, and juvenile American shad because spawning occurs shortly after immigration and incubation occurs relatively quickly. Therefore, juveniles are present when river temperatures are within those ranges reported for adults. Additionally, in the Sacramento River, juvenile American shad reportedly prefer water temperatures between 62.6 and 77°F (17 and 25°C) (Moyle, 2002).

Based on available information, a water temperature range of 63 to 77°F was utilized in this DEIR/EIS to evaluate potential effects on American shad larvae, fry, and juvenile rearing and emigration.

12D.3.11 Striped Bass

12D.3.11.1 Adult Spawning, Embryo Incubation, and Initial Rearing

Adult striped bass are present in Central Valley rivers throughout the year, with peak abundance occurring during the spring months. Adult and juvenile striped bass can survive temperatures as high as

34°C (93.2°F) for short periods of time. They are under stress after temperatures exceed 25°C (77°F), and temperatures over 30°C (86°F) are usually lethal (Moyle, 2002). Spawning reportedly does not occur until water temperatures reach 14°C (57.2°F), while optimal water temperatures for striped bass adult spawning, embryo incubation, and initial rearing are reported to range from approximately 15 to 20°C (59 to 68°F). Spawning ceases above 21°C (69.8°F) (Moyle, 2002).

Based on available information, a water temperature range of 59 to 68°F was utilized in this DEIR/EIS to evaluate potential effects on striped bass adult spawning, embryo incubation, and initial rearing.

12D.3.11.2 Larvae, Fry, and Juvenile Rearing and Emigration

One study reported that striped bass larvae can tolerate water temperatures from 12 to 23°C (53.6 to 73.4°F), while optimum water temperatures range from 16 to 19°C (60.8 to 66.2°F). Another study reported that striped bass larvae can tolerate water temperatures from 10 to 25°C (50 to 77°F), while optimum water temperatures range from 15 to 22°C (59 to 71.6°F). A third study also reported a larval striped bass tolerance range of 10 to 25°C (50 to 77°F), but an optimum water temperature tolerance range of 18 to 21°C (64.4 to 69.8°F). A fourth study reported that juvenile striped bass can tolerate water temperatures from 10 to 27°C (50 to 80.6°F), while optimum water temperatures range from 16 to 19°C (60.8 to 66.2°F). Optimal water temperatures for juvenile striped bass rearing have been reported to range from approximately 16 to 22°C (61 to 71°F) (Fay et al., 1983).

Based on available information, a water temperature range of 61 to 71°F was utilized in this DEIR/EIS to evaluate potential effects on striped bass adult spawning, embryo incubation, and initial rearing.

12D.3.12 Largemouth Bass

Juvenile and adult largemouth bass are generally tolerant of elevated water temperatures. For example, the upper optimal water temperature for adult and juvenile largemouth bass growth is reportedly approximately 86°F, while adult and juvenile largemouth bass can possibly tolerate water temperatures as high as or greater than 95°F (Moyle, 2002). Because simulated water temperatures under the influence of CVP and SWP reservoir operations would not be anticipated to reach or exceed the upper water temperature thresholds for warmwater game fishes, no evaluation of potential water temperature-related impacts was conducted. However, because water temperatures preferred during spawning are substantially lower than adult and juvenile water temperature thresholds, an evaluation of water temperature-related impacts on spawning largemouth bass was conducted.

12D.3.12.1 Adult Spawning

Some researchers report that largemouth bass spawning typically begins in the spring when the water temperature reaches 12.0 to 15.5°C (53.6 to 59.9°F) (Stuber et al., 1982). Others report that spawning has been recorded between 11.5 and 29.0° C (52.7 and 68°F), but most occurs between 16 and 22°C (60.8 and 71.6°F) (Stuber et al., 1982). Optimal temperatures for successful spawning and incubation are 20 to 21°C (68 to 69.8°F), with a range of 13 to 26°C (55.4 to 78.8°F) (Stuber et al., 1982). Literature from California, Arizona, and Nevada indicate that largemouth bass nest building begins at water temperatures of 15 to 16°C (59 to 60.8°F), while spawning may continue until water temperatures reach approximately 24°C (75.2°F) (Moyle, 2002).

Therefore, in consideration of available information, a range of 59 to 75°F was selected for use in this DEIR/EIS to evaluate potential effects on largemouth bass.

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