State of California
The Resources Agency
Department of Water Resources

Draft Final Report SP-T9
Recreation and Wildlife

Oroville Facilities Relicensing
FERC Project No. 2100

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REPORT SUMMARY

Relicensing stakeholders identified the need for an evaluation of the effects of current and future recreational use and development on wildlife and wildlife habitat during the collaborative process. Further, this evaluation provides information needed for the environmental documentation and review processes. Study objectives included:

- Identification of on-going and future recreation-related direct and indirect impacts to wildlife and plant communities.
- Identification opportunities to reduce or eliminate recreation-related impacts to wildlife and plant communities.

Current levels of recreation use and development are generally compatible with wildlife management goals and objectives. However, this evaluation identifies several opportunities to minimize or avoid wildlife/recreation conflicts at specific locations and during certain time periods.

The need for, and the location of, additional recreational developments has not been defined at this time. Resource sensitivity maps are presented in the report which should be useful for citing future recreational developments, while minimizing impacts to wildlife resources. These maps provide plant and animal location information related to:

- Habitats of species protected under the State or federal Endangered Species acts
- State and federal species of concern habitats
- At risk habitats including wetlands and riparian habitats
- Additionally, the report identifies the following 48 measures that have the potential to reduce or eliminate conflicts between current and future recreation use/development and wildlife management objectives within the project area. These measures are outlined in Section 5.6 of this report.

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1.0 INTRODUCTION

The potential impacts of current recreational use and future recreational use/development on wildlife were identified by stakeholders as a relicensing issue. Study Plan-T9 was developed collaboratively with stakeholders to evaluate the potential impacts associated with recreation and wildlife within the project vicinity. Data collection occurred between February 2002 and March 2004. This report summarizes the results of data analyses. Results are presented by study plan task.

Study objectives include:

- Identification of on-going and future recreation-related direct and indirect impacts to wildlife and plant communities.
- Identification opportunities to reduce or eliminate recreation-related impacts to wildlife and plant communities.

This study report is organized into seven sections. Section 1.0, Introduction, provides a brief overview of the purpose and objectives of the study as well as background information on the Oroville facilities. Section 1.0 also includes a synopsis of selected literature related to the effects of recreation on wildlife and wildlife habitats. Section 2.0, Need for Study, describes why the study is necessary to support Relicensing. Section 3.0, Study Objective(s), describes the purpose of the study. Section 4.0, Methodology, outlines how data collection occurred relative to each study task. Section 5.0, Results and Discussion, identifies and discusses areas of potentially significant wildlife/recreation conflict. Section 6.0, Analyses, discusses potential mechanisms or actions which could serve to limit or avoid potential wildlife/recreation conflicts. Section 7.0, References Cited, listed the data sources and references used in this study. In addition to these seven sections, Appendix A includes a literature review of the effects of recreation on wildlife resources. Appendix B includes California Wildlife Habitat Relationship (CWHR) model predictions of wildlife species occurrence within and adjacent to major project recreational developments.

1.1 BACKGROUND INFORMATION

The project area is one of the major recreation areas in Northern California with an estimated 1.7 million-visitor days use per year (CDWR 2004a). Recreational use in many forms occurs throughout the year with peak use occurring between May and September. These recreational uses include camping, boating, fishing, hunting, bird watching/nature study, horseback riding, hiking, biking, swimming, sailing, and picnicking.

Recreational developments impact wildlife and plant communities through direct loss due to habitat conversion (roads, boat ramps, campgrounds, trails, swimming beaches, parking lots, utilities, sewage systems, hatcheries, buildings, storage areas, fuel breaks, marinas, and other developments).

Literature review indicates that recreational activity can serve to:

- reduce populations of some wildlife species (Ream 1976; Garber and Burger, 1995; Hecnar and M'Closkey, 1998)
- reduce species productivity (Swenson, 1979; Levenson and Koplin, 1984; White and Thurow, 1985; Miller et al., 1998; Conservation Committee Report, 1978; Burger, 1998; Luckenbach,, 1978; Yarmoloy et al., 1988; Liddle and Scorgie, 1980; Hockin et al., 1992; Korschgen and Dahlgren, 1992; Knight and Cole (2), 1995; Anderson, 1995)
- modify wildlife species occurrence and densities (Clevenger and Workman, 1977; Boyle and Sampson, 1985; Blakesley and Reese, 1988; Knight and Cole, 1991; Hickman, 1990; Gutzwiller et al., 2002; Robertson and Flood, 1980)
- attract nuisance species or non-native species (Merrill, 1978; Knight and Cole, 1991; Hickman, 1990; Cole and Landres, 1996)
- increase disturbance/displacement (Ream 1976; Boyle and Sampson, 1985; Vos et al., 1985; Fraser et al., 1985; Freddy et al., 1986; Buehler et al., 1991; Mainini et al., 1993; Holmes et al., 1993; Knight and Cole, 1995; Joslin and Youmans, 1999; Conservation Committee Report, 1978; Liddle and Scorgie, 1980; Bouffard, 1982; Korschgen et al., 1985; Jackman et al., 1988; Kahl, 1991; Anthony et al., 1995; Grubbs et al., 2002; Rodgers and Schwikert, 2002; Batten, 1977; Kaiser and Fritzell, 1984; Knight and Knight, 1984; Steidl and Anthony, 1996; Burger, 1998; Busack and Bury, 1974; Yarmoloy et al., 1988; Stalmaster and Newman, 1978; Bell and Austin, 1985; Knight et al., 1991; Yalden, 1992; Knapton et al., 2000; Hockin et al., 1992; Boroski and Mossman, 1988; Anderson, 1995; Detrich, 1977; Van der Zande et al., 1984)
- increase predation rates (Miller and Hobbs, 2000; Denny, 1974; Boyle and Sampson, 1985; Joslin and Youmans, 1999)
- increase habitat degradation (Joslin and Youmans, 1999; Conservation Committee Report, 1978; Liddle and Scorgie, 1980; Busack and Bury, 1974; Luckenbach, 1978; Whinam et al., 1994; Cole and Landres, 1996),
- reduce physical condition (Mainini et al., 1993; Anderson, 1995; Korschgen and Dahlgren, 1992; Knight and Cole (2), 1995)
- cause direct mortality (Denny, 1974; Knight and Cole, 1995; Joslin and Youmans, 1999; Luckenbach, 1978; Melvin et al., 1994)

Other potential direct and indirect impacts to wildlife and plant communities are associated with recreation related maintenance activities, soil erosion, chemical contamination, fencing, herbicide and pesticide use.

Study Objectives include:

- Identification of on-going and future recreation-related direct and indirect impacts to wildlife and plant communities.
- Identification of opportunities to reduce or eliminate recreation-related impacts to wildlife and plant communities.

1.1.1 Statutory/Regulatory Requirements

The results of this study are required for both California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) compliance. Further, identification of potential recreational impacts to State and federal special status species is required for compliance with the State and federal Endangered Species acts

1.1.2 Study Area

The study area considered in this report includes areas within the FERC project boundary and other areas potentially affected by Project recreation facilities and use. Data collection on wildlife and habitat use took place outside the FERC boundary when evidence indicates that recreational disturbances extend beyond the FERC boundary. When surveys extend beyond the FERC boundary, the rationale and justification for additional data collection was provided within the survey report.

1.2 DESCRIPTION OF FACILITIES

The Oroville Facilities were developed as part of the State Water Project (SWP), a water storage and delivery system of reservoirs, aqueducts, power plants, and pumping plants. The main purpose of the SWP is to store and distribute water to supplement the needs of urban and agricultural water users in northern California, the San Francisco Bay area, the San Joaquin Valley, and southern California. The Oroville Facilities are also operated for flood management, power generation, to improve water quality in the Delta, provide recreation, and enhance fish and wildlife.

FERC Project No. 2100 encompasses 41,100 acres and includes Oroville Dam and Reservoir, three power plants (Hyatt Pumping-Generating Plant, Thermalito Diversion Dam Power Plant, and Thermalito Pumping-Generating Plant), Thermalito Diversion Dam, the Feather River Fish Hatchery and Fish Barrier Dam, Thermalito Power Canal, Oroville Wildlife Area (OWA), Thermalito Forebay and Forebay Dam, Thermalito Afterbay and Afterbay Dam, and transmission lines, as well as a number of recreational facilities. An overview of these facilities is provided on Figure 1.2-1. The Oroville Dam, along with two small saddle dams, impounds Lake Oroville, a 3.5-million-acre-feet (maf) capacity storage reservoir with a surface area of 15,810 acres at its normal maximum operating level.

The hydroelectric facilities have a combined licensed generating capacity of approximately 762 megawatts (MW). The Hyatt Pumping-Generating Plant is the largest of the three power plants with a capacity of 645 MW. Water from the six-unit underground power plant (three conventional generating and three pumping-generating units) is discharged through two tunnels into the Feather River just downstream of Oroville Dam. The plant has a generating and pumping flow capacity of 16,950 cfs and

5,610 cfs, respectively. Other generation facilities include the 3-MW Thermalito Diversion Dam Power Plant and the 114-MW Thermalito Pumping-Generating Plant.

Thermalito Diversion Dam, four miles downstream of the Oroville Dam, creates a tail water pool for the Hyatt Pumping-Generating Plant and is used to divert water to the Thermalito Power Canal. The Thermalito Diversion Dam Power Plant is a 3-MW power plant located on the left abutment of the Diversion Dam. The power plant releases a maximum of 615 cubic feet per second (cfs) of water into the river.

The Power Canal is a 10,000-foot-long channel designed to convey generating flows of 16,900 cfs to the Thermalito Forebay and pump-back flows to the Hyatt Pumping-Generating Plant. The Thermalito Forebay is an off-stream regulating reservoir for the 114-MW Thermalito Pumping-Generating Plant. The Thermalito Pumping-Generating Plant is designed to operate in tandem with the Hyatt Pumping-Generating Plant and has generating and pump-back flow capacities of 17,400 cfs and 9,120 cfs, respectively. When in generating mode, the Thermalito Pumping-Generating Plant discharges into the Thermalito Afterbay, which is contained by a 42,000-foot-long earth-fill dam. The Afterbay is used to release water into the Feather River downstream of the Oroville Facilities, helps regulate the power system, provides storage for pump-back operations, and provides recreational opportunities. Several local irrigation districts receive water from the Afterbay.

The Feather River Fish Barrier Dam is downstream of the Thermalito Diversion Dam and immediately upstream of the Feather River Fish Hatchery. The flow over the dam maintains fish habitat in the low-flow channel of the Feather River between the dam and the Afterbay outlet, and provides attraction flow for the hatchery. The hatchery was intended to compensate for spawning grounds lost to returning salmon and steelhead trout from the construction of Oroville Dam. The hatchery can accommodate 15,000 to 20,000 adult fish annually.

The Oroville Facilities support a wide variety of recreational opportunities. They include: boating (several types), fishing (several types), fully developed and primitive camping (including boat-in and floating sites), picnicking, swimming, horseback riding, hiking, off-road bicycle riding, wildlife watching, hunting, and visitor information sites with cultural and informational displays about the developed facilities and the natural environment. There are major recreation facilities at Loafer Creek, Bidwell Canyon, the Spillway, North and South Thermalito Forebay, and Lime Saddle. Lake Oroville has two full-service marinas, five car-top boat launch ramps, ten floating campsites, and seven dispersed floating toilets. There are also recreation facilities at the Visitor Center and the OWA.

The OWA comprises approximately 11,000-acres west of Oroville that is managed for wildlife habitat and recreational activities. It includes the Thermalito Afterbay and surrounding lands (approximately 6,000 acres) along with 5,000 acres adjoining the

Feather River. The 5,000 acre area straddles 12 miles of the Feather River, which includes willow and cottonwood lined ponds, islands, and channels. Recreation areas include dispersed recreation (hunting, fishing, and bird watching), plus recreation at developed sites, including Monument Hill day use area, model airplane grounds, three boat launches on the Afterbay and two on the river, and two primitive camping areas. California Department of Fish and Game's (DFG) habitat enhancement program includes a wood duck nest-box program and dry land farming for nesting cover and improved wildlife forage. Limited gravel extraction also occurs in a number of locations.

1.3 CURRENT OPERATIONAL CONSTRAINTS

Operation of the Oroville Facilities varies seasonally, weekly and hourly, depending on hydrology and the objectives that the California Department of Water Resources (DWR) is trying to meet. Typically, releases to the Feather River are managed to conserve water while meeting a variety of water delivery requirements, including flow, temperature, fisheries, recreation, diversion and water quality. Lake Oroville stores winter and spring runoff for release to the Feather River as necessary for project purposes. Meeting the water supply objectives of the SWP has always been the primary consideration for determining Oroville Facilities operation (within the regulatory constraints specified for flood control, in-stream fisheries, and downstream uses). Power production is scheduled within the boundaries specified by the water operations criteria noted above. Annual operations planning are conducted for multi-year carry over. The current methodology is to retain half of the Lake Oroville storage above a specific level for subsequent years. Currently, that level has been established at 1,000,000 acre-feet (af); however, this does not limit draw down of the reservoir below that level. If hydrology is drier than expected or requirements greater than expected, additional water would be released from Lake Oroville. The operations plan is updated regularly to reflect changes in hydrology and downstream operations. Typically, Lake Oroville is filled to its maximum annual level of up to 900 feet above mean sea level (msl) in June and then can be lowered as necessary to meet downstream requirements, to its minimum level in December or January. During drier years, the lake may be drawn down more and may not fill to the desired levels the following spring. Project operations are directly constrained by downstream operational constraints and flood management criteria as described below.

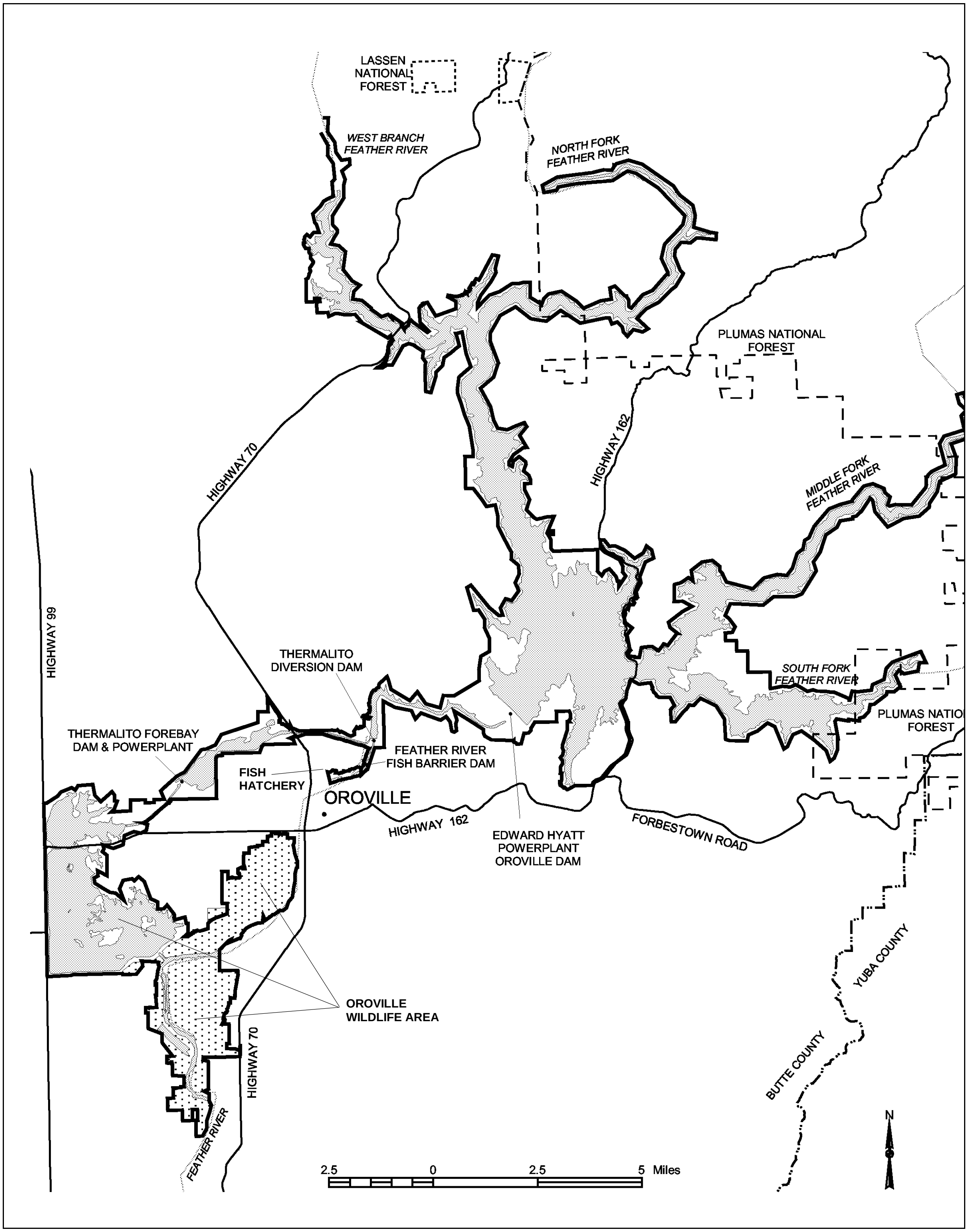

Figure 1.2-1 Oroville Facilities FERC Project Boundary

1.3.1 Downstream Operation

An August 1983 agreement between DWR and DFG entitled, "Agreement Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish & Wildlife," sets criteria and objectives for flow and temperatures in the low flow channel and the reach of the Feather River between Thermalito Afterbay and Verona. This agreement: (1) establishes minimum flows between Thermalito Afterbay Outlet and Verona which vary by water year type; (2) requires flow changes under 2,500 cfs to be reduced by no more than 200 cfs during any 24-hour period, except for flood management, failures, etc.; (3) requires flow stability during the peak of the fall-run Chinook spawning season; and (4) sets an objective of suitable temperature conditions during the fall months for salmon and during the later spring/summer for shad and striped bass.

1.3.1.1 Instream Flow Requirements

The Oroville Facilities are operated to meet minimum flows in the Lower Feather River as established by the 1983 agreement (see above). The agreement specifies that Oroville Facilities release a minimum of 600 cfs into the Feather River from the Thermalito Diversion Dam for fisheries purposes. This is the total volume of flows from the diversion dam outlet, diversion dam power plant, and the Feather River Fish Hatchery pipeline.

Generally, the instream flow requirements below Thermalito Afterbay are 1,700 cfs from October through March, and 1,000 cfs from April through September. However, if runoff for the previous April through July period is less than 1,942,000 af (i.e., the 1911-1960 mean unimpaired runoff near Oroville), the minimum flow can be reduced to 1,200 cfs from October to February, and 1,000 cfs for March. A maximum flow of 2,500 cfs is maintained from October 15 through November 30 to prevent spawning in overbank areas that might become de-watered.

1.3.1.2 Temperature Requirements

The Diversion Pool provides the water supply for the Feather River Fish Hatchery. The hatchery objectives are 52°F for September, 51°F for October and November, 55°F for December through March, 51°F for April through May 15, 55°F for last half of May, 56°F for June 1-15, 60°F for June 16 through August 15, and 58°F for August 16-31. A temperature range of plus or minus 4°F is allowed for objectives, April through November.

There are several temperature objectives for the Feather River downstream of the Afterbay Outlet. During the fall months, after September 15, the temperatures must be suitable for fall-run Chinook. From May through August, they must be suitable for shad, striped bass, and other warmwater fish.

The National Marine Fisheries Service has also established an explicit criterion for steelhead trout and spring-run Chinook salmon. Memorialized in a biological opinion on the effects of the Central Valley Project and SWP on Central Valley spring-run Chinook and steelhead as a reasonable and prudent measure; DWR is required to control water temperature at Feather River mile 61.6 (Robinson's Riffle in the low-flow channel) from June 1 through September 30. This measure requires water temperatures less than or equal to 65°F on a daily average. The requirement is not intended to preclude pump-back operations at the Oroville Facilities needed to assist the State of California with supplying energy during periods when the California ISO anticipates a Stage 2 or higher alert.

The hatchery and river water temperature objectives sometimes conflict with temperatures desired by agricultural diverters. Under existing agreements, DWR provides water for the Feather River Service Area (FRSA) contractors. The contractors claim a need for warmer water during spring and summer for rice germination and growth (i.e., 65°F from approximately April through mid May, and 59°F during the remainder of the growing season). There is no obligation for DWR to meet the rice water temperature goals. However, to the extent practical, DWR does use its operational flexibility to accommodate the FRSA contractor's temperature goals.

1.3.1.3 Water Diversions

Monthly irrigation diversions of up to 190,000 (July 2002) af are made from the Thermalito Complex during the May through August irrigation season. Total annual entitlement of the Butte and Sutter County agricultural users is approximately 1 maf. After meeting these local demands, flows into the lower Feather River continue into the Sacramento River and into the Sacramento-San Joaquin Delta. In the northwestern portion of the Delta, water is pumped into the North Bay Aqueduct. In the south Delta, water is diverted into Clifton Court Forebay where the water is stored until it is pumped into the California Aqueduct.

1.3.1.4 Water Quality

Flows through the Delta are maintained to meet Bay-Delta water quality standards arising from DWR's water rights permits. These standards are designed to meet several water quality objectives such as salinity, Delta outflow, river flows, and export limits. The purpose of these objectives is to attain the highest water quality, which is reasonable, considering all demands being made on the Bay-Delta waters. In particular, they protect a wide range of fish and wildlife including Chinook salmon, Delta smelt, striped bass, and the habitat of estuarine-dependent species.

1.3.2 Flood Management

The Oroville Facilities are an integral component of the flood management system for the Sacramento Valley. During the wintertime, the Oroville Facilities are operated under flood control requirements specified by the U.S. Army Corps of Engineers (USACE). Under these requirements, Lake Oroville is operated to maintain up to 750,000 af of storage space to allow for the capture of significant inflows. Flood control releases are based on the release schedule in the flood control diagram or the emergency spillway release diagram prepared by the USACE, whichever requires the greater release. Decisions regarding such releases are made in consultation with the USACE.

The flood control requirements are designed for multiple use of reservoir space. During times when flood management space is not required to accomplish flood management objectives, the reservoir space can be used for storing water. From October through March, the maximum allowable storage limit (point at which specific flood release would have to be made) varies from about 2.8 to 3.2 maf to ensure adequate space in Lake Oroville to handle flood flows. The actual encroachment demarcation is based on a wetness index, computed from accumulated basin precipitation. This allows higher levels in the reservoir when the prevailing hydrology is dry while maintaining adequate flood protection. When the wetness index is high in the basin (i.e., wetness in the watershed above Lake Oroville), the flood management space required is at its greatest amount to provide the necessary flood protection. From April through June, the maximum allowable storage limit is increased as the flooding potential decreases, which allows capture of the higher spring flows for use later in the year. During September, the maximum allowable storage decreases again to prepare for the next flood season. During flood events, actual storage may encroach into the flood reservation zone to prevent or minimize downstream flooding along the Feather River.

2.0 NEED FOR STUDY

Both direct and indirect impacts to wildlife and the plant communities that support them may occur as a result of the high level of recreational use in portions of the project area. Levels of recreational development and use are likely to increase in the future, resulting in localized and area-wide impacts to wildlife and their habitats. However, opportunities exist to reduce both on-going and future recreational impacts through project citing, project design, area closures, seasonal closures, habitat improvements, modification of maintenance practices, restrictions on certain types of recreational use, public education, and other practices.

The results of this study are required for both CEQA and NEPA compliance. Further identification of potential recreational impacts to State and federal special status species is required for compliance with the Endangered Species acts. Results of this study may lead to protection, mitigation, and enhancement measures incorporated into the license or development of conservation measures within the Section 7 ESA consultation process.

3.0 STUDY OBJECTIVE(S)

- Identification of on-going and future recreation-related direct and indirect impacts to wildlife and plant communities.
- Identification of opportunities to reduce or eliminate recreation-related impacts to wildlife and plant communities.

3.1 APPLICATION OF STUDY INFORMATION

The information provided in this report can be utilized in a variety of ways including:

- Impact assessment and avoidance
- Development of protection, mitigation and enhancement (PM&E) measures
- Input to other relicensing study plans
- Project operations scheduling and planning

3.1.2 Environmental Documentation

In addition to meeting FERC guidelines, the information provided in this report is required for compliance with State and federal environmental regulations including:

- California Environmental Quality Act
- National Environmental Policy Act
- California Endangered Species Act (CESA)
- Federal Endangered Species Act (FESA)
- Federal Power Act (FPA)
- Federal Migratory Bird Treaty Act (FMBTA)

3.1.3 Settlement Agreement

DWR or stakeholders may utilize the information in this report to identify potential PM&E measures appropriate for Settlement Agreement.

4.0 METHODOLOGY

A variety of survey methods and data sources were used in this study. Methodologies associated with each task are identified below.

4.1 STUDY DESIGN

4.1.1 Task 1

Task 1 involved wildlife habitat mapping within the project area in Geographic Information System (GIS) format. Habitat mapping was conducted using the California Wildlife Habitat Relationships (CWHR) classification system and presented in Appendix B of Relicensing Study Report-T4 (CDWR 2003a). GIS mapping allows wildlife habitats associated with each recreation facility or area to be identified. Use of the CWHR classification system allows use of the CWHR database to predict wildlife species occurrence associated with mapped wildlife habitat types including those associated with recreational facilities or areas.

4.1.2 Task 2

Task 2 involved mapping (GIS format) of all wildlife special status species sightings within and adjacent to the project area. These data were initially collected and reported under Relicensing Study Report T2 (CDWR 2003b). GIS mapping of special status species habitats within and adjacent to recreational facilities or areas was used to identify potential recreation/wildlife conflicts and to design minimization and avoidance measures for State and federal ESA compliance.

4.1.3 Task 3

Task 3 involved identification of current and potential future recreational developments and associated maintenance practices. Future recreational developments have not been identified at this time and are unlikely to be identified prior to Settlement. However, both the Environmental Work Group and the Cultural Resources Work Group have provided the Recreation and Socioeconomic Work Group with resource sensitivity maps. These maps identify areas where, based on current information, future recreational development can occur with minimal risk to environmental or cultural resources.

4.1.4 Task 4

Task 4 involves GIS mapping of existing recreation developments and associated maintenance practices identified in Task 3. Current recreational facilities were mapped in Relicensing Study Plan T1 (CDWR 2003b). Likewise, SP-T1 included an evaluation of the project effects on wildlife species and habitats of ongoing maintenance practices related to recreational facilities. Identification of areas where maintenance practices occur was developed from review of Operations and Maintenance plans and through DWR, DFG, and California Department of Parks and Recreation (DPR) maintenance staff interviews. These data sources identified the frequency, timing, and location of maintenance activities. Recreation facility classifications used in GIS mapping include:

Facilities
Includes facilities consisting primarily of concrete and steel structures with no vegetation (including landscaping). Category includes some dams, fish hatchery, equipment storage areas, power canal, spillway, unvegetated sewer ponds, tanks, and parking lots that go with them.

Habitat Improvement
Habitat improvement areas include brood ponds, nest cover, and forage enhancement areas. These areas received disproportionately higher recreation use than unmanipulated habitats.

Miscellaneous Disturbed
Miscellaneous disturbed usually included graded areas beside roads or other facilities, often embankments. These areas may have some rather degraded herbaceous/weedy vegetation on parts.

Recreation Boating Facilities
Boating facilities include unvegetated boat ramps, marinas, cartop boat launch sites, and their associated parking lots.

Recreation Campgrounds
Campgrounds include the vegetated campsites, excluding the roads that go thru them, which are separately mapped, as “Roads”. This facility type also includes the parking lots associated with campgrounds. Also includes boat-in and primitive campgrounds.

Recreation Day Use
Includes all designated Day Use Area lands that are not also roads. Category does include the Day Use area parking lots. Also included are miscellaneous recreation sites such as picnic areas, shooting areas, Foreman Creek road networked area, a Swim Beach, Model Airplane Club, and a Group Staging Area. Moderately high disturbance and some natural vegetation, some landscaping.

Recreation Facilities
Moderate amount of disturbance with some landscaping. Has structures such as entrance area to Loafer Creek Recreation Area, the Bidwell Canyon Visitor’s Center, Campfire circle and some parking lots associated with some of the above.

Recreation Trails

All trails not also mapped in the middle of (and therefore attributed as) roads. Trails data were primarily developed from Global Positioning Satellite (GPS) data, but a few were added after the fact from aerial photo interpretation. Category includes trail substrate (dirt, wooden, gravel, and paved surfaces, as well as unknown surfaces).

Recreation General
All raw land, with natural vegetation, but probably minor disturbance, within designated Recreation Areas but not otherwise mapped as roads, facilities, trails etc.

Roads
Includes all roads, including those that also coincide with trails or levees. GIS data developed from both GPS and aerial photo interpretation. Category includes paved, gravel and dirt surfaces, and many unknown surfaces. All have acreages since they are polygons (so no need to assign widths to certain types etc.).

4.1.5 Task 5

Task 5 includes collection and evaluation of recreation use levels by season, location, and use type. These data were provided by Relicensing Study R-9 (CDWR 2004a)

4.1.6 Task 6

Two subtasks are included in Task 6 including:

- Seasonal field evaluations conducted throughout the study area to identify areas of potential wildlife/recreational conflicts.
- Direct and indirect habitat loss/conversion was estimated for each recreational facility.

Quarterly surveys of high recreation use areas and facilities were conducted between March 2002 and September 2003. These surveys were both qualitative and quantitative in nature and included evaluation of:

- Recreational disturbance of nesting bald eagles, peregrine falcons, and Swainson’s hawks
- Off-Road Vehicle (ORV) impacts to vernal pool habitats
- Seasonal trail use on nesting waterfowl
- ORV and trail use damage to valley elderberry longhorn beetle habitat (VELB)
- Watercraft impacts on nesting grebes

Direct habitat acreage losses associated with existing recreational facilities were identified in Relicensing Study T-1. Indirect habitat losses were projected based on both buffered direct habitat loss calculations and qualitative and quantitative evaluations conducted as part of Task 6.

4.1.7 Task 7

Task 7 involved development of site-specific alternative actions to reduce or eliminate current and future wildlife/recreation use conflicts based on Tasks 1 through 6.

5.0 STUDY RESULTS

5.1 TASK 1-CWHR HABITAT MODELING

CWHR modeling indicate that the habitats present within the project area could support up to 340 vertebrate wildlife species including 13 amphibians, 22 reptiles, 241 birds, and 64 mammals (SP-T4 Final Report). Concentrated recreation use occurs only within a few areas and habitats within the project area. Table 5.1.1 identifies major recreation facilities within the project area, acreage of CWHR wildlife habitats, and estimated recreational use (CDWR 2004a)).

Table 5.1.1 Summary Of Recreation Use And Wildlife Habitat Acreage Associated With Major Recreation Facilities

Major Recreation Facilities	Estimated Total Recreational Use (recreation days)	Acreage by CWHR Habitat Type
Bidwell Canyon Complex	217,709	AGS-5.8 BAR-6.1 BOP-77.0 FEW-0.34 MCH-1.9 URB-20.83 VRI-0.23
Loafer Creek Complex	89,544	AGS-12.1 BAR-7.5 BOP-563.93 BOW-69.4 MCH-1.98 MHC-6.45 MHW-299.74 MRI-0.78 URB-13.2
Lime Saddle Complex	162,220	AGS-49.9 BAR-2.4 BOP-36.12 BOW-87.06 FEW-0.2 LAC-1.9 MCH-14.63 MHW-146.61 MRI-1.01 URB-12.3 VRI-1.11
Spillway Boat Ramp	80,516	URB-18.4

Oroville Dam Overlook	189,765	BAR-5.2 BOP-1.4 URB-7.7
Lake Oroville Visitors Center	93,553	BOP-12.6 URB-5.8
North Forebay	86,065	AGS-94.21 FEW-7.71 URB-38.2 VRI-2.78
Monument Hill	56,767	AGS-0.1 URB-3.66
Afterbay Outlet	84,966	BAR-139.3 FEW-3.8 LAC-5.8 URB-153.2 VRI-74.8
Feather River Fish Hatchery	160,395	AGS-0.12 BOP-0.12 URB-19.4 VRI-1.59
CWHR Key AGS-annual grassland URB-Urban LAC-lacustrine MCH-Mixed chaparral	BOP-Blue oak/foothill pine BOW-Blue oak woodland VRI-Valley/foothill riparian MRI-Montane riparian MHC-Montane hardwood-conifer	BAR-Barren FEW-freshwater emergent wetland MHW-Montane hardwood

Major recreation facilities are defined as localized areas which receive greater than 50,000 visitor use days/year and includes Bidwell Canyon Complex, Loafer Creek Complex, Lime Saddle Complex, Spillway Boat Ramp, Oroville Dam Overlook, Lake Oroville Visitors Center, North Forebay, Monument Hill, Afterbay Outlet, and the Feather River Fish Hatchery.

CWHR modeling predicts that wildlife habitats associated with major recreational facilities can support up to 189 vertebrate wildlife species including 3 amphibians, 5 reptiles, 155 birds, and 26 mammals (Appendix B).

Recreational activities and facilities can affect wildlife in several ways including direct loss of habitat (roads, trails, parking areas, campgrounds, boat ramps and other facilities) habitat modification and disturbance/displacement. This assessment deals specifically with habitat modifications associated with Lake Oroville recreation facilities. Acreage of direct habitat loss are further quantified and discussed under Task 6.

This assessment is based on observations conducted during new campground, road, and trail construction as well as during facilities maintenance activities. For the purpose of these analyses, paved, graveled, or graded facilities including roads, parking lots, and boat ramps are considered direct habitat loss. Only minor wildlife use of these areas by a very limited number of species is predicted. Indirect habitat loss includes habitat modifications associated with recreational facilities which may alter species composition or use. These recreational development and maintenance activities primarily affect wildlife habitat through reduced canopy coverage, loss of natural cavities, snags, and large woody debris, and reduced shrub understory.

Projected species impacts are based on the CWHR predictions. CWHR was used to identify all wildlife species associated with an affected habitat element. These element/species predictions were screened to exclude species absent from Butte County. CWHR element species predictions have a three tiered hierarchy:

- Essential- if this element is absent, then species dependent upon this element will also be absent from otherwise suitable habitat.
- Secondarily Essential-this element is considered essential unless it is compensated for by the presence of other Secondarily Essential elements
- Preferred- these elements are preferred by the species and enhance habitat capability for the species, but is not essential for the species.

The vast majority of recreational facilities within the project area are within blue oak/foothill pine habitat (Table 5.1.1). A relatively small acreage of grassland habitats also contain roads, trails, boat ramps, parking areas and other recreational developments. However, this assessment focuses on indirect habitat modifications within blue oak/foothill pine habitat.

Campground construction is planned to minimize habitat impacts especially removal of mature trees. However, construction of roads, parking, buildings, and other facilities results in direct habitat loss which includes removal of some mature trees. The amount of direct habitat loss and loss of mature trees increases with percent slope as cut and fill slopes associated with roads, parking areas remove more habitat on steep slopes than on more gentle slopes. As trees are removed, canopy coverage is decreased. However, average tree size is generally not substantially altered. In a blue oak/foothill pine community minor decreases in canopy coverage do not result in the loss of any wildlife species from the community. CWHR modeling indicate that even a relatively major opening of the canopy from a dense stand (> 60 percent canopy closure) to an open stand (25 to 40 percent canopy cover) produce minimal changes in the species composition or habitat suitability for species occurring in this habitat. Trail construction generally does not require removal of mature trees and only minor removal of shrub understory.

Campground construction does result in removal of some mature trees primarily oaks or foothill pines. These trees (especially oaks) frequently contain cavities. Cavities are an essential habitat component for a number of species which commonly occur in the blue oak/foothill pine community. These species include acorn woodpecker, American kestrel, ash-throated flycatcher, Bewick's wren, bufflehead, Lewis' woodpecker, northern saw-whet owl, western gray squirrel, western screech owl, and wood duck. Table 5.1.2 identifies the number of species of amphibian, reptile, bird, or mammal in the project area which could be adversely impacted by loss of tree cavities.

Table 5.1.2 Wildlife Groups Potentially Affected By Loss Of Tree Cavities.

Criteria	Amphibian	Reptile	Bird	Mammal
# of species which use tree cavities	0	0	43	27
# of non-native species that use tree cavities	0	0	2	0
# of species where tree cavities are Essential	0	0	11	3
# of species where tree cavities are of Secondary Essential	0	0	21	10
# of species which Prefer tree cavities	0	0	11	14
# of DFG harvest species which use tree cavities	0	0	3	9
# of special status species which use tree cavities	0	0	5	6

Snags are a potential hazard to recreational users, recreational facilities, utilities, and campground construction workers. Snags are frequently removed during recreation facility construction and during maintenance activities. Large snags are not identified as essential for any species in the blue oak/foothill pine habitat (Table 5.1.3). However, the presence of sound or rotten snags can improve habitat for a variety of species including acorn woodpecker, double crested cormorant, downy woodpecker, ermine, flammulated owl, long-tailed weasel, northern pygmy owl, northern saw-whet owl, osprey, pileated woodpecker, Vaux's swift, western bluebird, western spotted skunk, white-breasted nuthatch, hairy woodpecker, chestnut-backed chickadee, mountain chickadee, northern flicker, oak titmouse, purple martin, pygmy nuthatch, raccoon, red fox, red-breasted nuthatch, red-breasted sapsucker, ringtail, tree swallow, violet green swallow, western bluebird, and Williamson's sapsucker.

Table 5.1.3 Wildlife Groups Potentially Affected By Removal Of Snags

Criteria	Amphibian	Reptile	Bird	Mammal
# of species which use snags	0	0	58	33
# of non-native species that use snags	0	0	2	1
# of species where snags are Essential	0	0	0	0
# of species where snags are of Secondarily Essential	0	0	20	11
# of species which Prefer snags	0	0	38	22

# of DFG harvest species which use snags	0	0	4	13
# of special status species which use snags	0	0	16	6

Removal of snags during recreation facility construction and maintenance also leads to reduced accumulation of dead and down woody material. Even when snags are dropped and left on the ground they are subject to use as campground fuelwood. These materials can also provide habitat for a variety of wildlife species (Table 5.1.4) including long-tailed weasel, winter wren, sharp-tailed snake, western spotted skunk, California slender salamander, ensatina, pileated woodpecker, western skink, western toad, bobcat, raccoon, red fox, ringtail, and rubber boa.

Table 5.1.4 Wildlife Groups Potentially Affected By Loss Of Large Woody Debris

Criteria	Amphibian	Reptile	Bird	Mammal
# of species which use down logs	5	19	10	30
# of non-native species that use down logs	0	0	0	4
# of species where down logs are Essential	0	0	0	0
# of species where down logs are of Secondarily Essential	3	3	2	11
# of species which Prefer down logs	2	16	8	19
# of DFG harvest species which use down logs	0	0	2	14
# of special status species which use down logs	1	1	0	2

Recreational developments frequently include a variety of buildings or structures including restrooms, shade structures, visitor's centers, kiosks, pump houses, and storage sheds. These structures can provide habitat for a substantial number of wildlife species (Table 5.1.5). Three project area species require buildings or other human structures for reproduction including barn swallow, house sparrow, and rock dove.

Table 5.1.5 Wildlife Species Potentially Affected By Loss Of Structures

Criteria	Amphibian	Reptile	Bird	Mammal
# of species which use buildings	0	1	41	26
# of non-native species that use buildings	0	0	3	4
# of species where buildings are Essential	0	0	3	0
# of species where buildings are of Secondarily Essential	0	0	6	9
# of species which Prefer buildings	0	1	32	17
# of DFG harvest species which use buildings	0	0	2	10
# of special status species which use buildings	0	0	2	6

Buildings can provide habitat for at least four species of introduced mammal. Buildings or other structures in the project area can provide cover for up to 15 species of bats, many of which are special status species.

The shrub understory is frequently removed or greatly reduced within campgrounds, along roads, and adjacent to parking areas to manage fuels, improve safety, and aesthetics. Reduced shrub cover has the potential to adversely affect 175 wildlife species within the project area (Table 5.1.6). Shrub cover is essential for 15 wildlife species including black-chinned sparrow, black-tailed jackrabbit, brush mouse, brush rabbit, California ground squirrel, California thrasher, desert cottontail, dusky-footed woodrat, fox sparrow, song sparrow, striped skunk, Trowbridge's shrew, white-throated sparrow, wrentit, and western whiptail.

Table 5.1.6 Wildlife Groups Potentially Affected By Shrub Understory Removal.

Criteria	Amphibian	Reptile	Bird	Mammal
# of species which use shrub understory	1	15	114	47
# of non-native species that use understory	0	0	3	5
# of species where shrub understory are Essential	0	1	6	8
# of species where shrub understory are Secondarily Essential	0	3	61	8
# of species which Prefer shrub understory	0	11	47	39
# of DFG harvest species which use shrub understory	0	0	10	18
# of special status species which use shrub cover	0	1	23	9

In summary, recreation facility related habitat modifications have the potential to alter wildlife species occurrence or densities in the vicinity of recreation facilities. The impact to wildlife species is directly related to the area of habitat modifications within the project area and the extent of habitat modifications. These data should be considered if new or expanded recreation facilities are proposed for the project area.

5.2 TASK 2-ESA SPECIES

5.2.1 Introduction

Twelve wildlife species protected under the State or federal Endangered Species acts may occur in the project vicinity. Potentially suitable habitat for all of these species is present within the study area. Breeding populations of peregrine falcon, bank swallow, bald eagle, valley elderberry longhorn beetle, and Swainson's hawk were documented within the study area. No habitat use by wintering greater sandhill cranes was observed. However, minor amounts of marginally suitable wintering habitat were identified within the study area. Potentially suitable habitat was also identified within the study area for western yellow-billed cuckoo, California red-legged frog, giant garter snake, Conservancy fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp.

During the course of the relicensing studies potential recreation related impacts were identified related to bald eagle, valley elderberry longhorn beetle, giant garter snake, Conservancy fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp. These potential impacts required consultation under the State and/or federal Endangered Species acts and modification of current and future actions to minimize or avoid impacts.

In addition to species protected under the State or federal Endangered Species acts, 1,470 observations of 26 species of State or federal Species of Concern were recorded in the study area between February 21, 2002 and September 19, 2003 (CDWR 2003 b). Location information related to these observations may prove useful for future citing of recreational facilities.

5.2.2 Bald Eagle

Bald eagles can be intolerant of human activity during the breeding season. However, tolerance to human activity varies from pair to pair. Human activity can result in nest abandonment and subsequent loss of production (Detrich 1980, Bogener 1980, Lehman 1983). In some cases breeding bald eagles have relocated their nest in response to human activity (Thelander 1973). Recreation related disturbance/displacement of nesting, wintering, or foraging bald eagles is well documented (Detrich, 1977; Fraser et al., 1985; Buehler et al., 1991; Anthony et al., 1995; Grubbs et al., 2002; Steidl and Anthony, 1996). For these reasons human activity (including Oroville Facilities Relicensing recreation, environmental, and cultural resources survey efforts) were restricted in the vicinity of all active nest territories during the 2002 and 2003 during the breeding seasons.

The identification of a new bald eagle territory on Lake Oroville during the 2002 breeding season required a prompt evaluation of potential impacts for State and federal Endangered Species act compliance. Both U. S. Fish and Wildlife Service (USFWS) and DFG were notified concerning the location of the new or previously unknown nest territory. DWR and DPR jointly evaluated potential impacts to the nest territory. To avoid potential impacts, a primary zone was delineated wherein human activity was restricted during the breeding season. The size and shape of the primary zone was based on observed eagle use, nest location, screening vegetation, and physical topography. Further protection was provided through a shoreline recreation closure, relocation of recreation facilities, seasonal trail closure, and avoidance of new recreational development. USFWS and DFG staffs were informally consulted during the development of protective measures. Further, USFWS staff visited all active nest territories to evaluate the adequacy of previously developed territory management plans. Their recommendations were incorporated into both new and existing territory management plans. These territory management plans are required for State and Federal Endangered Species act compliance and will be submitted as conservation measures within the federal Biological Assessment.

5.2.3 Valley Elderberry Longhorn Beetle

Recreation related impacts to valley elderberry longhorn beetle (VELB) habitat include trampling and mechanical damage adjacent to certain recreation facilities as well as ORV damage to individual plants. Conservation measures are being developed to address these impacts within the Biological Assessment. Future recreational developments in areas adjacent to VELB habitat should consider incorporation of physical barriers to protect plants from damage by recreational users.

5.2.4 Giant Garter Snake

Approximately 4,300 acres of potentially suitable giant garter snake habitat have been delineated within the project area. This habitat occurs within portions of the Thermalito Forebay, Thermalito Afterbay, and Oroville Wildlife Area. Recreation related mortality of these snakes is unlikely based on their habitat preference and life history. However, some types of wetland related recreational use can serve to disturb/displace giant garter snakes or reduce habitat suitability. The greatest recreation related risk to giant garter snakes is future habitat losses or fragmentation associated with additional recreational developments within the snake’s habitat. Conservation measures have been developed in consultation with USFWS to limit direct and indirect recreational impacts to giant garter snake’s and their habitats. Giant garter snakes are highly vulnerable to earthmoving activities during hibernation which includes the period from October through March (Miller and Hornaday 1999). Restrictions on earthmoving during the snake’s inactive period are likely to be required within certain areas.

5.2.1.5 Vernal Pool Invertebrates

Potentially suitable vernal pool invertebrate habitat including habitat for the federally listed Conservancy fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp is present within the study area (CDWR 2003b). Within the project boundary, there are 253 vernal pools totaling 18.3 acres, ranging from 0.002 to 3.9 acres in size. One-hundred and sixty-seven of these pools are around the Thermalito Afterbay, with the remaining eighty-five pools around the Forebay. Approximately 67 percent of the pools within the study area are formed by the interruption of natural runoff flow patterns by some artificial structure, such as a road, berm, weir, or levee. Approximately 60 percent of the pools occur in two clusters, the south end of Wilbur Road (with 83 pools) and the South Forebay boat ramp area (with 47 pools).

Identified recreational impacts to vernal pool invertebrate habitats are limited to ORV use. ORV damage to pools was noted within 57 (22.5 percent) of the delineated pools, ranging from very light impacts, usually one vehicle passage, to extremely heavy, where the tire tracks could affect the hydrological and ecological integrity of a pool. Off-road vehicle use can damage vernal pools by disruption of overland flow patterns and from direct habitat destruction. The weight of the vehicle can crush or displace fairy and tadpole shrimp when present during the wet season or destroy their cysts in the summer. The compacted soils in the resulting tire ruts are unsuitable for sustainability of the vernal pool ecology, affecting the growth of aquatic plants and algae.

Off-road vehicle use is fairly high within the project area, virtually all of it done illegally by the general public. DWR's policy is to restrict off-road vehicle use by employees and the public within the Oroville Field Division except in designated ORV parks. State lands are generally fenced, posted, and patrolled in an attempt to prevent unauthorized ORV entry and use.

Conservation measures designed to minimize or avoid ORV damage to vernal pool invertebrate habitat were developed during the federal ESA consultation process.

5.3 TASKS 3 AND 4-IDENTIFICATION AND MAPPING OF CURRENT AND FUTURE RECREATIONAL FACILITIES AND IDENTIFICATION OF ASSOCIATED MAINTENANCE PRACTICES

Tasks 3 and 4 involved identification and mapping of current and potential future recreational developments and identification of associated maintenance practices. Future recreational developments have not been identified at this time and are unlikely to be identified prior to Settlement. However, both the Environmental Work Group and the Cultural Resource Work Group have provided the Recreation and Socioeconomic Work Group with resource sensitivity maps. These maps identify areas where future recreational development can occur with minimal risk to environmental resources (Figures 5.3.1 through 5.3.8).

Table 5.3.1 identifies the acreage of various types of recreational facilities or areas identified and mapped under these tasks. It is important to note that not all of the acreage classified as miscellaneous disturbed, facilities, or roads are directly related to recreation facilities or use.

Project area land management agencies including DWR, DFG, and DPR conduct a wide variety of maintenance activities within the project area. Land management agency's maintenance staffs were interviewed to identify maintenance activities, locations, and timing. Some of these activities have the potential to directly affect wildlife species and wildlife habitat. Recreation related maintenance activities with the greatest potential to affect wildlife species or wildlife habitat are discussed below.

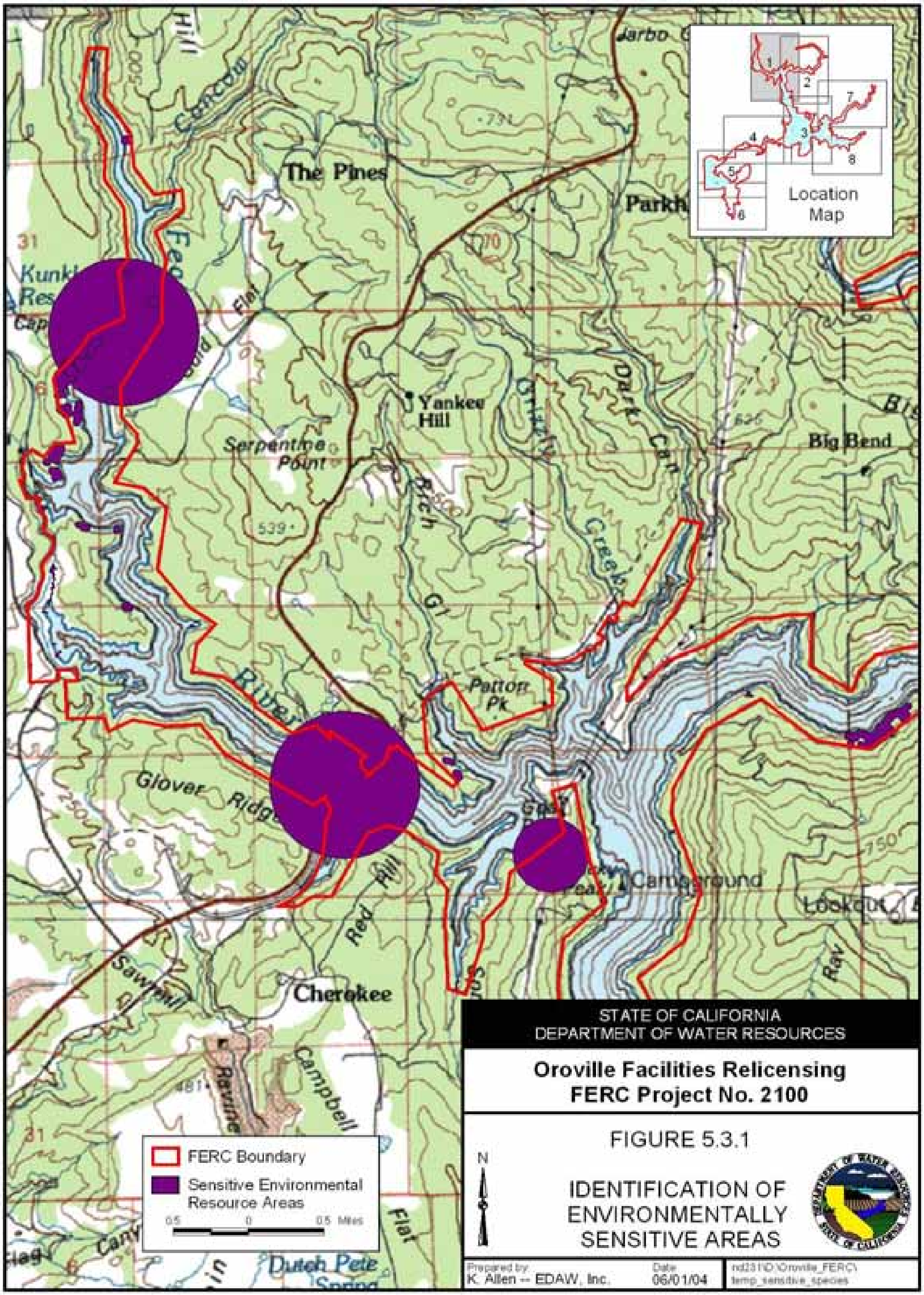

Figure 5.3.1 **Identification of Environmentally Sensitive Areas**

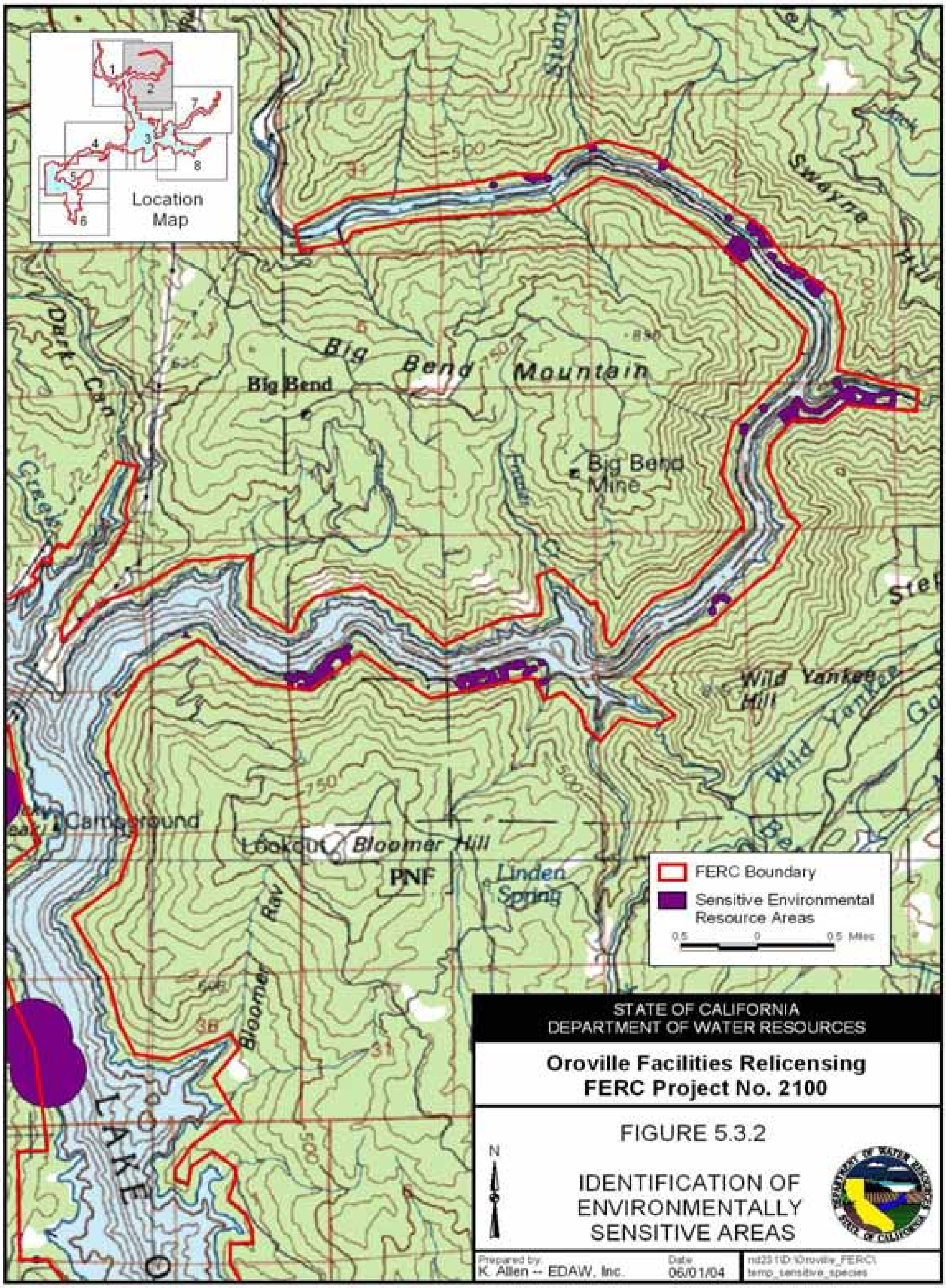

Figure 5.3.2 Identification of Environmentally Sensitive Areas

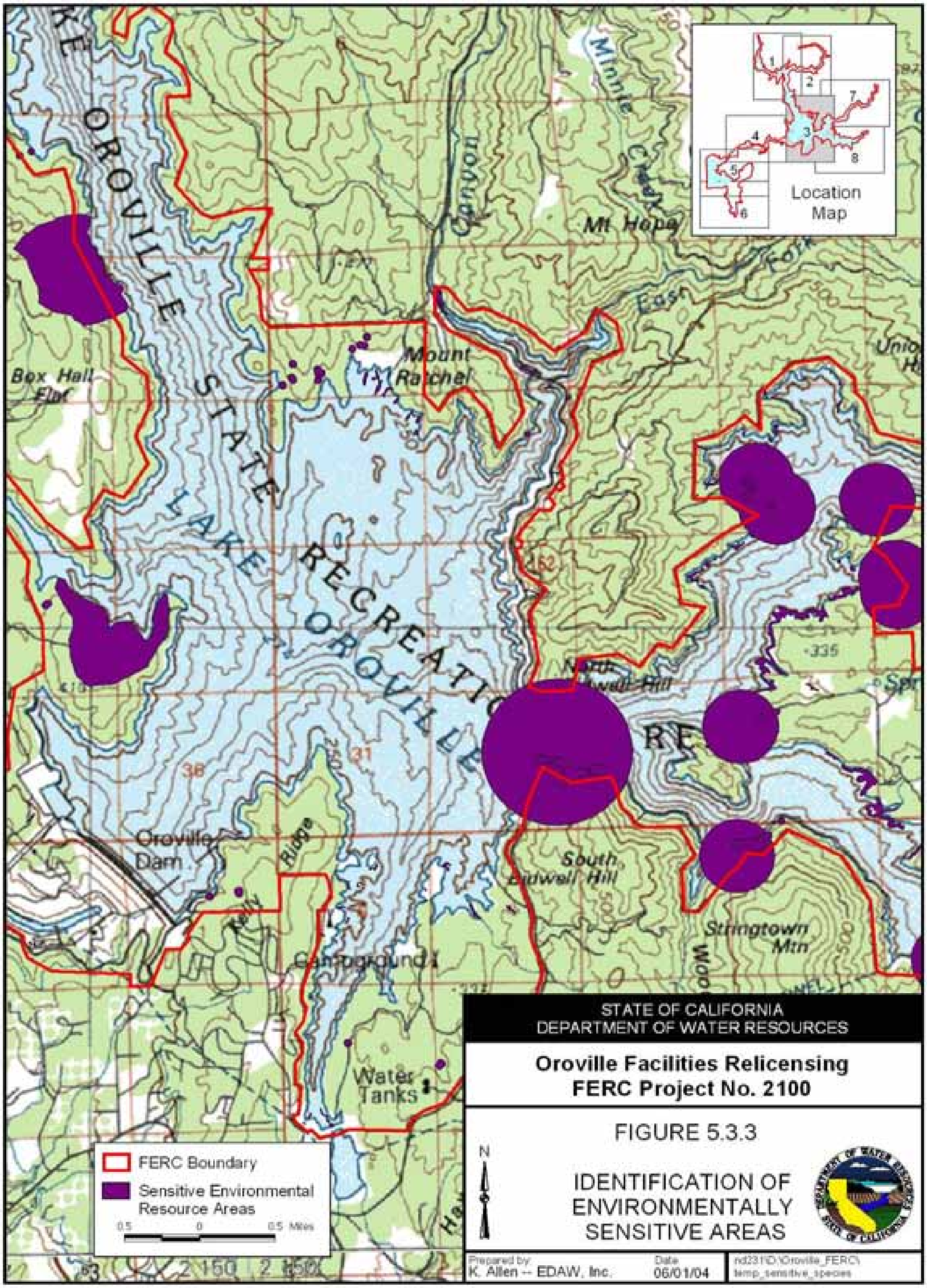

Figure 5.3.3 **Identification of Environmentally Sensitive Areas**

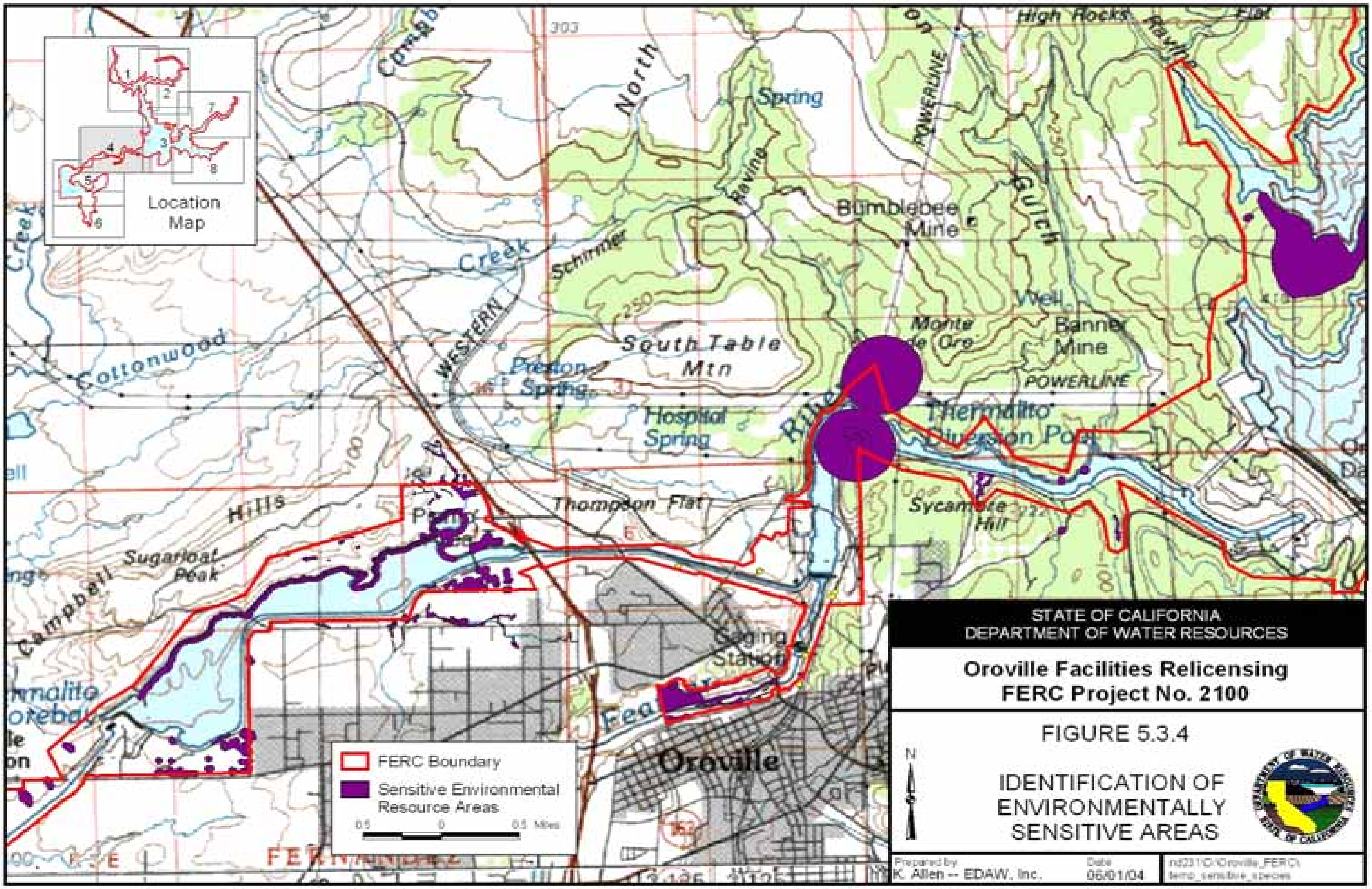

Figure 5.3.4 **Identification of Environmentally Sensitive Areas**

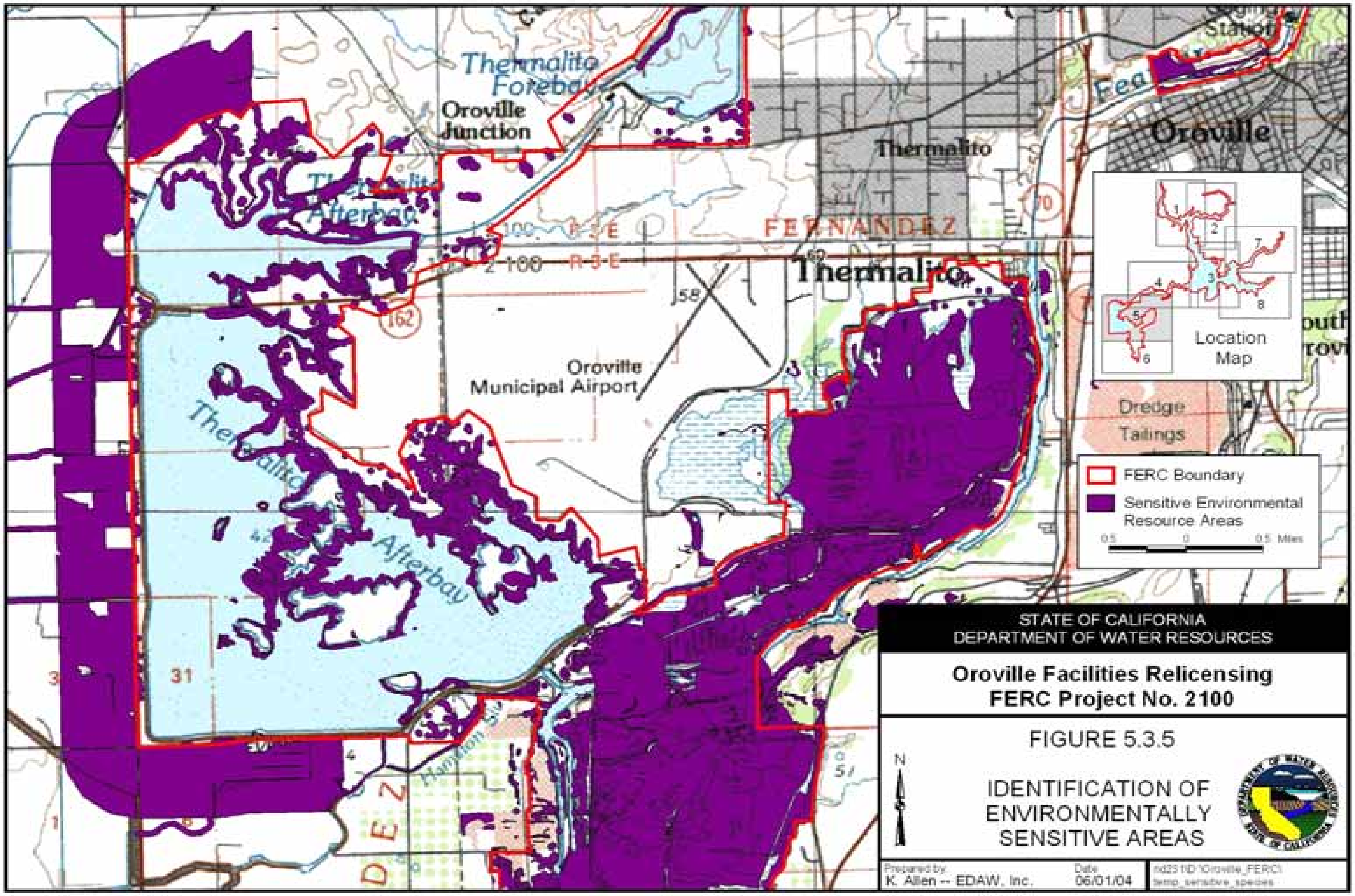

Figure 5.3.5 **Identification of Environmentally Sensitive Areas**

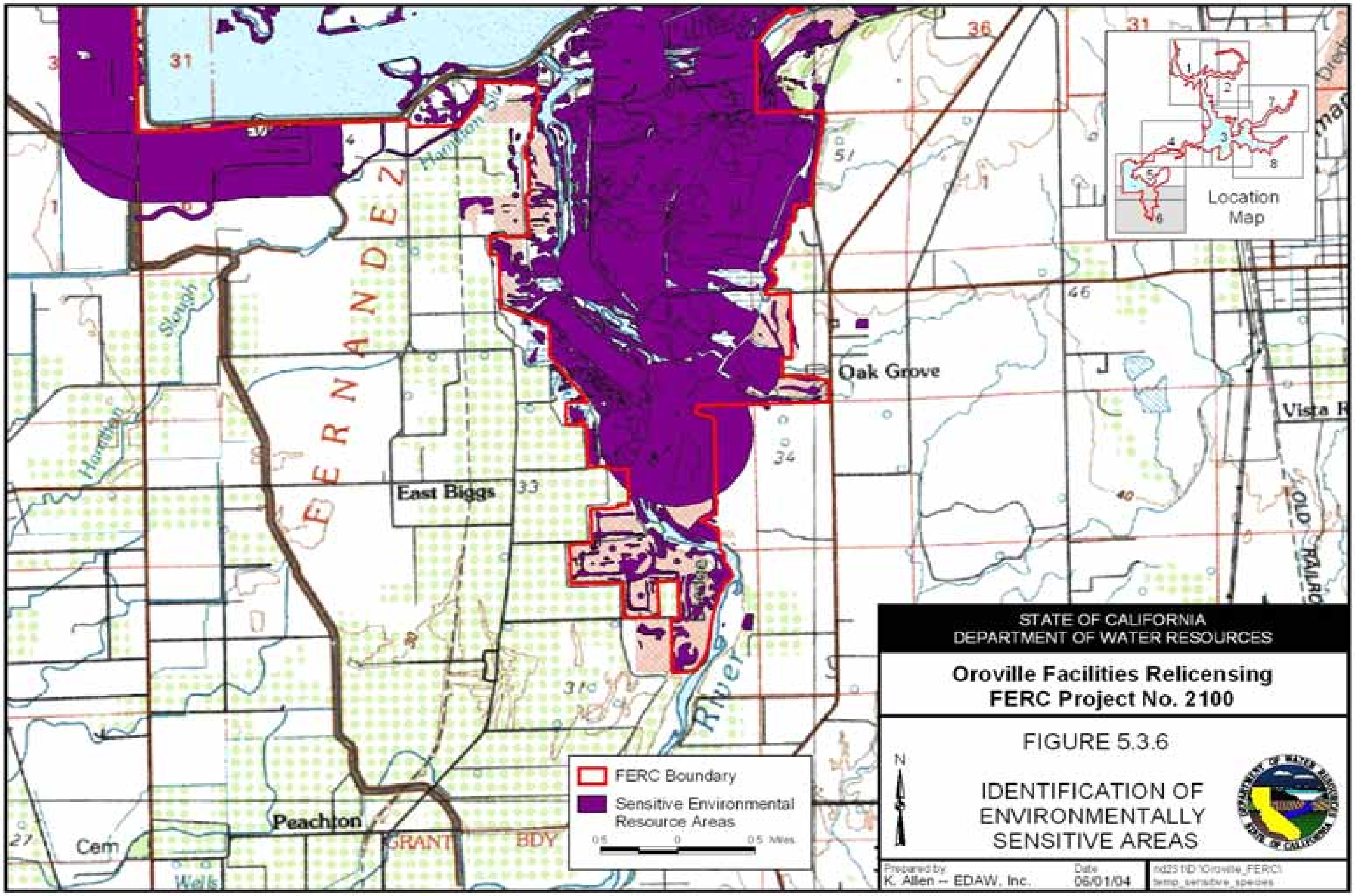

Figure 5.3.6 **Identification of Environmentally Sensitive Areas**

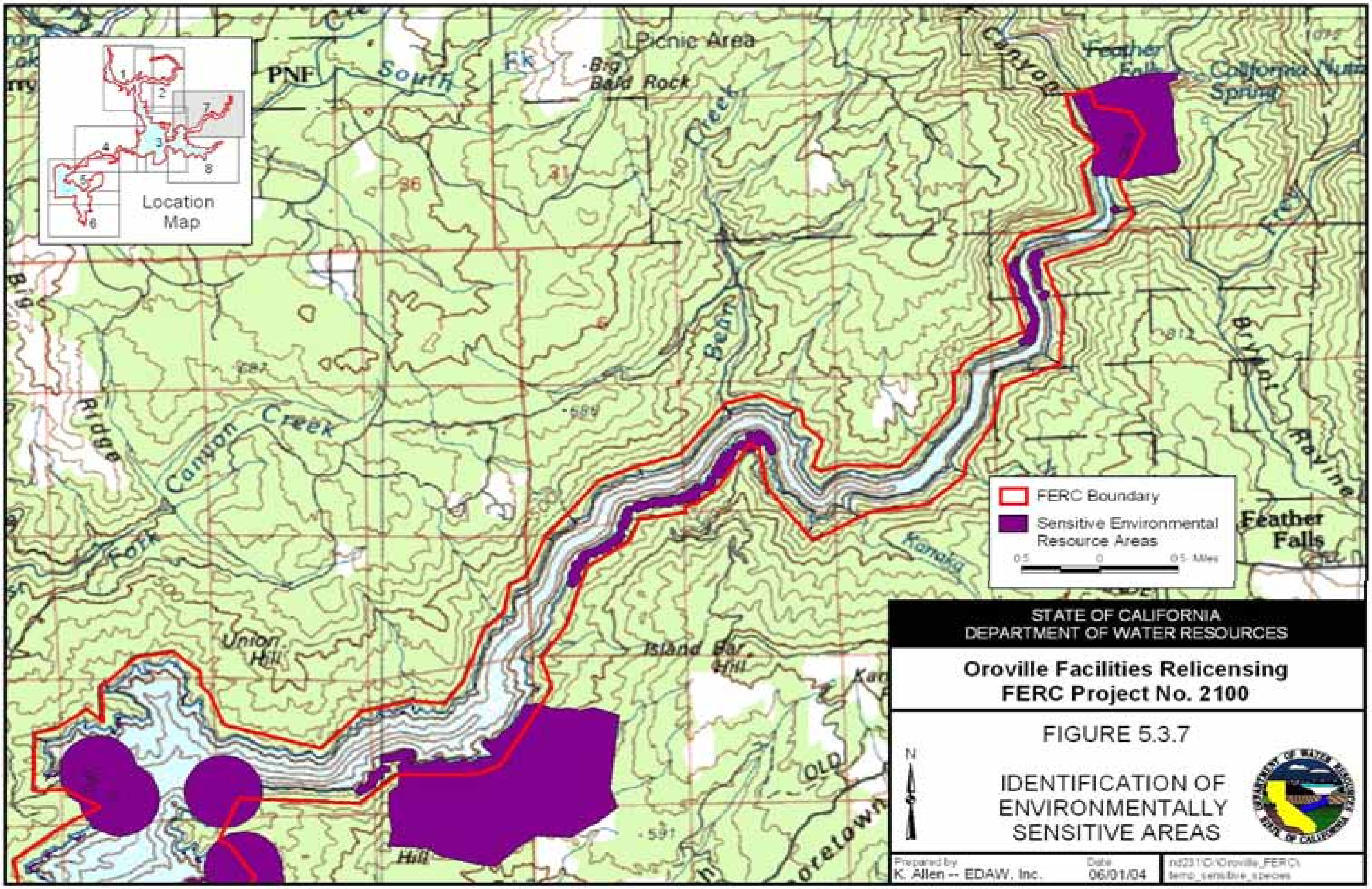

Figure 5.3.7 **Identification of Environmentally Sensitive Areas**

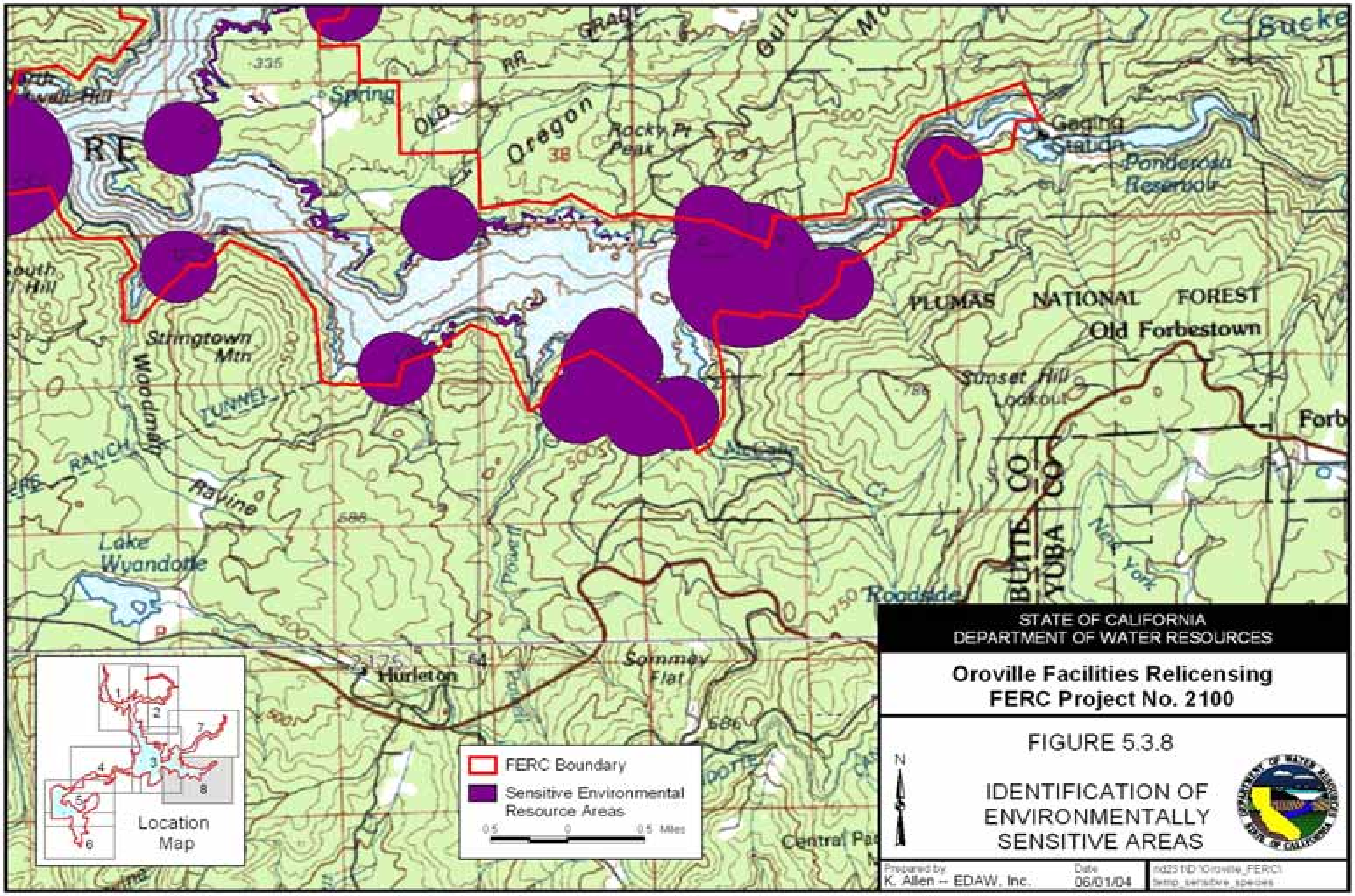

Figure 5.3.8 **Identification of Environmentally Sensitive Areas**

GIS data analyses identify about 870 acres of roads and 90 acres of trails in the project area. Maintenance activities associated with roads, trails, and parking areas vary as to the type of base (dirt, gravel, paved). In general, road maintenance consists of maintaining the road base, controlling vegetation along roadsides, and cleaning ditches and culverts to insure drainage. Dirt and gravel road bases are primarily maintained by grading (spring and fall/winter). However, herbicide treatments are infrequently used to supplement grading in some locations. Paved road bases are repaved on approximately 10-year intervals. The amount of roadside vegetation treatment varies by type of road and use standard. Along high-speed roads mowing or herbicide is used on an annual basis to control herbaceous vegetation on the shoulder of the road and on trails. Further, along these roads woody vegetation is often mechanically removed to improve site distances and public safety.

Table 5.3.1 Acreage Of Categories Of Recreational Facilities

Facility Category	Number of Polygons	Acreage	Percentage of the Project Area
Habitat Improvement	26	87.15	0.21
Recreation General	198	3,923.25	9.53
Subtotal	**224**	**4,010.40**	**9.74**
Miscellaneous Disturbed	165	647.67	1.57
Recreation Campground	47	73.07	0.17
Recreation Day Use	82	99.22	0.24
Recreation Facilities	21	8.16	0.02
Recreation Trails	778	87.54	0.21
Subtotal	**1093**	**915.66**	**2.22**
Facilities	285	292.69	0.71
Recreation Boating Facilities	137	80.22	0.19
Roads	1,137	867.84	2.11
Subtotal	**1,559**	**1,240.75**	**3.01**
Total	**3,075**	**6,249.4**	**15.18**

Road maintenance activities have the potential to adversely affect federally listed vernal pool plant and animal species, as well as, the federally listed VELB. Habitat surveys indicate that approximately 67 percent of the vernal pools within the project area are associated with physical structures, primarily roads. Analyses of each of the 253 vernal pools within the project area identified some opportunities to improve road maintenance practices in areas containing vernal pools. Elderberry bushes, the primary habitat for the VELB, occur primarily along the Feather River below Oroville Dam. High elderberry densities are associated with levee roads within the portion of the OWA along the Feather River. To avoid potential impacts, all elderberry bushes within 100 feet of roads and other project facilities are mapped using GPS technology. These data/maps allow maintenance staff to identify and avoid locations where ground disturbance, herbicide treatment, or woody vegetation removal would be restricted. Additional vernal pool and elderberry conservation measures are likely to be identified within the ESA Section 7 consultation process

An evaluation of existing barren or degraded upland habitats will be conducted under Relicensing Study-T10 for the purpose of identifying unnecessary roads and other areas of habitat disturbances suitable for upland site restoration.

A large variety of bridges are present within the project area ranging from small wooden structures on trails to State Highway bridges spanning Lake Oroville. Maintenance activities associated with bridges primarily include safety inspection, repainting, and redecking. Repainting has the greatest potential to impact wildlife. Larger bridges within the project area have the potential to support nesting sensitive raptors, cliff swallows, rock doves, house sparrows, barn owls, and up to 15 species of bats. Repainting large bridges generally occurs during the dry season (to limit discharge of hazardous material into waters) and has the potential to disrupt wildlife reproduction. Historic practices to limit impacts include timing (sandblasting and repainting outside the reproductive season) and/or pre-project screening to exclude wildlife from work areas. Bridge inspection also has the potential to adversely impact nesting sensitive raptors through disturbance. Human disturbance can adversely affect nesting success by displacing incubating adults, or prefledged young from the nest site. Maintenance staff were notified of sensitive raptors nesting locations, response to disturbance, and the breeding season (March through August) to prevent disturbance of nesting raptors.

Pesticides are one management tool used at several locations to control undesirable rodents, insects, and vegetation. Ground squirrel control is practiced by DWR along the Forebay and Afterbay dams using bait stations to limit non-target and secondary species poisoning. Neither DPR nor DFG conduct any vertebrate pest control employing chemicals on a regular basis. Butte County Mosquito Abatement Department and the City of Oroville annually treat selected areas within the project area for mosquito abatement purposes.

All three of the principal land management agencies (DWR, DFG, and DPR) utilize herbicides to control vegetation at specific locations for specific purposes including fuels management, noxious weed control, public safety, and to allow facilities inspection. Roadside spraying is the largest amount of area treated on an annual basis. However, the Thermalito Afterbay and Forebay dams are treated on an annual basis to facilitate structural integrity inspections. DPR spot treats noxious weeds along the wetland edge of theThermalito Forebay, while aerial spraying for purple loosestrife control has been conducted by DFG along portions of the Thermalito Afterbay margin. All three land management agencies have licensed pesticide applicators who fully comply with safety, application criteria, and reporting requirements.

The principal wildlife associated impacts related to pesticide use include potential impacts to vernal pool invertebrates and VELB. Both Thermalito Afterbay and Forebay dams and associated roads are located near vernal pools. Some purple loosestrife treatment areas are also close to vernal pool or giant garter snake habitats. Preliminary estimates indicate that over 90 acres of elderberry shrubs are present within 100 feet of project roads within the portion of the OWA near the Feather River. Maps identifying the locations of all vernal pool habitats and elderberry shrubs are being distributed to maintenance staff associated with DFG, DWR, Caltrans, Butte County Mosquito Abatement, and DPR, which should facilitate avoidance of these sensitive habitats during maintenance activities.

5.4 TASK 5 QUANTIFICATION OF RECREATION USE

Relicensing Study R-9 quantified current levels of recreation use by facility and season (Table 5.4.1.1). There were a total of about 1.73 million Recreation Days (RDs) in the study area between May 15, 2002, and May 14, 2003 (Table 5.4.1). Use was split between the 4 month recreation season and the 8 month off-season; 56 percent of use occurred in the recreation season (960,000 RDs) and 44 percent of use occurred in the off-season (768,000 RDs). In total, there was more weekday use than weekend use in both seasons. In the recreation season, 59 percent of use occurred on the weekdays (565,000 RDs) and 41 percent occurred on the weekends (395,000 RDs). In the off-season, 64 percent of use occurred on weekdays (490,808 RDs) and 36 percent occurred on weekends (277,000 RDs).

Lake Oroville had the highest daily average number of RDs in both seasons (recreation season: 4,181; off-season: 1,630) and dispersed use sites (within the FERC boundary) had the lowest (recreation season: 57; off-season: 49). All sites had higher daily averages in the recreation season than in the off-season and most had higher daily averages on weekends than on weekdays.

The Thermalito Forebay, Thermalito Afterbay, and the Oroville Wildlife Area contain the bulk of the habitat for State and federally listed species within the project area including 18.3 acres of vernal pool invertebrate habitat, 94 acres of valley elderberry longhorn beetle habitat, and 4,280 acres of giant garter snake habitat. Recreation use is currently estimated to average about 1,500 recreation uses per day within the 13,240 acre OWA (CDWR 2004a). Potential conflicts between current and future recreational use and development and compliance with the State and federal ESAs will require close coordination between DWR, DPR, and DFG. However, within a State designated Wildlife Area, like the OWA, wildlife management is the principal land management objective balanced with appropriate recreational development and use.

Table 5.4.1 Visitation (Recreation Days) In The Oroville Facilities Study Area.1

Area	Recreation season			Off-season			Combined Seasons Total (Daily Avg.)
	Weekday Total (Daily Avg.)	Weekend Total (Daily Avg.)	Season Total (Daily Avg.)	Weekday Total (Daily Avg.)	Weekend Total (Daily Avg.)	Season Total (Daily Avg.)	
Lake Oroville	314,063 (3,739)	204,409 (5,110)	518,472 (4,181)	256,692 (1,484)	136,019 (2,000)	392,711 (1,630)	911,183 (2,496)
Bidwell Canyon Complex	83,606 (995)	49,759 (1,244)	133,365 (1,076)	58,100 (336)	26,244 (386)	84,344 (350)	217,709 (596)
Loafer Creek Complex	34,108 (406)	29,633 (741)	63,741 (514)	18,346 (106)	7,457 (110)	25,803 (107)	89,544 (245)
Lime Saddle Complex	71,824 (855)	41,212 (1,030)	113,036 (912)	32,417 (187)	16,767 (247)	49,184 (204)	162,220 (444)
Diversion Pool	4,312 (51)	2,743 (69)	7,055 (57)	8,251 (48)	5,297 (78)	13,548 (56)	20,603 (56)
Thermalito Forebay	37,113 (442)	41,124 (1,028)	78,237 (631)	36,722 (212)	20,761 (305)	57,483 (239)	135,720 (372)
Thermalito Afterbay	33,501 (399)	28,333 (708)	61,834 (499)	19,554 (113)	11,980 (176)	31,534 (131)	93,368 (256)
Oroville Wildlife Area	110,483 (1,315)	80,635 (2,016)	191,118 (1,541)	73,974 (428)	53,370 (785)	127,344 (528)	318,462 (872)
Additional Sites within FERC boundary	47,518 (566)	25,412 (635)	72,930 (588)	72,940 (422)	33,335 (490)	106,275 (441)	179,205 (491)
Feather River Fish Hatchery	44,478 (530)	21,412 (535)	65,890 (531)	68,320 (395)	26,185 (385)	94,505 (392)	160,395 (439)
Dispersed Use Sites[2]	3,040 (36)	4,000 (100)	7,040 (57)	4,620 (27)	7,150 (105)	11,770 (49)	18,810 (52)
Additional Sites Outside FERC boundary	17,835 (212)	12,293 (307)	30,128 (243)	22,636 (131)	16,381 (241)	39,017 (162)	69,145 (189)
Total for Study Area	**564,825 (6,724)**	**394,949 (9,874)**	**959,774 (7,740)**	**490,769 (2,837)**	**277,143 (4,076)**	**767,912 (3,186)**	**1,727,686 (4,733)**

[1] These calculated values are rounded when reported in the text to avoid conveying unwarranted precision.
[2] Dispersed sites include: Old Nelson Bar, Parrish Cove, Nelson Avenue Bridge over Thermalito Forebay, Highway 162 Overlook, Canyon Creek Bridge, South Wilbur Road TA, Tres Vias Road TA, and Toland Road TA. Also included in these totals are "other dispersed use sites" which includes any dispersed use occurring within the study area at sites other than those that are known dispersed sites.
Sources: DPR 2003; DWR 2003; EDAW, Inc. 2003.

5.5 TASK 6 QUANTIFICATION OF DIRECT AND INDIRECT WILDLIFE HABITAT LOSS AND SPECIAL EVALUATIONS

5.5.1 Direct and Indirect Wildlife Habitat Loss

Table 5.5.1 summarizes the evaluation of direct and indirect wildlife habitat loss by project feature category. For the purposes of these analyses, habitat losses related to inundation are considered type conversions rather than direct or indirect habitat losses. However, it is important to realize that this type conversion represents the greatest amount of project related wildlife habitat alteration, exceeding 20,000 acres.

Project features with primarily low levels of indirect wildlife habitat loss occupy about 4,100 acres or 10 percent of the project area. Project features resulting in moderate levels of both direct and indirect habitat total about 900 acres or about two percent of the project area. While project features resulting in direct loss of wildlife habitat currently occupy about 1,200 acres or about three percent of the project area.

Table 5.5.1 Direct And Indirect Wildlife Habitat Losses Associated With Categories Of Project Facilities

Facility Category	Number of Polygons	Acreage	Habitat Loss Classification
Habitat Improvement	26	87.15	indirect-low impact
Recreation General	198	3,923.25	Indirect-low impact
Transmission Lines	191	76.11	Indirect-low impact
Cemetery	8	6.49	Indirect-low impact
Subtotal	**423**	**4,093.00**	
Miscellaneous Disturbed	165	647.67	direct & indirect-moderate impact
Recreation Campground	47	73.07	direct & indirect-moderate impact
Recreation Day Use	82	99.22	direct & indirect-moderate impact
Recreation Facilities	21	8.16	direct & indirect-moderate impacts
Recreation Trails	778	87.54	direct & indirect-moderate impacts
Subtotal	**1093**	**915.66**	
Facilities	285	292.69	direct-high impact
Recreation Boating Facilities	137	80.22	direct-high impact
Roads	1,137	867.84	direct-high impact
Subtotal	**1559**	**1,240.75**	
Total	**3075**	**6,249.4**	

Additional direct and indirect habitat losses may occur resulting from implementation of Relicensing Resource Actions. To the extent possible additional habitat loss, fragmentation, or degradation should be avoided particularly in the portion of the project area managed as a State Wildlife Area. Relicensing stakeholders should be aware of the trade-offs associated with additional recreational developments and long-term maintenance of wildlife habitat.

5.5.2 Site Specific Field Evaluations

Quarterly surveys of high recreation use areas and facilities were conducted between March 2002 and September 2003. These surveys were both qualitative and quantitative in nature and included evaluation of:

- Recreational disturbance of nesting bald eagles, peregrine falcons, and Swainson's hawks
- Off-Road Vehicle impacts to vernal pool habitats
- Effects of seasonal trail use on nesting waterfowl
- ORV and trail use damage to VELB habitat
- Watercraft impacts on nesting grebes

5.5.2.1 Bald Eagle, Peregrine Falcon, and Swainson's Hawk Field Evaluations

Nesting bald eagle, peregrine falcon and Swainson's hawk can be adversely impacted by recreational activity and development. Recreational disturbance early in the nesting cycle can result in nest abandonment. Disturbance of incubating raptors can displace adults and result in breakage or chilling of eggs. Disturbance later in the nesting cycle can induce nestlings to leave the nest prematurely before they are fully capable of flight which serves to reduce nestling survival.

To evaluate the potential for recreational disturbance of these sensitive raptors, monthly site visits were conducted at each nest location. Recreational activities in the area were noted as well as any associated disturbance response.

Three bald eagle nest territories are present within the project area. Observations of recreational activity indicated significant differences in types and intensities of recreational use between the three territories as well as a variety of behavioral responses to these activities.

The Middle-Fork nest territory is located well away from the lake shoreline and is screened from disturbance both by topography and vegetation. The area is remote, steep, brushy and not conducive to either shoreline or shore based recreation. No disturbance of nesting eagles was identified at this location. The territory management plan developed in coordination with USFWS prescribes a seasonal recreational closure around the two nests present in the territory as well as habitat protection measures.

The bald eagle territory located near the main body of the lake is in a high recreation use area with trails, high levels of boat-based fishing use, and extensive shoreline based recreational use. The nest is highly visible from the water and relatively close to the high water mark. This nest was discovered in February 2002. In consultation with USFWS, DPR and DWR implemented a number of conservation measures including a seasonal closure of the area near the nest including an existing trail, relocation of a planned trail, shoreline closure, and relocation of floating campsites. This territory successfully fledged two young in both 2002 and 2003. This pair appears to very tolerant of most recreational activities which occur within the area and was occasionally observed to forage within 20 yards of shoreline fishermen. The only disturbance response reported occurred outside the territory and involved trail users approaching recently fledged young perched on the shoreline. Both adults and fledglings exhibited disturbance responses until the young flew. Based on the successful reproduction in 2002 and 2003 it appears that conservation measures have effectively limited recreational conflicts within this nest territory.

The third nest territory is located on the North Fork below the confluence with the West Branch. This nest is located within 100 feet of the high water mark and is highly visible from the lake. The area is not conducive to either shoreline or shore based recreation. However, the area receives a high amount of boat-based traffic within sight of the nest. Boat-based traffic on the lake was observed to flush adults from the nest whenever boats came within 200 yards of the nest. Disturbance/displacement of foraging eagles was also observed. This pair has not successfully reproduced during their last three nesting seasons. USFWS has recommended signage on floating buoys to exclude boat traffic near the nest and to prevent shoreline moorage.

All three peregrine falcon nest locations are located on cliffs or cliff-like human structures where vertical distance and inaccessibility limit human intrusion. No recreational disturbance was identified at any of the nest locations. Further, foraging peregrines appeared to disregard recreational activity and occasionally pursued and captured prey in close proximity to recreational activity.

The single Swainson's hawk nesting location within the project area is located along the Feather River within the OWA. Observations of recreational use near this nest indicate that a gravel bar immediately below the nest was infrequently used as a river fishing access point and that limited shoreline recreation including swimming occurred. Recreational use increased throughout the nesting season with the greatest amount of use observed during the fledging period. No disturbance response was identified by the adults or nestlings and the territory successfully fledged two young during both years of observation indicating that current levels of recreational activity are not impacting reproduction at this location. No modification of recreational use is recommended. However, if additional recreational development or changes in the types of recreational use are considered at this location it would be prudent to evaluate these actions in consultation with DFG to insure State ESA compliance.

5.5.2.2 Off Road Vehicle Use in Vernal Pool Habitats

Identified recreational impacts to vernal pool invertebrate habitats are limited to ORV use. ORV damage to pools was noted within 57 (22.5 percent) of the delineated pools, ranging from very light impacts, usually one vehicle passage, to extremely heavy, where the tire tracks could affect the hydrological and ecological integrity of a pool. Off-road vehicle use can damage vernal pools by disruption of overland flow patterns and from direct habitat destruction. The weight of the vehicle can crush or displace fairy and tadpole shrimp when present during the wet season or destroy their cysts in the summer. The compacted soils in the resulting tire ruts are unsuitable for sustainability of the vernal pool ecology, affecting the growth of aquatic plants and algae.

Off-road vehicle use is fairly high within the project area, virtually all of it done illegally by the general public. DWR’s policy is to restrict off-road vehicle use by employees and the public within the Oroville Field Division except in designated ORV parks. State lands are generally fenced, posted, and patrolled in an attempt to prevent unauthorized ORV entry and use.

Conservation measures designed to minimize or avoid ORV damage to vernal pool invertebrate habitat were developed during the federal ESA consultation process and generally involved greater efforts to educate the public, sign, patrol and enforce area closures. Regular inspection and prompt vehicular barrier maintenance are also required.

5.5.2.3 Seasonal Trail Use Impacts on Nesting Waterfowl

Portions of the Brad Freeman Trail occur within the area actively managed for nesting waterfowl along the northern end of the Thermalito Afterbay. Relicensing stakeholders questioned the compatibility of spring trail use and area management for waterfowl production.

To evaluate these potential effects, selected areas were subject to intensive survey to locate and map waterfowl nest locations during mid-to-late April 2002. The study design placed eight 3.2 acre circular plots adjacent to the portion of the Brad Freeman Trail within the Oroville Wildlife Area north of Highway 162 to determine the impact of recreational use of the trail on the location and density of nesting waterfowl. Nest locations were detected by dragging a 1 inch diameter cotton rope around a central point. The area surveyed was 70 yards in radius. The movement of the rope through the vegetation flushes hens from the nest. This allows the surveyors to identify and map nest locations. This method does not allow assessment of predated nests where the hen is no longer present. To check the reliability of this method to detect nesting waterfowl, intensive nest searches were conducted at two of the eight sampling locations. These searches involved two observers walking the entire plot on a 10 yard grid pattern to visually detect any missed nests or flush any nesting hens.

This study design does not allow assessment of potential increased predation rates associated with recreational use of the trail. Repeated visits to each nest site over time would be required to establish predation rates. However, repeated visits by the survey team can in themselves lead to increased predation rates and mask any effects related to recreational use of the trail. No additional nests were detected using the 10 yard grid search of the two 3.2 acre plots resurveyed using this method.

In two days of weekday spring sampling at this location a single bicyclist was observed to use the trail. Four nests were located in the 25.3 acres surveyed for a density of 0.16 nests per acre. One of these nests had been destroyed by an unknown predator. This density of nesting is significantly less than those documented by previous studies in food/cover plantings near brood ponds at the Afterbay. Mallard was the only species found to nest in the area sampled and averaged 6.5 eggs per nest.

No quantitative vegetation data was collected as part of this evaluation. Vegetation in the plots sampled varied in density and height but was generally of low to moderate density and less than 12 inches in height. However, individual bunchgrass plants up to 4 feet in height occurred on some plots. No star thistle was evident. Star thistle growth phenology is such that most growth occurs after the first mallard hatch.

Nests were located at distances ranging from 24 to110 yards from the trail. We noted one disturbance of a nesting hen which we flushed approximately 10 yards from the trail as we drove between sampling locations. Nest density did not increase with increasing distance from the trail. Qualitative observations indicate that distance from the trail did not appear to be as significant a factor in waterfowl nesting density as the availability of adequate nesting cover.

5.5.2.4 Watercraft Impacts on Nesting Grebes

Recreation use of watercraft including: powerboats, fishing boats, personal watercraft, sailboats, and canoes have been documented to adversely impact waterfowl (Batten, 1977; Kahl, 1991; Liddle and Scorgie, 1980; Bouffard, 1982; Korschgen et al., 1985; Conservation Committee Report, 1978). Waterfowl species which construct floating nests on the surface of the water are most at risk from recreational boating activities. Both Clark’s and western grebes are known to nest on the surface of the Thermalito Afterbay. A DFG Statewide study conducted in 2003 identified two mixed grebe colonies in the southeastern portion of the Afterbay totaling about 90 nests (Ivey 2004). Neither grebe species is currently protected under the State or federal Endangered Species acts, nor are they recognized as State or federal Species of Concern. However, because grebes construct floating nests in shallow water areas that they anchored to aquatic or emergent vegetation they are sensitive to boating activities. Boat based recreation including personal watercraft can adversely impact nesting grebes through:

- Boat wakes swamping nests resulting in loss of eggs or young
- Displacement of incubating adults resulting in reduced hatching rates or predation of young or eggs
- Abandonment of nests
- Direct mortality associated with ski, propeller, or boat strikes

The 2004 DFG study indicated that recreational use of the water ski course adjacent the largest grebe colony was disruptive to grebes and that the potential for reduced production through loss of nest, egg, or young was present. However, monitoring of reproduction in the same study indicated that the Thermalito Afterbay grebe colonies had the second highest level of production documented in the Statewide survey at 1.41 young per adult. These data indicate that while recreationally related impacts may occur, they are not significantly reducing grebe production on the Thermalito Afterbay. No recreational closures or relocation of the water ski course are recommended for protection of nesting grebes based on analyses of available data.

5.6 TASK 7- IDENTIFICATION OF MEASURES TO MINIMIZE RECREATIONAL IMPACTS TO WILDLIFE AND WILDLIFE HABITAT

The following measures have the potential to reduce or eliminate conflicts between current and future recreation use/development and wildlife management objectives. Further, many of these measures are required for State or federal ESA compliance.

5.6.1 Measures to be considered during citing or construction of additional recreational facilities

- Avoid citing or development of recreational facilities within areas mapped as sensitive resource areas.
- Minimize direct habitat loss during project design and construction
- Retain screening vegetation to limit indirect habitat loss and wildlife disruption/displacement
- To the extent possible, restrict construction and associated habitat disturbance to periods outside the primary reproductive period (March through July)
- Retain key wildlife habitat elements to the extent possible including snags, woody dead and down material, live trees containing cavities, and shrub cover
- Retain mature trees and minimize use of non-native landscaping
- Avoid recreational development in riparian or wetland habitats
- Consider designing recreational developments with physical barriers to limit resource damage in habitats adjacent to high recreation use areas

- Avoid incompatible recreational uses and developments within the OWA
- Revegetate areas of disturbed soil

5.6.2 Measures to Minimize Recreation Related Impacts to ESA Habitats and Species

5.6.2.1 Bald Eagles

- Retain seasonal recreation closures in the vicinity of nesting bald eagles
- Maintain signage, patrol, and enforcement of bald eagle nest territory seasonal closures
- Periodically revaluate the effectiveness of conservation measures designed to minimize recreational impacts to nesting bald eagles
- Conduct annual nest surveys to identify new or previously unknown bald eagle nest territories
- In consultation with USFWS and DFG, develop and implement conservation measures to protect new nest territories from recreational disturbance

5.6.2.2 Vernal Pools

- Retain ORV closures in areas containing vernal pool habitats
- Maintain or increase signage, patrol, and enforcement to limit ORV use in vernal pool habitats
- Maintain fences or barriers to ORV use in vernal pool areas
- Periodically inspect fences and barriers to ORV use and repair as needed
- Periodically inspect and report on the effectiveness of conservation measures designed to minimize ORV impacts to vernal pool habitats
- Avoid recreational development, expansion, or use within vernal pool habitats

5.6.2.3 Valley Elderberry Longhorn Beetle

- Avoid recreational development or expansion into areas of valley elderberry longhorn beetle (VELB) habitat
- Minimize ORV use in areas containing VELB habitat
- Consider installation of fencing or barriers adjacent to high recreation use areas within VELB habitat
- Consider additional road closures to limit ORV damage to VELB habitat
- Periodically revaluate the effectiveness of VELB conservation measures designed to limit recreational impacts to VELB

5.6.2.4 Giant Garter Snake

- Avoid recreational developments within giant garter snake habitat
- Provide educational signage at key recreational facilities to limit take associated with the public's "fear of snakes" behaviors
- Limit areas of dog trial training within giant garter snake habitat during the snake's active period (March 1 through October 31)

5.6.3 Measures Designed to Limit Recreation Related Impacts to Wildlife During Operations and Maintenance Activities

- Retain existing seasonal recreation closure in waterfowl nesting areas
- Restrict herbicide use in areas containing vernal pool or VELB habitat
- Abandon and revegetate or surface dirt roads adjacent to vernal pool habitats
- Limit bridge maintenance activities to the period from August 30 through February 1
- Limit to the extent practical, bridge inspections to the period between August 30 and February 1
- Maintain exclusionary fencing and gates on bridge inspection catwalks
- Implement Best Management Practices when conducting earthmoving, grading, levee maintenance, or culvert maintenance in areas containing vernal pools or VELB habitat
- Consider seasonal closure or consolidation of recreational use of campgrounds, day use areas, and other recreational facilities during low use periods
- Maintain and enforce the day use limitation within the OWA (excluding campground locations)
- Consider a restriction on boat speeds within the portion of the Thermalito Afterbay north of Highway 162 to limit disturbance of waterfowl
- Improve consultation and coordination between DFG, DWR, and the California Highway Patrol related to "special recreational event" planning at the Thermalito Afterbay and on the OWA.
- Restrict ORV use within the drawdown zone of Lake Oroville to minimize habitat degradation and wildlife disturbance/displacement

5.6.4 Measures Designed to Enhance Recreational Use of Wildlife Resource

- Construct four additional waterfowl brood ponds
- Implement a wood duck nest box program
- Implement a program to enhance waterfowl and upland game bird forage
- Implement a program to enhance waterfowl and pheasant nest cover
- Encourage development of wildlife viewing opportunities
- Maintain or enhance hunting opportunities on lands administered by DPR and DFG (excluding areas within bald eagle nest territories)
- Explore opportunities to control populations of non-native wild turkey on DPR lands while providing opportunities for increased sport harvest

6.0 ANALYSES

The project area contains a high diversity of wildlife habitats which are projected to support up to 340 vertebrate wildlife species. Maintenance of this rich wildlife assemblage over time is important at both a local and regional scale.

Habitats capable of supporting up to 12 species protected under the State or federal Endangered Species acts are present within the project area as well as habitats which are documented to support 26 State or federal Species of Concern. Maintaining or enhancing wildlife habitat diversity over time is the most effective tool available to land management agencies to prevent additional listing under the State and federal Endangered Species acts and to recover currently listed species.

The project area contains habitats which are increasingly uncommon in California and the Nation including vernal pools, riparian, and freshwater emergent wetlands. These habitats seasonally provide key wildlife habitat elements for migratory and resident species including waterfowl, shorebirds, and neotropical migrants. As habitat losses and fragmentation continue Statewide in the face of ever increasing human population growth, the importance of maintaining these habitats (saving the pieces) and the species dependent upon them will likewise increase.

As the human population increases, so will the demand for additional opportunities for recreation. Relicensing stakeholders recognized the need to maintain or enhance wildlife habitats and populations while providing for current and future recreational development and use. Towards this goal they collaboratively developed study plan SP-T9 including the following study objectives:

- Identification of on-going and future recreation-related direct and indirect impacts to wildlife and plant communities.
- Identification of opportunities to reduce or eliminate recreation-related impacts to wildlife and plant communities.

Study results indicate that both direct and indirect impacts to wildlife and wildlife habitats occur as a result of the high level of recreational use and development within portions of the project area. Levels of recreational use and development are likely to increase in the future as the human population increases. This increased recreational use and development may result in additional direct and indirect wildlife habitat loss and fragmentation.

The most important product of this report is information on the location of sensitive resources including sensitive wildlife habitats. These data will allow recreational planners and relicensing stakeholders to avoid recreational development or increased recreational use in sensitive wildlife habitats including habitats protected under the State or federal Endangered Species acts.

If additional appropriate recreational developments are required to meet future recreational needs, Section 5.6.1 provides general guidance on project citing, design, and construction which would serve to minimize the impact of additional recreational use and development on wildlife populations and habitats.

Section 5.6.2 briefly describes conservation measures (likely to become FERC license conditions) designed in consultation with DFG and USFWS, to minimize or avoid direct, indirect, interdependent, and interrelated recreation related impacts to species protected under the State or federal Endangered Species acts.

Potential measures to limit currently identified recreation/wildlife conflicts related to ongoing project affects are summarized in Section 5.6.3, while opportunities to enhance some types of wildlife related recreational activities are identified in Section 5.9.1.4.

These measures/opportunities will serve to minimize or avoid current and future recreation related affects to wildlife resources and habitats. Implementation of these measures will allow for potential increases in recreational development and use over time while maintaining wildlife species and habitat diversity over the term of the new license.

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Oroville Facilities Relicensing Project
SP-T9: Recreation and Wildlife
Appendix A
Recreation/Wildlife Literature Review

This review is a compilation of 83 annotated references related to the impacts of recreation on wildlife. Recreation impacts are categorized by activity type and by facilities/factors associated with recreation. Within each category, reviewed articles are presented in chronological order. Many articles are reviewed in more than one category because the impacts of several recreational activities were studied. The literature cited section contains citations for all articles reviewed, as well as citations for three annotated bibliographies that were used as a starting point to gather appropriate articles.

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Impacts of Recreation by Activity Type

Recreation in General

Nesting bald eagles were observed in the Chippewa National Forest in north-central Minnesota to determine the effect of human disturbance on nest success. Disturbance was categorized as no disturbance (wilderness area), little disturbance (trail nearby, possible habitat modification in area, nest may be visible from road or water but hard to get to), or high disturbance (frequent human activity in the form of camping, hiking, boating, fishing; road may lead directly to nest; nest is easily accessible and location is well known to public). Occupied nests were identified during April or May and checked for success from the ground in mid-summer. A nest was considered successful if one young reached fledgling stage, but not all nests were observed each year. Statistical analysis found no significant difference in nest success between the three levels of disturbance. Observed nests in the wilderness were occupied 78 percent of the time with a 54 percent success rate, while nests in disturbed areas were occupied 79 percent of the time and successful 48 percent of the time. Author did not look at number of young per nest, number of fledglings per nest, or number of abandoned nests (not all nests were observed). Conclusion was that human disturbance does not affect nest occupancy or success, which was possibly due to the onset of disturbance late in the nesting cycle (after egg-laying and incubation). (Mathisen, 1968)

A bald eagle management study in the Shasta-Trinity National Forest in Shasta and Trinity counties notes the possible effects of recreation on wildlife. Observations were that nesting behavior does not appear to be affected by recreation because of a lack of upslope movement of nest locations. However, disturbance during foraging activity was commonly observed. Boats were the major cause of foraging disturbance. Roads are readily visible from some mud bars, but traffic on them is light. Campers, especially along shorelines, were found to disturb foraging eagles. Disturbance was not believed to have caused a decline in successful fledging. (Detrich, 1977)

A review of the impacts of recreation on freshwater animals by shore-based activities (including angling, bird watching, swimming, camping, picnicking, and walking) finds that recreationists indirectly affect wildlife by trampling or removing vegetation, or by changing species composition along trails. Birds are most seriously affected by shore activity. Breeding failure is usually named as the result of disturbance, but authors caution that the failure is most likely due to an increase in nest predation in response to the flushing of the adults. A tendency for larger birds to flush at greater distances from disturbance than smaller birds has been frequently observed, indicating that passerine species are less sensitive to disturbance than waterfowl. (Liddle and Scorgie, 1980)

Researchers studied the impact of outdoor recreation on the density of thirteen breeding bird species in woods adjacent to urban residential areas. Outdoor recreation included hiking and bicycling along trails and occurred at different frequencies in different study sites. Numerous unleashed dogs were also observed. Bird counts were made from the beginning of May through July. Results showed that recreation activity had a significant negative correlation with densities of eight of the 13 bird species studied. The relation between traffic intensity and bird densities is the same if traffic is increased equally at sites that already have low or high traffic intensity. Therefore, it is better to allow the intensity of already busy areas to increase, rather than allow visitor intensity to spread out. (Van der Zande et al., 1984)

A special session at a conference on recreational impacts on wildlife in wildlands points out the gaps in current impact research and the need for more research of this topic. Most recreational impact studies merely record observations of a superficial nature, have short time frames, lack theory, rarely utilize experimental designs, and rarely produce results that lead to broader generalizations. Authors suggest that the management strategy of avoiding concentrated use on weekends, holidays, and during certain seasons by attempting to spread out use over time and space may actually be more detrimental if, in fact, low levels of disturbance have a significant impact on wildlife. Research efforts need to focus on an understanding of the responses of wildlife to recreational activities, the factors that influence the nature and magnitude of impacts, develop improved research methods, and develop and implement new management strategies. (Cole and Knight, 1991)

A literature review of 40 articles studying the effects of human disturbance on birds during breeding season found that 36 of the 40 articles reported reduced breeding success in response to disturbance. On average, reproductive success was reduced by 40%. The main reasons suspected to be responsible for the decline were nest abandonment and increased predation of eggs and young. Other topics covered include effects on nest-site choice, population density, community structure, distribution and habitat use, and energy budgets. (Hockin et al., 1992)

A Fish and Wildlife Leaflet summarizes the causes and effects of human disturbance of waterfowl. Activities that cause disturbance are listed in order of decreasing disturbance as rapid over-water movement and loud noise (power-boating, water skiing), over-water movement with little noise (sailing, wind surfing, rowing, canoeing), little over-water movement or noise (wading, swimming), and activities along shorelines (fishing, bird-watching, hiking, traffic). Disturbance during the breeding season resulted in declining numbers of breeding pairs, increased desertion of nests, reduced hatching success, and decreased duckling survival. Increased energy expenditure, depleted fat reserves, and changed migration patterns are listed as results of disturbance on non-breeding waterfowl. (Korschgen and Dahlgren, 1992)

A summary of distinct factors that influence wildlife responses to recreationists explains that the type of activity (motorized or non-motorized, land-, water-, or snow-based, air- versus ground-based, and those that have localized or widespread impacts) causes different reactions from wildlife. Fast movement directly toward animals frightens them, while movement away from or at an oblique angle is less disturbing. High speeds are typically more alarming than slower speeds. The frequency and magnitude of a disturbance is another factor. Nests visited more frequently than others tend to have lower reproductive success. Predictability is also important; when animals perceive a disturbance as expected and non-threatening, they show little response. Conversely, if the disturbance is perceived as predictable and threatening, an aversion reaction is common. The timing of disturbance is also a factor. Disturbance during the breeding season will affect productivity (nest-building and incubation), while disturbance outside of the breeding season can affect energy balance (disruption of foraging and reaction of fleeing), and consequently, survival. Finally, the location of the disturbance is an important factor. Wildlife react more to approaches from above, such as from the top of a cliff. Wild animals also appear to feel more secure when there is an open distance between them and potential threats. Authors also list type of animal, group size, age, and sex as influential factors. (Knight and Cole (2), 1995)

A review of the effects of human disturbance on wildlife cites intrusion and stress as the most influential factors of disturbance. Water-related recreation activities cause waterfowl to avoid prime nesting areas or to abandon their nests. Anglers prevent waterfowl from establishing territories or selecting nest sites in small open areas. Walking to a nest to view it can attract predators to the area. There is evidence that a single visit by humans to a nest site can cause nest abandonment. Vehicles along waterways can startle avian family units, causing the separation of parent and young. Motor boat activity results in decreased foraging by waterfowl on rivers. Bears have been observed to habituate to human presence, but are attracted to refuse. Bears that use dumps for food tend to be larger, live longer, and have higher productivity. (Anderson, 1995)

A review of the indirect effects of recreation on wildlife shows that research is lacking on this topic. The authors show that impacts or changes to soil and vegetation, such as trampling, removal, or introduction of exotic species, greatly change the food structure for wildlife. (Cole and Landres, 1995)

Researchers investigated the potential human impacts on bald eagle reproductive success along the Upper Mississippi River National Wildlife and Fish Refuge (Iowa to Wisconsin). Rates of human activity occurring near active bald eagle nests were documented throughout the breeding season (early February through early June) and reactions of eagles to the various recreational activities were observed for two years. Reproductive success was also monitored. Human activities included small pleasure-boat traffic, sport and commercial fishing, camping, hiking, and research efforts. Results showed that in the first year, when study sites were easily categorized as having high or low human traffic, nests in high traffic areas were less productive than in low traffic areas. However, in the second year, when levels of traffic were low and did not differ significantly at each of the nest sites studied, reproductive success was similar at all nests. Overall, researchers concluded that human activity did negatively affect reproductive success in bald eagles. (McKay et al., 1996)

A review of the impacts of recreation on Montana wildlife shows that herpetofauna located in and around recreational facilities may be at risk of increased mortality as a result of handling and killing by humans, as well as by their pets. Herpetofauna are also impacted by the artificially high number of common predators associated with recreation areas, such as raccoons, skunks, and ravens. Herpetofauna that breed and forage nocturnally may be negatively affected by artificial light from flashlights, fixed lights, or passing car headlights. (Joslin and Youmans, 1999)

A paper introducing the idea that behavioral changes in response to human presence is not necessarily an indication of susceptibility to disturbance. Most recreational impact studies suggest that the species that displayed the greatest avoidance effort should receive protection from disturbance, while those that seemed unaffected did not need protection. The authors suggest that those species that flush do so because there is a nearby suitable area to retreat to. Therefore the cost of flight is low. Conversely, those species that remain in the area and appear to be unaffected by human activity may actually be forced to remain in the area due to a lack of suitable habitat, prey base, or territory elsewhere. The misinterpretation of results could lead to the closure of areas to human activity where the species does not actually need protection, and a lack of protection in areas where it is needed. Changes in population size and reproductive success are suggested as more reasonable variables to study the impacts of recreation on wildlife. (Gill et al., 2001)

Camping

Research of the possible causes of the decline in loon populations in the Superior National Forest of Minnesota showed evidence that human disturbance is a major cause. Loons were observed from May through mid-October. The opening of fishing season coincided with the beginning of the loon nesting season. Loons were more likely to abandon their nests if disturbed early in the nesting season. Canoeists, who entered the area approximately two weeks after nest sites were established, chose campsites on small islands which were preferred nesting sites for loons. Campers therefore tended to keep loons away from their nests. (Ream, 1976)

Researchers studied the effects of campgrounds on small mammals in a National Park in Utah by live-trapping for a mark and recapture study five consecutive days per month for approximately 5 months in established campgrounds, and simultaneously in similar areas that were undisturbed. Statistical analysis was used to compare the total number of species captured in each area. Results showed that the Colorado chipmunk, woodrats, and deer mice existed in significantly higher numbers in the campgrounds than in the control areas; while the desert cottontail, Antelope ground squirrel, and Ord’s kangaroo rat existed in similar numbers in both areas. Difference is possibly due to the increased food source provided by camping use, and also possibly due to the decrease in predator species (i.e. coyotes and hawks) in the camping areas. (Clevenger and Workman, 1977)

Backcountry (remote) campgrounds in Glacier National Park were studied to determine what characteristics of campgrounds influence black bear depredations. Campgrounds were surveyed and numerous characteristics were noted, as well as whether a bear incident had occurred at that campground. Statistical analysis showed that bear problems occurred most often at campgrounds that were in forested areas, in areas of ungulate winter range, along lake shores, within 5 km of a developed area, associated with two or more established trails, had larger party limits, allowed open fire pits, and where fishing quality was high and fish entrails were improperly disposed of.
(Merrill, 1978)

Researchers studied nest success in Yellowstone National Park to determine the effects of human recreation on the osprey population. Active nests in areas of no disturbance, moderate disturbance, and high disturbance were monitored between late April and mid-August. Disturbance occurred in the form of shore fishing, boating, or camping. Statistical analysis showed that nests in areas of little human use or more than 1-km away from backcountry campsites were significantly more successful than those in areas of high use or within 1-km of a campsite. Undisturbed nests had a reproductive success rate that could sustain the population, while nests in areas of human use had low success rates. Therefore, the overall rate was not high enough to sustain the population. During one year of the study, backcountry campsites within 1-km of a nest were closed, resulting in a nesting success and productivity equal to that of undisturbed nests. Human use of the shoreline for fishing appeared to be responsible for a change in nest location along the lake. Heavily used areas experienced a 90% population decline, while lightly used areas experience only a 20 percent decline. Boating was not determined to be a serious factor unless combined with shore activity. The timing of human activity, which in this study abruptly began near nests during the incubation period, most likely caused the decrease in reproductive success. If human activity was present before nesting began, it may not have had such a detrimental effect. Authors recommend restrictive management of backcountry use. (Swenson, 1979)

A review of 166 journal articles containing original data found 17 articles on birds and 24 articles on mammals that showed that camping negatively affects wildlife through trampling of habitat, disturbance of animals, and from discarded food or other items. Garbage at campsites can attract high densities of small mammals. (Boyle and Samson, 1985)

Researchers studied the effects of campgrounds in riparian zones in a Utah National Forest on avian populations by establishing 31 plots in campground areas and 80 plots in non-campground areas. The variable circular plot method was used to census 14 bird species, and statistical analysis was used to compare avian use in campgrounds to use in control areas. In general, results showed that campgrounds, which have lower vegetation densities and litter depth than the control areas, were positively associated with tree nesting birds, while negatively associated with birds that nest on the ground, in shrubs, or in small trees. Also negatively associated with campgrounds were three bird species that are ground foragers, possible due to avoidance of human activity. There were exceptions to each result. (Blakesley and Reese, 1988)

A summary of the effects of recreational activity on wildlife in wildlands shows that campsites, which require habitat alterations, tend to have reductions in ground and shrub nesting birds. Litter and garbage left behind can cause animals to change food habits; garbage and food left by recreationists alters the foraging ecology of bears. (Knight and Cole, 1991)

A review of the impacts of recreation on Montana wildlife found that improper storage of pet food within campgrounds attracts many species of wildlife. Wild animals that obtain improperly stored food may become habituated to humans. (Joslin and Youmans, 1999)

Researchers studied the impacts of camping at Isle Royale National Park, USA, and developed suggestions for campsite management that will minimize those impacts. Campsites in the park are designated and contain three-sided wooden shelters, individual campsites, or group campsites. The majority of campsites are along the perimeter of the park in clusters. This arrangement is advantageous in that it concentrates camping activities and the associated impacts. The most noticeable impact from the campsites is vegetation trampling, which is confined to a small area with this arrangement. The potential for habitat fragmentation and disturbance or displacement of wildlife is also minimized. Picnic tables were viewed as a resource protection facility because they tend to concentrate human activity. (Marion and Farrell, 2002)

Hiking / Trails

Researchers observed breeding pairs of osprey in Humboldt and Mendocino counties to determine the effects of human disturbance on nesting success. Disturbance was rated as low (occasional hiking by researchers), relatively constant (includes normal county and highway traffic, picnicking, hiking – activities that were present at time of nesting), and constant intense disturbance from logging, which started after incubation of eggs began. Occupied nests were checked from late April through early August. Statistical analysis showed that the average percent of occupied nests producing fledglings and the average number of young fledged per occupied nest declined with increasing activity levels. Mean productivity of occupied nests at low and relatively constant levels of disturbance did not differ, but mean productivity of nests subjected to levels of intense constant disturbance was significantly lower. Researchers suggest that human activity should not be initiated after nesting begins, and should be held off until young have fledged. (Levenson and Koplin, 1984)

A review of 166 journal articles containing original data found 17 articles on birds and 24 articles on mammals that showed that hiking negatively affects wildlife through trampling of habitat, disturbance of animals, and from discarded food or other items. Hiking activity can displace animals from trails. (Boyle and Samson, 1985)

Experimenters studied the response of breeding great blue herons to human disturbance in north-central Colorado. Two years of study focused on non-controlled disturbance, while the third year of study observed responses to controlled disturbance (the number of observations was too low in the first two years for statistical analysis). Observations were made from late February through July. Results showed that uncontrolled human intrusions, in the form of hiking, boating, or motorcycle riding, caused minimal responses in 67 percent of the cases. Passing boats resulted in minimal responses 92 percent of the time. Intrusions that elicited local responses were caused by slow-moving boats or canoes that were maneuvered directly under trees with nests, but no general responses were observed. Land-related intrusions resulted in local responses 61 percent of the time, while minimal responses were only observed 22 percent of the time. A general response was caused 17 percent of the time. Herons were most responsive to human disturbance early in the breeding season. They flushed from their nests and did not return until the disturbance was gone. Herons were less willing to abandon their nests during egg-laying and incubation. Herons were least affected by fast-passing boats, possibly due to habituation, but were sensitive to unexpected disturbance such as people walking by and motorcycles passing by. (Vos et al., 1985)

Experimenters studied 62 nesting pairs of ferruginous hawks in south-central Idaho to determine their behavior and nesting success. At 24 of the nests, experimenters simulated disturbance to determine the effects of disturbance on nesting success. Nests were disturbed either by approaching them on foot, approaching them in a vehicle, continuously operating a gasoline engine, firing a rifle, or using various noisemakers. The disturbance was stopped when the parent flushed from the nest. Nests were disturbed in early May once per day at various times during the day until young were ready to leave the nest, or until the nest was abandoned. Each nest experienced only one type of disturbance. The control nests experienced hatching success of 4-5 young per nests, with 1-2 young per nest being rare. In contrast, disturbed nests rarely produced 4-5 young, but generally produced 0-2 young per nest. Birds did not become habituated to disturbance, but instead became sensitized. Eight of the nine nests that failed due to disturbance were not used the following year. None of the types of disturbance produced significantly different effects on the birds. Disturbed nests had low levels of parental care (parental neglect), and young hawks attempted to fledge prematurely, making the young more susceptible to predation and environmental factors. Prey abundance and other factors not studied could have contributed to the observed results. A buffer zone of 250 m is suggested to minimize the impact of human disturbance. (White and Thurow, 1985)

Researchers studied the effects of human activities on breeding bald eagles in north-central Minnesota. Human activity was simulated by researchers who approached active nests on foot. Reaction, flushing distance, and nest success was documented over a three year period from late March through September. Statistical analysis showed no evidence that human activities had a major impact on bald eagle reproduction during the course of the study. Nest location did appear to be negatively correlated with human settlements. Also, researchers observed that eagles did not habituate to repeated intrusions, but instead flushed at increasing distances with additional disturbances. A buffer zone based on the needs of individual breeding pair responses is recommended instead of a standard zone. (Fraser et al., 1985)

Experimenters subjected radio-collared mule deer in north-central Colorado to controlled disturbance by persons on foot (and on snowmobile) from January through March. The level of response behavior and distance between person and deer at time of response was noted by two observers hidden in blinds. Statistical analysis showed that deer had more instances of moderate and high responses to persons on foot than on snowmobiles. Similarly, deer activity was disrupted more by persons on foot than on snowmobiles. Disturbance reaction to persons on foot was longer in duration. Researchers speculate that this is due to the fact that persons on foot took longer to leave the area than did snowmobiles. (Freddy et al., 1986)

Investigators studied repulsion or attraction of forest-breeding birds to nature trails in three large forest preserves in Lake County, Illinois. Two preserves contained nature trails open to foot traffic, while one did not. Bird counts of calling male birds were made on five days on various trails in each preserve in June, and on imaginary (control) trails in the third preserve. Average distance of a species' territory from the trail was noted. Statistical analysis was used. Of 33 species observed, only 5 had territories that were significantly different in distance from the trails than in the control area. Acadian flycatcher (reason unknown), blue jay (expected result), American robin (expected result), and brown-headed cowbird (expected result) territories were significantly closer to nature trails than in the control, and white-breasted nuthatches were farther than expected (reason unknown). Results show that generalist/edge species are attracted to trails, which may affect area-sensitive forest-interior species. (Hickman, 1990)

Researchers studied the effects of human activity on bald eagle distribution on the northern Chesapeake Bay shoreline in Maryland. Radio-tagged eagles were monitored for three years using telemetry, and shoreline surveys were conducted monthly to observe eagles, boats, and pedestrians. Statistical analysis showed that bald eagles rarely used developed areas or areas frequented by boats or pedestrians. Eagles did not use the Baltimore area shoreline, which was 70 percent developed. (Buehler et al., 1991)

Two observers carried out experiments in the Swiss Alps simulating trail hiking on the trail, off the trail, and hiking across burrows in areas of high marmot densities on established, highly-frequented, trails. Distance of first reaction, flight distance, frequency and duration of disappearance, duration of foraging interruption, and warning whistles were noted. Observers found through statistical analysis that marmots were more likely to retreat to burrows when hikers left the trail and/or walked across the burrows. Marmots rarely reacted to hikers that stayed on the trail; possibly already adapted to this activity. (Mainini et al., 1993)

Researchers studied the responses of wintering grassland raptors to human disturbance in Weld County, Colorado. Species studied included American kestrels, merlins, golden eagles, rough-legged hawks, and ferruginous hawks. Disturbance consisted of walking or driving in a direct line of sight toward a perched bird. Two years of surveying and statistical analysis showed that all raptors were more likely to flush when approached by a human on foot than an automobile, but prairie falcons were equally sensitive to both disturbance types. Overall, 97 percent of all raptors flushed when approached by a person on foot, while only 38 percent flushed when approached by a car. Flush distance varied between species and between disturbance types within species. These results are similar to those of other studies and support the finding that slow-moving disturbance causes greater reaction than fast-moving disturbance. (Holmes et al., 1993)

Volunteer researchers observed the reactions of colonial nesting birds to visitor use at Lake Renwick Heron Rookery in north-eastern Illinois. Visitors hiked along designated trails every Saturday as individuals, small groups, or large tour groups, and were observed for 11 weeks from early June to late August. The reactions of egrets, herons, and cormorants were observed. Volunteers reported that no birds flushed from their nests in response to human activity, regardless of the group size or weather conditions. Only birds flying over the observation station or birds roosting along the shoreline were disturbed. (DeMauro, 1993)

Two reproductively isolated populations of the North American wood turtle were studied for ten years in a protected watershed in south-central Connecticut, then for another ten years after the area was opened to recreation (hiking permits were issued). Ambient conditions, such as water quality, temperature, pH, turbidity, nitrogen, etc… were monitored for all 20 years and were not found to differ significantly. Predation and other factors were ruled out during the study. Statistical analysis of the mark and recapture study showed that the two populations had constant numbers during the first 9 years of study, began to decline when recreation commenced, and were completely absent by the end of the study, indicating a 100% decline over the ten year period. Turtle decline was most closely correlated with the number of permits issued in surrounding towns each year. (Garber and Burger, 1995)

A review of the impacts of hiking on wildlife showed that the non-consumptive activity has the potential to displace wildlife from an area. Various bird species disturbed by hikers displayed short-lived behavioral responses. Hiking disturbance was found to reduce a breeding population, but did not affect breeding success of the remaining population. Ungulates have been displaced from their home ranges until the disturbance ceased. (Knight and Cole, 1995)

Researchers investigated the effects of repeated human intrusion on avian richness and abundance near Laramie, Wyoming. Selected sites were disturbed by hikers on a spatial scale, with 25 percent or 100 percent of the area being disturbed for one hour, with one or two intrusion treatments per week, or received no disturbance (control areas) for a period of 5 years. Point counts were not found to be intrusive. Caution was taken to leave the habitat undisturbed and avoid the creation of trails. Bird surveys evaluated species richness and abundance in all selected sites. Statistical analysis showed that habitat characteristics did not differ significantly between control and intruded sites and therefore did not confound with other studied variables. Researchers did not detect cumulative or yearly declines in seasonal richness, mean richness, or mean total abundance of bird species. Overall, patterns of cumulative decline did not develop, indicating that repeated intrusions did not cause widespread impacts on avian community structure. (Riffell et al., 1996)

Researchers studied the effects of repeated human intrusions on the seasonal timing of avian song during breeding season at two sites in south-eastern Wyoming. Selected sites were disturbed by hikers on a spatial scale, with 25 percent or 100 percent of the area being disturbed for one hour, with one or two intrusion treatments per week, or received no disturbance (control areas) for a period of five years. Bird species studied sang primary songs frequently, were easily heard and readily distinguishable, sang during various parts of the 10-week study per year, and were abundant in the study area. Point counts were not found to be intrusive. Statistical analysis showed that mean singing dates for the three species studied did not differ significantly between control and intruded sites, with the exception of the Ruby-crowned kinglet in one year of study. The proportions of control and intruded sites at which singing occurred did not differ significantly, with the exception of the yellow-rumped warbler during one year. Both exceptions had lower numbers at the intruded sites. Researchers determined that their methods could only detect medium and large scale difference, but not small differences. Therefore, they could not be sure that small differences in song timing did not occur. (Gutzwiller et al., 1997)

Researchers studied the effects of recreational trails on breeding bird communities in forest and grassland ecosystems near Boulder, Colorado. Species diversity, composition, and abundance, as well as nest predation rates by brown-headed cowbirds were studied near and away from trails from May to July. Trail recreation included hiking, wildlife viewing, jogging, exercising pets, mountain biking, and horseback riding. Statistical analysis showed that three grassland bird species were significantly more abundant along control transects than trail transects, and two species increased in abundance with increasing distance from trails. Five forest bird species were significantly more abundant along control transects than along trails, and four species increased in abundance with increasing distance from trails. American robins, however, were more abundant along and near forest trails than in control transects. Black-billed magpies and house finches were found only along grassland and forest trails, respectively. On both habitats, there was a positive relationship between nest survival and distance from trails. No significant relationship was found between brood parasitism and distance from trails. Overall, generalist species were more abundant along trails. (Miller et al., 1998)

Researchers studied the effects of human activity on the abundance and distribution of five-lined skinks at Point Pelee National Park, Canada. Several areas heavily used by recreationists and other areas with little use were studied and compared. Statistical analysis of five years of study showed that there were significantly fewer skinks in areas of high disturbance. A significantly decreasing trend in population numbers existed in high use areas, and age structure appeared to be adult-biased, indicating that recruitment may be insufficient to maintain population size. The low numbers of skinks in high use areas was attributed to the lack of woody debris and surrounding vegetation that resulted from the clearing of the area for footpaths. (Hecnar and M'Closkey, 1998)

Experimenters placed artificial nests baited with quail eggs and a tethered clay egg in trees and shrubs along two lowland riparian paved recreational trails and in two control sites to determine the effect of the trails on the risk of nest predation in Boulder County, Colorado. Nests mimicked those of American robins, and rubber gloves, boots, and clothing were worn when touching the nests or climbing trees. After two summers of observations, results showed that 94 percent of the nests were depredated. Over 83 percent of the clay eggs showed signs of predation. Imprints on the clay eggs revealed that 11 percent of the eggs were predated by house wrens, 69 percent were predated by either common grackles, blue jays, or black-billed magpies, 25 percent were destroyed by mice (most likely deer mice), and 11.5 percent were destroyed by squirrels. Some eggs had impressions from raccoon and red fox. The risk of predation tended to increase with distance from trails. Predation pressure by birds, however, was higher near trails. Most of the predatory mammal species appeared to avoid the trails, explaining the higher rate of predation to the nests as distance from the trail increased. (Miller and Hobbs, 2000)

Researchers studied the effects of repeated human intrusions on the potential for nest predation by gray jays. Selected sites were disturbed by hikers on a spatial scale, with 25 percent or 100 percent of the area being disturbed for one hour, with one or two intrusion treatments per week, or received no disturbance (control areas) for a period of five years. During treatments, any encountered gray jays were faced and directly approached by technicians. Gray jay numbers were surveyed throughout the study. Statistical analysis showed that the average number of gray jays on intruded sites was higher than that on control sites during all five years, but the percent differences in the averages decreased during the study period. Intrusion effects were significant during the first two years, but not during the last three. During the two years that intrusion had a significant effect, gray jays were detected within approximately three days of the start of intrusions. Researchers conclude that jays were attracted to technicians during the first two years, but then became habituated or disinterested because the intrusion had no rewards. Authors caution that the increase in gray jay occurrence does not necessarily result in higher rates of nest predation, as this variable was not studied. (Gutzwiller et al., 2002)

Swimming

A review of 166 journal articles containing original data found six articles that showed that swimming has a similar negative effect on wildlife to that of boating, as birds tend to be disturbed by sight disturbance more than noise disturbance alone. (Boyle and Samson, 1985)

A review of the impacts of swimming on wildlife showed that the non-consumptive activity may displace wildlife populations as well as alter wildlife communities. Most examples refer to beaches and the avian populations that use them. (Knight and Cole, 1995)

Dog Walking

Investigators mailed questionnaires to state wildlife conservation/natural resource agencies throughout the United States, asking what effects, if any, owned and feral dogs had on wildlife, agriculture, and humans. Wildlife damage due to dogs was ranked highest of all impacts listed. Uncontrolled (unleashed or feral) dogs were attributed to mortalities of deer, waterfowl, upland game, rodents, and songbirds. Destruction of ground nests was specifically reported. Mortality was either caused directly from attack or as a result of chasing. (Denney, 1974)

Two observers carried out experiments in the Swiss Alps simulating trail hiking on the trail, off the trail, hiking with a dog on a leash, and hiking with a free-running dog in areas of high marmot densities on established, highly-frequented, trails. Distance of first reaction, flight distance, frequency and duration of disappearance, duration of foraging interruption, and warning whistles were noted. Observers found through statistical analysis that marmots were more likely to retreat to burrows when dogs were present than not, and that they took much longer to reappear after a dog passed through than when just a hiker did. Warning whistles were only emitted when dogs were present, and more often when the dogs were free-running. The highest level of disturbance was caused by free-running dogs. This disturbance interrupts foraging activities and reduces fat stores. (Mainini et al., 1993)

A review of the impacts of domestic dogs on wildlife showed that wildlife displays a stronger fear response to dogs than they do to other wild canid predators. Fear response was measured as elevated heart rate or flushing. Dogs generally are viewed negatively because they chase and kill wildlife. (Knight and Cole, 1995)

A review of the impacts of recreation on Montana wildlife found domestic dogs to be a major threat to river otters, which have few natural predators but are most vulnerable on land. Dogs can potentially spread disease and parasites to small mammals (canine distemper, rabies, parvovirus, and plague), damage burrows of fossorial animals, flush incubating birds from nests, disrupt foraging activity, and disturb roosting activity. Dogs have been documented to harass, injure, and kill white-tailed deer, and caused stress-induced mortality in deer that reached a rectal temperature of 109 degrees after being chased by the dogs. (Joslin and Youmans, 1999)

Motor Boating

A literature review of the impacts of boating on birds on National Wildlife Refuges found that high-speed boating causes shoreline degradation, disruption of nesting and feeding areas, and displacement. Loss of production of young is a major result of boating activity in at least one refuge. (Conservation Committee Report, 1978)

Researchers studied nest success in Yellowstone National Park to determine the effects of human recreation on the osprey population. Active nests in areas of no disturbance, moderate disturbance, and high disturbance were monitored between late April and mid-August. Disturbance occurred in the form of shore fishing, boating, or camping. Statistical analysis showed that nests in areas of little human use or more than 1-km away from backcountry campsites were significantly more successful than those in areas of high use or within 1-km of a campsite. Undisturbed nests had a reproductive success rate that could sustain the population, while nests in areas of human use had low success rates. Therefore, the overall rate was not high enough to sustain the population. During one year of the study, backcountry campsites within 1-km of a nest were closed, resulting in a nesting success and productivity equal to that of undisturbed nests. Human use of the shoreline for fishing appeared to be responsible for a change in nest location along the lake. Heavily used areas experienced a 90 percent population decline, while lightly used areas experience only a 20 percent decline. Boating was not determined to be a serious factor unless combined with shore activity. The timing of human activity, which in this study abruptly began near nests during the incubation period, most likely caused the decrease in reproductive success. If human activity was present before nesting began, it may not have had such a detrimental effect. Authors recommend restrictive management of backcountry use. (Swenson, 1979)

Researchers studied six lakes in southern Ontario, Canada, to investigate the effects of the recreational use of shorelines on breeding bird populations. Level of use was ranked based on the density of cottages in the area, the proximity of roads, and the boat traffic. Bird populations were censused using the strip transect method from mid-May through early July. The nesting success of common loons was also observed from May to August. Twenty-five areas were studied with varying levels of recreational use. Results showed that the relative density of birds was positively correlated with disturbance and edge habitat, which was created by roads. A nonsignificant tendency toward decreasing diversity with increasing development was noted. Species common in an urban setting, such as the American robin, were found more frequently and in greater abundance in disturbed areas. Other species, such as warblers, were found in undisturbed areas only. Common loons had higher nesting success in undisturbed areas than in disturbed areas (sample size too small for statistical testing). Kingbirds had statistically higher hatching success in undisturbed areas than in disturbed areas. The decrease in nesting success in disturbed areas was attributable to adults being flushed from the nest by boat disturbance and consequently leaving eggs susceptible to predation. (Robertson and Flood, 1980)

A review of the impacts of recreation on freshwater animals by water-based activities finds that boats disturb wildlife by sight and sound. Boats indirectly affect wildlife through the destruction of aquatic vegetation, but have direct impacts on waterfowl through human presence. This disturbance results in the redistribution on, or movement away from, the water body. The critical factor in determining the effect of boating on wildfowl appears to be size of water body and whether boating takes place over the whole of the water surface. (Liddle and Scorgie, 1980)

A review of the history of the Ruby Lake National Wildlife Refuge (Nevada) and the conflicts between recreational boating and wildlife, specifically canvasback populations, is presented by the author. An increase in boating use caused increased disturbance to waterfowl, creating the need for changes in boating regulations to protect wildlife. (Bouffard, 1982)

Experimenters studied a fall migration staging area along the Upper Mississippi River (Minnesota to Illinois) to determine the effects of boating disturbance on waterfowl (diving ducks – mostly canvasbacks) activity. Boating activity was classified as hunting or fishing activity. Observation periods were used to note waterfowl activity before, during, and after boating disturbance. On average, diving ducks were disturbed over five times per day, with a mean flock size of disturbed canvasbacks approximated at 12,500 birds. Sport fishermen accounted for at least 42 percent of disturbances, hunters for at least 22 percent, and researchers for over 7 percent. Disturbance response was flight. (Korschgen et al., 1985)

Experimenters studied the response of breeding great blue herons to human disturbance in north-central Colorado. Two years of study focused on non-controlled disturbance, while the third year of study observed responses to controlled disturbance (the number of observations was too low in the first two years for statistical analysis). Observations were made from late February through July. Results showed that uncontrolled human intrusions, in the form of hiking, boating, or motorcycle riding, caused minimal responses in 67 percent of the cases. Passing boats resulted in minimal responses 92 percent of the time. Intrusions that elicited local responses were caused by slow-moving boats or canoes that were maneuvered directly under trees with nests, but no general responses were observed. Land-related intrusions resulted in local responses 61 percent of the time, while minimal responses were only observed 22 percent of the time. A general response was caused 17 percent of the time. Herons were most responsive to human disturbance early in the breeding season. They flushed from their nests and did not return until the disturbance was gone. Herons were less willing to abandon their nests during egg-laying and incubation. Herons were least affected by fast-passing boats, possibly due to habituation, but were sensitive to unexpected disturbance such as people walking by and motorcycles passing by. (Vos et al., 1985)

In a study of the compatibility of bald eagles with PG&E facilities and operations at Poe Powerhouse, along the North Fork Feather River in Butte County, researchers observed and noted human-eagle interaction. An adult eagle was flushed by a motorboat from a mud bar perch in French Creek cove, but later tolerated the fishing boat within 30 m of its perch. (Jackman et al., 1988)

Canvasback reactions to boating disturbance were observed at Lake Poygan, Wisconsin, during the fall and spring staging periods. Statistical analysis showed that 94 percent of disturbance was attributable to recreational boating activity, with 98 percent of disturbance from sport fishing boats in the spring and 64 percent from hunting boats in the fall. Boating disturbance elicited a flight response 13-14 times per day in the spring, and 8 times per day in the fall. Flight times were greatest during the fall, but birds tended to return to the feeding area. Canvasbacks tended to return to nearby loafing areas in the spring before moving back to feeding areas after disturbance. The disruption of feeding behavior is estimated to have a large detrimental effect. (Kahl, 1991)

Researchers studied the effects of human activity on bald eagle distribution on the northern Chesapeake Bay shoreline in Maryland. Radio-tagged eagles were monitored for three years using telemetry, and shoreline surveys were conducted monthly to observe eagles, boats, and pedestrians. Statistical analysis showed that bald eagles rarely used developed areas or areas frequented by boats or pedestrians. Eagles did not use the Baltimore area shoreline, which was 70 percent developed. (Buehler et al., 1991)

A review of the impacts of motorboats on bald eagles found that boats cause both active and passive displacement of eagles. Active displacement occurs when the eagle-use area consists of a narrow river corridor and where boaters come into close contact with the eagles. Eagles generally react by flushing from perches. Passive displacement occurs when the eagle-use area, namely a foraging area, consists of a large body of water that has high boating use but does not result in close contact between eagles and humans. Eagles generally change their foraging locations and behaviors in response. (Anthony et al., 1995)

Researchers quantified the behavioral responses of nesting bald eagles to watercraft in Voyageurs National Park, Minnesota. Nine nests were studied for two years from mid-May to mid-July. Watercraft included motorboats, canoes, sailboats, houseboats, and personal watercraft. The location, response, and distance of the eagles from the disturbance were recorded. Types of watercraft were pooled and statistical analysis showed that eagles had an overall response frequency of only 5 percent, and over 97 percent of responses were elicited by motorboats. Responses were either alert behavior (3.2 percent) or flight (1.5 percent). Distance was determined to be the most critical factor in causing disturbance, followed by duration and number of disturbance units. A 100-m buffer-zone of no activity is suggested for protection from disturbance, while a buffer of 100 to 400 m should be established within which watercraft cannot group together or stop. The low rate of response was less than reported in other studies and regions. Researchers speculate that habituation contributed to the observed difference. (Grubb et al., 2002)

Researchers studied foraging and loafing waterbird responses to outboard-powered boats and personal watercraft (PWC) to determine buffer distances that would minimize disturbance on the north- and west coast of Florida. Multiple areas of low, moderate, and high watercraft use were studied for two seasons; researchers created the disturbance with one of the two types of watercraft and recorded flush distance and noise levels of the approaching vessel. When comparing flush distances from the two vessel types, data was pooled. Twenty-three species of birds were disturbed, including herons, pelicans, osprey, and terns. A comparison of the approaches by each vessel showed that 11 of 16 bird species reacted similarly to either disturbance, and only the great blue heron exhibited significantly larger flush distances in response to the PWC. The osprey and three other species exhibited significantly larger flush distances in response to the outboard motor. The results of this study for reaction to PWC's by non-nesting birds contrasts with those of a study on the reaction of nesting birds. Researchers suggest buffer zones of 180 m for wading birds, 140 m for terns and gulls, 100 m for plovers and sandpipers, and 150 m for ospreys. (Rodgers and Schwikert, 2002)

Sailing

A reservoir in north-west London was studied to determine the effects of sailing on water birds (time of year and duration of observations unclear). The scope of study set out to determine which species are most affected by sailing, how permanent the effects are, and the different species' tolerance to sailing disturbance. Observations were made and results showed that grebes and gulls leave the area when sailboats are near, or retreat to a small area inaccessible to boats. Terns, coots, and mallards do not seem to be affected. Moorhens remain along the banks or in areas where boats do not have access. Goldeneye and teal leave the area when sailing commences and do not return. Conclusions are that continued bird use of the area is dependent upon the availability of areas not accessible to boats, and most birds that take flight when sailing commences tend to return the next morning. (Batten, 1977)

Canoeing

The impact of canoe float trips on green-backed herons was studied on an Ozark riverway in south-eastern Missouri. Heron abundance surveys were conducted while noting level of recreation activity and whether the herons were in the main river or on side channels away from recreationists. In three of the four stream sections studied, regression analysis showed a negative relationship between the number of herons on the main channel and the number of recreationists. Herons also had shorter foraging bouts when recreation activity was present. Although herons using backwater areas were not disturbed by recreationists, it did not appear that the ones disturbed on the main channel retreated to the backwater areas. (Kaiser and Fritzell, 1984)

The response of wintering bald eagles to experimenters drifting in a canoe was studied along the Skagit and Nooksack rivers in north-western Washington. The Skagit has heavy motor and drift boat activity while the Nooksack is rarely used by boaters. Levels of boating activity in study areas were documented by counting boats or counting cars with boat trailers in parking lots. Eagle response to the canoe was reported as whether or not the eagle flew off, the flight distance if the eagle flew, and whether the eagle was perched in a tree or feeding on the ground at the time of approach. ANOVA and linear regression analysis showed that in both areas eagles on the ground almost always flew when approached, but eagles perched in trees flushed less often in the heavy use area than in the undisturbed area. Habituation is one possible reason for this behavior. (Knight and Knight, 1984)

Experimenters studied the response of breeding great blue herons to human disturbance in north-central Colorado. Two years of study focused on non-controlled disturbance, while the third year of study observed responses to controlled disturbance (the number of observations was too low in the first two years for statistical analysis). Observations were made from late February through July. Results showed that uncontrolled human intrusions, in the form of hiking, boating, or motorcycle riding, caused minimal responses in 67 percent of the cases. Passing boats resulted in minimal responses 92 percent of the time. Intrusions that elicited local responses were caused by slow-moving boats or canoes that were maneuvered directly under trees with nests, but no general responses were observed. Land-related intrusions resulted in local responses 61 percent of the time, while minimal responses were only observed 22 percent of the time. A general response was caused 17 percent of the time. Herons were most responsive to human disturbance early in the breeding season. They flushed from their nests and did not return until the disturbance was gone. Herons were less willing to abandon their nests during egg-laying and incubation. Herons were least affected by fast-passing boats, possibly due to habituation, but were sensitive to unexpected disturbance such as people walking by and motorcycles passing by. (Vos et al., 1985)

Researchers studied the responses of breeding and non-breeding bald eagles to human activity along the Gulkana National Wild River in south-central Alaska. Researchers simulated recreation disturbance by floating down the river in inflatable rafts during the summer months (early June to mid-September) and recording whether or not an eagle flushed, the distance at which it flushed, and how far it flew. Age class and breeding status were also noted. Statistical analysis showed that only 23 percent of breeding adults flushed in response to the approach of the raft. Only 8 percent of adults on nests flushed. Flush response increased as an eagle's distance from the nest increased, decreased as nest height increased, and decreased as the distance from the river's edge and the perch increased. Flushing responses occurred more often for birds nesting in remote reaches of the river that are rarely disturbed. Overall, 58 percent of non-breeding eagles flushed. Flush response rate decreased as perch height and distance from river's edge increased. Response rate also increased with eagle group size. Juveniles flushed less often than all other age classes. Visibility of the disturbance seemed to be the most important factor that influenced flush distance. Both flush response and distance of breeders and non-breeders were highest in areas with the lowest levels of human activity. Authors caution that this does not necessarily mean that eagles habituate to human activity, but rather that eagles which are more sensitive to human activity relocate to areas with lower levels. Authors feel that a buffer zone would be unrealistic, but that limited numbers of users should be considered. (Steidl and Anthony, 1996)

Personal Watercraft Use

Park staff at Glacier National Park, Montana, researched the environmental and social impacts of personal watercraft use on the lakes of the park. The use of PWC's has gained popularity, and park staff did not want to make it a common activity without researching its effects on the area. An informal analysis caused the park to place a temporary ban on PWC use pending completion of the park's general management plan in order to protect resources. (National Parks, 1996)

The effects of motor boats and personal watercraft on common terns were studied in New Jersey after experimenters noticed a decline in reproductive success of terns subjected to personal watercraft (PWC) disturbance. Observations were made of a nesting area near a boating channel. Disturbance was classified as by motor boat, by PWC with a seated rider, and by PWC with a standing rider; the reaction of the terns was then recorded. Terns reacted negatively to motor boats and PWC's, but the reaction was more severe when PWC's were near. Motor boats tended to obey posted speed limits; PWC's did not. Also, PWC's were able to go closer to shore than motor boats. Disturbance reaction was flight over the area. (Burger, 1998)

Researchers studied foraging and loafing waterbird responses to outboard-powered boats and personal watercraft to determine buffer distances that would minimize disturbance on the north- and west coast of Florida. Multiple areas of low, moderate, and high watercraft use were studied for two seasons; researchers created the disturbance with one of the two types of watercraft and recorded flush distance and noise levels of the approaching vessel. When comparing flush distances from the two vessel types, data was pooled. Twenty-three species of birds were disturbed, including herons, pelicans, osprey, and terns. A comparison of the approaches by each vessel showed that 11 of 16 bird species reacted similarly to either disturbance, and only the great blue heron exhibited significantly larger flush distances in response to the PWC. The osprey and three other species exhibited significantly larger flush distances in response to the outboard motor. The results of this study for reaction to PWC's by non-nesting birds contrasts with those of a study on the reaction of nesting birds. Researchers suggest buffer zones of 180 m for wading birds, 140 m for terns and gulls, 100 m for plovers and sandpipers, and 150 m for ospreys. (Rodgers and Schwikert, 2002)

Off-Road Vehicle Use

Observers created three plots in the Mojave Desert representative of heavy, moderate, and no use by off-road vehicles, then used the removal method to census lizard populations on each plot for three days. There was equal species diversity in the no use and moderate use plots, but the no use plot had much higher density (no statistical analysis). The heavy use plot was used by one species of lizard, of which only two individuals were found. A suggested reason for this result is the varying amounts of vegetation in each plot (i.e. the no use plot has high vegetation density). (Busack and Bury, 1974)

A literature review finds that the impact of off-road vehicles on desert avifaunas is negative. ORV use can cause nest destruction, crushing of individuals, harassment, and noise disturbance. Habitat alteration decreases habitat quality. Studies prove loss of breeding pairs and breeding success due to ORV activity. Also, ORV's create a reduction in vegetation cover that is crucial to rodents, which provide a prey base for raptors. (Luckenbach, 1978)

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Experimenters subjected five radio-collared does from an unhunted mule deer population in Canada to harassment with an ATV every other day or every day, at dusk or dawn. Overall activity of harassed animals was compared to unharassed animals and statistically analyzed, although data were lumped in violation of the assumption of independence among samples. Results showed that harassed deer spent more time active during darkness, spent the times of day when harassment occurred in hiding, increased their use of cover, left their home ranges more often, and suffered decreased reproduction in comparison to unharassed animals. Deer that were subjected to the ATV's but not pursued by them habituated to the activity. (Yarmoloy et al., 1988)

Reported mortalities of piping plovers caused by off-road vehicles on Atlantic coast beaches were investigated and found to have occurred in areas where warning signs were posted and where only official vehicles were allowed with monitors walking in front of them to look for plover chicks. Investigators concluded that the only way to avoid mortalities would be to ban all ORV use during the hatching and fledging season. (Melvin et al., 1994)

A review of the effects of recreation on Montana wildlife shows that factors other than direct mortality from off-road vehicle collisions may affect herpetofauna. ORV's may disrupt habitat to the point that it becomes unusable. Evidence also exists that numbers of birds and mammals, which are potential prey for some herpetofauna, are reduced in ORV-use areas. (Joslin and Youmans, 1999)

Fishing

Research of the possible causes of the decline in loon populations in the Superior National Forest of Minnesota showed evidence that human disturbance is a major cause. Loons were observed from May through mid-October. The opening of fishing season coincided with the beginning of the loon nesting season. Loons were more likely to abandon their nests if disturbed early in the nesting season. Canoeists, who entered the area approximately two weeks after nest sites were established, chose campsites on small islands which were preferred nesting sites for loons. Fishermen therefore tended to keep loons away from their nests. (Ream, 1976)

Researchers studied wintering bald eagles along the Nooksack River in northwest Washington to determine the effect of human activity on avoidance behavior. The study area is subject to logging, housing, mining, and recreation, including sport steelhead fishing. Observers simulated disturbance by approaching the eagles on foot in areas of heavy vegetation and canopy (vegetation zone), in open meadows adjacent to the river's edge (riverbank), and along gravel bars or by wading in the river (river channel). All disturbances were conducted during the day on birds perched in trees. Reaction, flight distance, and age class were noted for each disturbance. The eagles studied had a distribution reflective of the level of human activity in the area. Areas of lower human disturbance had higher numbers of birds along the riverside. Feeding behavior was disrupted by just the presence of humans, and did not resume until several hours after the disturbance stopped. Adult birds were more sensitive to disturbance than younger birds. Statistical analysis showed that the distance of the human at time of flight and flight distances for older birds were greater than that of younger birds for all three simulated disturbance types. Birds were more tolerant in the vegetation zone when humans were partially obscured from their line of sight. Activity on the river channel was the most disturbing in areas where there is normally not much disturbance. Habituation appeared to be a factor in areas where human activity is regularly high, as it was easier for researchers to approach the eagles in those areas. (Stalmaster and Newman, 1978)

A literature review of the impacts of fishing on birds on National Wildlife Refuges found that excessive use of shallow vegetated areas of lakes and streams by wading and boating fisherman can disturb feeding and nesting waterbirds. Many refuges prohibit fishing to protect wintering waterfowl, but open the lakes when resident species begin nesting. Some closure dates were found to be unrealistic because they did not include the entire nesting season. (Conservation Committee Report, 1978)

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Overwintering waterfowl on Llandegfedd Reservoir in Wales were studied to determine the effects of the opening of the game fishing season. Bird counts were conducted prior to the start of fishing season and at the start of the season. A nearby undisturbed waterfowl refuge was also studied for comparison. Statistical analysis showed that populations of widgeon, teal, and mallard declined 60 percent, 90 percent, and 80 percent, respectively, during the first few days of bank (shore) angling and continued to decline until they were absent. All species avoided the central, deep-water area before the start of the fishing season, but aggregated to the area once fishing commenced. Waterfowl also avoided grazed open grassland areas after fishing began. (Bell and Austin, 1985)

In a study of the compatibility of bald eagles with PG&E facilities and operations at Poe Powerhouse, along the North Fork Feather River in Butte County, researchers observed and noted human-eagle interaction. An adult eagle was flushed from its perch near the diversion dam by fishermen on foot at a distance of 75 m. (Jackman et al., 1988)

Experimenters studied the responses of an avian scavenging guild (bald eagles, common ravens, American crows) to anglers on Toutle River, Washington, in February and March. Steelhead fishing was allowed two days per week in the area. The avian scavenging guild was observed on fishing and non-fishing days. Two salmon carcasses were placed on each of ten gravel bars (too heavy to be lifted by any of the birds) each day and then weighed at the end of the day to determine amount of scavenging. Statistical analysis showed that carcass consumption was higher during non-fishing days. The presence of anglers did not affect the presence of scavengers, but did affect the behavior of bald eagles and ravens because they were more likely to be found in trees in the presence of anglers, and more likely to be found on the ground on non-fishing days. Crows were found more often on the ground in the presence of anglers. All three species were interrupted in feeding behavior and diurnal patterns. (Knight et al., 1991)

Researchers studied the influence of recreational disturbance on breeding common sandpipers near an upland reservoir in England. Bird censusing and angler and casual visitor counts were conducted over two breeding seasons. The angling season began before the sandpipers returned from their wintering areas and continued throughout the breeding season. Results showed that presence of common sandpipers is negatively correlated with the presence of anglers and beach visitors. Because sandpipers avoided human activity, they tended to intrude on each others territories. More fighting activity was noted than in an undisturbed population. Overall, breeding success was not affected, but there were fewer breeding pairs due to a lack of available, undisturbed shoreline for territories. (Yalden, 1992)

A review of the impacts of fishing on wildlife showed that fishing is less disturbing to terrestrial wildlife than either hunting or motorized boating, possibly because when done from the shore, the activity is quiet and relatively stationary. Anglers were not found to affect the presence of an avian scavenging guild, but did affect the numbers and behavior of each species. (Knight and Cole, 1995)

Researchers studied the effects of human disturbance on diving ducks on Long Point Bay, Lake Erie. Four sites were monitored throughout the spring and fall seasons. The number of waterfowl present on the water, number of birds disturbed, flush distance, flight time, waterfowl activity before disturbance, and type of disturbance were noted. Results showed that diving ducks were the most frequently disturbed by human activity, representing 74 percent of all disturbances. Only 19 percent of all birds were disturbed during the spring, while 81 percent were disturbed during the fall. Most disturbances occurred in the early morning hours. Commercial fishing boats caused the most disturbances during the spring, representing 85.2 percent of all disturbance types and 81.2 percent of waterfowl disturbed. Hunting boats caused the most disturbances in the fall, representing 50.7 percent of all disturbance types and 66.6 percent of waterfowl disturbed. (Knapton et al., 2000)

Hunting

A literature review of the impacts of hunting on birds on National Wildlife Refuges found that federal regulations on hunting are adequate to maintain avian populations. Hunters provide funding for the habitat purchased and therefore are entitled to hunt the areas. The author expresses concern over the hunting of species that look similar to endangered species. (Conservation Committee Report, 1978)

Experimenters studied 62 nesting pairs of ferruginous hawks in south-central Idaho to determine their behavior and nesting success. At 24 of the nests, experimenters simulated disturbance to determine the effects of disturbance on nesting success. Nests were disturbed either by approaching them on foot, approaching them in a vehicle, continuously operating a gasoline engine, firing a rifle, or using various noisemakers. The disturbance was stopped when the parent flushed from the nest. Nests were disturbed in early May once per day at various times during the day until young were ready to leave the nest or until the nest was abandoned. Each nest experienced only one type of disturbance. The control nests experienced hatching success of 4-5 young per nests, with 1-2 young per nest being rare. In contrast, disturbed nests rarely produced 4-5 young, but generally produced 0-2 young per nest. Birds did not become habituated to disturbance, but instead became sensitized. Eight of the nine nests that failed due to disturbance were not used the following year. None of the types of disturbance produced significantly different effects on the birds. Disturbed nests had low levels of parental care (parental neglect), and young hawks attempted to fledge prematurely, making the young more susceptible to predation and environmental factors. Prey abundance and other factors not studied could have contributed to the observed results. A buffer zone of 250 m is suggested to minimize the impact of human disturbance. (White and Thurow, 1985)

A summary of the effects of recreational activity on wildlife in wildlands finds that hunting/harvesting has been reported to affect age and sex ratios, alter birth and death rates, influence behaviors, and alter habitat usage due to the consumptive nature of the activity. The activity assumes compensatory responses in populations, but studies have shown that this is not true. Hunting has also been shown to result in waterfowl shifting their foraging patterns. (Knight and Cole, 1991)

A review of shooting-related disturbance and its effect on birds showed that widgeon and geese were most susceptible to shooting disturbance. Widgeon tend to concentrate in refuge areas during hunting season, then to move out to shot-over areas once the activity has ended. Hunting accounted for 36 percent of disturbance to widgeon and brant geese at unprotected sites. In another study, shooting disturbance contributed to 10-22 percent of all disturbance flights of white-fronted geese. Wildfowl tend to stay closer to water once the shooting season begins. (Hockin et al., 1992)

A review of the impacts of hunting on wildlife showed that the consumptive activity can alter behavior (a change in feeding time, feeding location, or date of conception), population structure, and distribution patterns of wildlife populations. Hunted populations function differently than unhunted ones. Researchers found no evidence of a compensatory response to hunting in studied populations, and found evidence that hunting actually caused additive mortality. (Knight and Cole, 1995)

A review of the impacts of hunting on wildlife showed that the activity can alter predator-prey relationships. Hunting was found in several cases to be additive, altering the balance of predator and prey. Trophy hunting may alter population structures. The noise of shooting causes animals to flee. A study of snow geese and tundra swan reactions to shooting revealed that the birds broke their flight formations, flared, increased altitude, increased calling behavior, and changed speed. Entire flocks took to flight without pre-flight coordination of families, causing confusion and disorder among social groups. Gunfire on the edge of a refuge was shown to disturb birds within the refuge. Hunting can also cause animals to avoid habitats. (Anderson, 1995)

Researchers observed water use patterns of mule deer in the presence and absence of human disturbance before and during the hunting season in the McCloud Ranger District of the Shasta-Trinity National Forest in north-central California. Deer were observed at a guzzler, a man-made pond, and a livestock trough. All three were near dirt roads used by hunters. Observers noted how long the deer remained at the water source, whether or not they drank, and whether there was disturbance (person on foot or in vehicle along dirt road). There was low disturbance before the hunting season, a six-fold increase in disturbance occurrences during archery season, and 12 times greater the frequency of disturbance during rifle season. Results showed that deer shifted the time periods that they drank, increased the amount of time spent at the water source (being cautious), and frequented the water more often (returning after each disturbance) in response to disturbance. However, disturbance did not preclude or seriously impede deer use of water. (Boroski and Mossman, 1998)

A review of the impacts of recreation on Montana wildlife found that hunting negatively impacts wildlife. Wild turkeys in protected areas were not alarmed when approached by vehicles. However, after several years of hunting and an increase in disturbance, birds sought out cover when approached. Range abandonment was observed with increased disturbance and harassment. For semi-aquatic wildlife such as beavers, muskrats, and river otters, fall hunting activities in riparian areas occur when these animals are most often on the banks cutting stems for caches and actively building houses. Mink and river otter may benefit from wounded or abandoned upland game or waterfowl during hunting season, but the dogs that accompany bird hunters present a danger. (Joslin and Youmans, 1999)

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Horse Riding

A study cites the effects of horse trampling on trailside vegetation in Tasmania. (This could be related to loss of habitat for some of our species.) (Whinam et al., 1994)

A review of recreational use and its management found that the impact of packstock (horses) was removal and redistribution of materials from grazing (habitat degradation). One study showed that brown-headed cowbirds in the Sierra Nevada were positively associated with recreational packstock stations. (Cole and Landres, 1996)

Wildlife Viewing

A review of 166 journal articles containing original data found 19 articles on birds and five articles on mammals that showed that wildlife viewing and photography negatively affects wildlife through disturbance from frequent encounters of long duration with humans. Human visits to passerine and waterfowl nests can increase chances of nest losses to predation because disturbance causes the adults to leave the nests for extended periods of time. (Boyle and Samson, 1985)

A summary of the effects of recreational activity on wildlife in wildlands finds that unintentional disturbance, such as photography and viewing, are the primary means by which non-consumptive recreational activities impact wildlife. (Knight and Cole, 1991)

Researchers studied an avian scavenging guild on the North Fork of the Nooksack River in Washington to determine the relationship, feeding ecology, and behavior of bald eagles, American crows, and glaucous-winged gulls as they fed on salmon carcasses, and to determine how human disturbance interrupted that relationship. After observing regular behavior, researchers simulated wildlife viewing disturbance by walking toward the feeding area until birds reacted with flight. In the absence of human activity, crows fed early in the morning and eagles and gulls fed from mid-morning through early afternoon. Crows and gulls used opened carcasses (by eagles or researchers), indicating that they may not be able to tear open intact carcasses. Eagles were dominant over gulls and crows during aggressive interactions, and gulls were dominant over crows. Eagles tended to displace gulls and crows from feeding. Eagles fed far from shoreline cover, while gulls and crows fed near shoreline cover. In response to human disturbance, researchers found that eagles flew from disturbance first, followed by crows, then gulls. Eagles rarely returned, and gulls returned faster than crows. Disturbance reduced feeding opportunity for eagles, but increased it for gulls; crows were unaffected. All three species fed more in the afternoon on disturbed days. Eagles are necessary to open the carcasses, so foraging efficiency of crows and gulls is enhanced by eagle presence. Areas disturbed by wildlife viewing could favor an increase in gull and crow numbers feeding on carcasses abandoned by eagles. (Skagen et al., 1991)

A review of the impacts of nature viewing on wildlife showed that the non-consumptive activity has the potential to negatively affect wildlife because viewers intentionally seek out species. Of five different types of recreation users, photographers were found to be most disruptive because they stopped, left their vehicles, and approached the wildlife. Songbirds were shown to act aggressively to people who routinely disturbed them or their nests, and to alter nest placement to areas inaccessible to humans. Predators tend to follow human scent trails that lead to nests. (Knight and Cole, 1995)

A review of the impacts of wildlife viewing showed that the activity can have diverse impacts on wildlife. An example of a staging area for sandhill cranes shows that viewers disturb them to the point of flight and disrupt the important accumulation of body fat for migration. Energy stores are wasted in fear responses, and foraging time is lost. (Anderson, 1995)

Rock Climbing

A review of 166 journal articles containing original data found two articles on birds and one on mammals that showed that rock climbing negatively affects wildlife by disturbing nesting raptors and other cliff-dwelling species, although effects are usually seasonal and local. (Boyle and Samson, 1985)

A review of the impacts of rock climbing on wildlife showed that the non-consumptive activity has the potential to disrupt wildlife species that use cliffs. Rock climbers choose routes that follow cracks, which are commonly used for breeding, roosting, and foraging. Ledges used for resting may be areas used for nest or perch sites. Typically, what little vegetation exists in cracks and on ledges is removed by climbers. Peak climbing activity also tends to overlap with the nesting season. (Knight and Cole, 1995)

A review of recommendations for protecting raptors from human disturbance lists the impacts of rock-climbing on raptors. Rock-climbing often involves shouting and other noises which disturb raptors and keep them away from their nests. Absence by parents can lead to missed feedings, nest predation, overheating, chilling, or desiccation of eggs or young. Rock-climbing near peregrine falcons during the nesting season can cause nest abandonment or the refusal to breed. Ferruginous hawks will abandon their nests during incubation if subject to human disturbance. (Richardson and Miller, 1997)

Cave Exploration

A review of 166 journal articles containing original data found eight articles that showed that recreational cave exploration negatively affects wildlife through disturbance of bat colonies to the point of roost abandonment, or by arousing hibernating bats to the point that all energy reserves are exhausted. (Boyle and Samson, 1985)

A review of the impacts of spelunking on wildlife showed that the non-consumptive activity has the potential to cause declines in sensitive wildlife populations. Most declines are observed at roosting and maternity sites for bats. (Knight and Cole, 1995)

Impacts of Facilities and Factors Associated With Recreation

Dams

Researchers gathered information on the direct and indirect effects of a dam on the foothill yellow-legged frog on the Trinity River in north-western California, from Lewiston Dam downstream to the confluence with the North Fork Trinity. Frog populations were studied following the dam construction and compared to pre-dam historical accounts. Habitat structure and the effects of flow releases were researched. Results showed a 94 percent loss of potential breeding habitat (bar habitat) and the creation of a deeper and narrower river channel that lacks habitat complexity. During the first two years of study, high flow releases destroyed all egg masses laid. Egg masses laid after the high flow release were also destroyed by a second flow release. Few larvae survived. During the last year of study, high-flow releases were done earlier in the year and a substantial proportion of egg masses and larvae survived. Two aspects of the dam were found to have the largest impact on the yellow-legged frog population; changes in river morphology due to controlled flows have resulted in loss of breeding habitat, and the timing of high-flow releases has caused the loss of entire cohorts. Researchers also suspect that the cool water temperatures artificially maintained during the summer for fish may retard the development of eggs and larvae. Controlled flows and lack of winter flooding may also create suitable habitat for the predatory bullfrog. (Lind et al., 1996)

Review of the impact of recreation on Montana wildlife found that any activity that results in reduced bank cover, decreased bank stability and erosion, or the destruction of houses, tunnels, feeding areas, and dryness of nests will detrimentally affect beaver, muskrat, and river otter. The main cause of these occurrences is the fluctuation of water levels associated with dams, as well as the recreational use supported by them. (Joslin and Youmans, 1999)

Roads

Researchers studied the effects of roads on small mammal populations in south-eastern Ontario and Quebec. Roadway types included two-lane county gravel roads, two-lane county paved roads, two-lane paved highways, and two divided four-lane paved highways. Mark and recapture studies were conducted over several weeks. White-footed mice, eastern chipmunks, and red-backed voles were most commonly captured. Results showed that roadways inhibit the movements of small forest mammals. Traffic volume alone did not appear to inhibit road crossings. The few small mammals that did cross roads crossed over both paved and unpaved roads. Road clearance appeared to be the most important factor inhibiting movements. The highest populations of mice and chipmunks occurred at the divided highway site, where crossings did not occur. Authors suggest that highways with clearances of 90 m or more are as effective barriers to dispersal as are bodies of water twice as wide. (Oxley et al., 1974)

Researchers studied the effects of vehicles on wintering deer within the El Dorado National Forest. A four-wheel-drive pickup truck was driven along a number of predetermined routes and deer reactions to the vehicle were observed for one winter. Overall deer response was an urgent escape response 56 percent of the time, and intermediate response 24 percent of the time, and no response 20 percent of the time. In 38 percent of the encounters, the moving vehicle had no effect on the deer. When the vehicle was stopped 32 percent of those deer undisturbed by the moving vehicle became disturbed. Researchers theorized that the urgent escape response placed significant physiological stress on the deer. (Barrett, 1976)

Researchers studied the impact of roads on big game distribution in the Blue Mountains of Washington. Roads were classified into three categories (main, secondary, or primitive roads), vegetation was classified into four groups (grassland and meadow, open forest, dense forest, and riparian), and pellet group transects were conducted for two summers. Statistical analysis showed that habitat use of deer was depressed to one-half mile by main roads, to one-eighth mile by secondary roads, and to one-quarter mile by primitive roads. (Perry and Overly, 1977)

Researchers studied six lakes in southern Ontario, Canada, to investigate the effects of the recreational use of shorelines on breeding bird populations. Level of use was ranked based on the density of cottages in the area, the proximity of roads, and the boat traffic. Bird populations were censused using the strip transect method from mid-May through early July. The nesting success of common loons was also observed from May to August. Twenty-five areas were studied with varying levels of recreational use. Results showed that the relative density of birds was positively correlated with disturbance and edge habitat, which was created by roads. A nonsignificant tendency toward decreasing diversity with increasing development was noted. Species common in an urban setting, such as the American robin, were found more frequently and in greater abundance in disturbed areas. Other species, such as warblers, were found in undisturbed areas only. Common loons had higher nesting success in undisturbed areas than in disturbed areas (sample size too small for statistical testing). Kingbirds had statistically higher hatching success in undisturbed areas than in disturbed areas. The decrease in nesting success in disturbed areas was attributable to adults being flushed from the nest by boat disturbance and consequently leaving eggs susceptible to predation. (Robertson and Flood, 1980)

Researchers observed breeding pairs of osprey in Humboldt and Mendocino counties to determine the effects of human disturbance on nesting success. Disturbance was rated as low (occasional hiking by researchers), relatively constant (includes normal county and highway traffic, picnicking, hiking – activities that were present at time of nesting), and constant intense disturbance from logging, which started after incubation of eggs began. Occupied nests were checked from late April through early August. Statistical analysis showed that the average percent of occupied nests producing fledglings and the average number of young fledged per occupied nest declined with increasing activity levels. Mean productivity of occupied nests at low and relatively constant levels of disturbance did not differ, but mean productivity of nests subjected to levels of intense constant disturbance was significantly lower. Researchers suggest that human activity should not be initiated after nesting begins, and should be held off until young have fledged. (Levenson and Koplin, 1984)

Experimenters studied 62 nesting pairs of ferruginous hawks in south-central Idaho to determine their behavior and nesting success. At 24 of the nests, experimenters simulated disturbance to determine the effects of disturbance on nesting success. Nests were disturbed either by approaching them on foot, approaching them in a vehicle, continuously operating a gasoline engine, firing a rifle, or using various noisemakers. The disturbance was stopped when the parent flushed from the nest. Nests were disturbed in early May once per day at various times during the day until young were ready to leave the nest or until the nest was abandoned. Each nest experienced only one type of disturbance. The control nests experienced hatching success of 4-5 young per nests, with 1-2 young per nest being rare. In contrast, disturbed nests rarely produced 4-5 young, but generally produced 0-2 young per nest. Birds did not become habituated to disturbance, but instead became sensitized. Eight of the nine nests that failed due to disturbance were not used the following year. None of the types of disturbance produced significantly different effects on the birds. Disturbed nests had low levels of parental care (parental neglect), and young hawks attempted to fledge prematurely, making the young more susceptible to predation and environmental factors. Prey abundance and other factors not studied could have contributed to the observed results. A buffer zone of 250 m is suggested to minimize the impact of human disturbance. (White and Thurow, 1985)

Researchers studied the reactions of mountain lions to logging and associated human activity (traffic on logging roads, operation of machinery) in south-central Utah and north-central Arizona. Lions were radio-collared and tracked using aerial and ground telemetry over several years. Lion locations were classified as in the area of an active or inactive logging area, less than 1 km away from the area, or not in or near the area. Activity patterns were noted with the aid of motion-sensitive collars. Results showed that lions did not use logging sites in proportion to their occurrence. Most resident lions appeared to restrict their activities to areas outside of logging sites, whether the sites were active or inactive. Lions did not use areas that had previous logging activity for up to six years after the activity had ceased. The avoidance of these areas could be attributable to human presence and activity, increased road density, increased human access allowing hunting pressure, altered prey densities, or altered habitat characteristics. Researchers felt that long-term avoidance was due to habitat alteration, but that the presence of humans and road densities greatly contributed to avoidance. (Van Dyke et al., 1986)

Time budgets of burrowing owls nesting and foraging near roadsides on the Rocky Mountain Arsenal, Colorado, were analyzed to determine the impact of vehicular traffic on owl activity. Sixty-nine owls were banded in April and May after pair bonds had been established. Observations were made from April to August for two years; type of behavior was noted using the instantaneous, focal-animal sampling scheme. Statistical analysis showed that vehicle traffic was not correlated with feeding, resting, comfort, courtship, agonistic, and out-of-sight behavior. Traffic was weakly correlated with locomotion and alert behaviors, but researchers felt that the level of disturbance was negligible. Greater levels of vehicle activity could cause greater disturbance and affect productivity. (Plumpton and Lutz, 1993)

Researchers studied the responses of wintering grassland raptors to human disturbance in Weld County, Colorado. Species studied included American kestrels, merlins, golden eagles, rough-legged hawks, and ferruginous hawks. Disturbance consisted of walking or driving in a direct line of sight toward a perched bird. Two years of surveying and statistical analysis showed that all raptors were more likely to flush when approached by a human on foot than an automobile, but prairie falcons were equally sensitive to both disturbance types. Overall, 97 percent of all raptors flushed when approached by a person on foot, while only 38 percent flushed when approached by a car. Flush distance varied between species and between disturbance types within species. These results are similar to those of other studies and support the finding that slow-moving disturbance causes greater reaction that fast-moving disturbance. (Holmes et al., 1993)

Researchers studied the effect of traffic intensity on amphibian (anuran) density near Ottawa, Canada. Two-lane road segments in two regions were selected to represent low, medium, and high traffic intensity. On six evenings during the spring breeding season, all dead and live frogs along 1 km sections of the roads were counted. Frog and toad choruses were also observed at various distance intervals. Regression analysis showed that the number of frogs and toads, as well as density, decreased with increasing traffic intensity. The number of dead frogs and toads increased with increasing traffic intensity. (Fahrig et al., 1995)

A review of studies of the ecological impacts of roads in the Netherlands, Australia, and the United States found that overall, road kill is highest for amphibians and reptiles on two-lane roads with low to moderate traffic, for medium and large-sized mammals on two-lane, high-speed roads, and for birds and small mammals on wider, high-speed highways. Roads near wetlands and ponds tend to have the highest road-kill rates. Road-kill rarely has a population effect, unless the species is already endangered.

A larger impact comes from road avoidance due to traffic disturbance and noise. Most species tend to have lower densities near roads than in surrounding areas. Roads create movement barriers and habitat fragmentation, with road width and traffic density determining the barrier effect. The creation of metapopulations through fragmentation causes genetic alteration in populations. The barrier effect is considered the biggest impact on animals of roads with vehicles. (Forman and Alexander, 1998)

A review of the impacts of recreation on Montana wildlife found that roads can negatively impact herpetofauna. Direct mortality from vehicle collisions is common, but herpetofauna may also suffer from indirect effects of roads. Reduced habitat quality, habitat fragmentation, and vehicle noise may be important impacts. Predators may use roads to access sites with amphibian and reptile prey. (Joslin and Youmans, 1999)

A literature review of the ecological effects of roads found consistent negative effects on biotic integrity in both terrestrial and aquatic ecosystems. Negative effects were found in the form of mortality from road construction or collision with vehicles (kills sessile or slow-moving organisms, injures organisms adjacent to the road, affects demography of many species), modification of behavior (changes in home ranges, movement patterns, reproductive success, escape response), alteration of the physical and chemical environment (soil density, temperature, heavy metals, salts, organic molecules, ozone, nutrients), spread of exotics (by altering habitats, stressing native species), and increased disturbance from use of areas by humans (promote increased hunting, fishing, recreation, passive harassment of animals). Article cites species-specific examples from various journal articles. (Trombulak and Frissell, 2000)

Researchers studied the influence of roads on the movements of small mammals in Bryan County, Oklahoma, by using trap lines in combination with radio telemetry, capture-mark-recapture, or fluorescent pigments. The hispid cotton rat, fulvous harvest mouse, marsh rice rat, house mouse, white-footed mouse, and deer mouse were treated with one of the three study methods and observed to determine individual use of roads. Pairs of trap lines were set along each side of a blacktop road, along an unimproved dirt road, and in a hay field. Results showed that significantly fewer rodents spontaneously crossed the roads than those that were displaced to the opposite side of the road. Individual marked rodents were frequently recaptured in both trap lines in the field, but usually only in one trap line on either side of a road. Both the dirt and blacktop roads were at least partial barriers to movements of small mammals, which is consistent with the findings of other cited studies. This habitat fragmentation could have genetic consequences. Researchers also noted that rodent road-kill is never observed, seemingly supporting the fact that few rodents cross roads, but the number of scavengers in the area was not mentioned. (Clark et al., 2001)

Researchers studied the use of drainage culverts by mammals in the Bow River Valley of Banff National Park, Canada. Small- and medium-sized mammal use of 36 drainage culverts was quantified by monitoring passage with sooted track plates and comparing the results with the expected passage rate for the surrounding population numbers. Weasels and deer mice used the culverts the most, followed by bushy-tailed woodrats and American martens. Coyotes and voles showed the lowest use. Abundance calculations showed red squirrels and snowshoe hares to make up most of the presence, while small-mammal communities made up only 1.6 percent. Noise level had a significant negative correlation for snowshoe hares, traffic volume had a negative correlation for coyotes, and culvert height had a positive correlation for weasels and a negative correlation for martens. For all species combined, traffic volume was the most significant factor affecting culvert use. As traffic volume increased, use of the culvert increased. Coyotes were the exception, a species which was also negatively influenced by road width. Culvert attributes definitely affected species' use, but each species was affected differently by different attributes. (Clevenger et al., 2001)

Artificial Lighting

Researchers explain that each species of frog has an optimum ambient illumination and is active only in a narrow range of environmental illuminations. Therefore, a shift to a level above this illumination may cause the cessation or modification of a particular behavior. A study was conducted simulating the effect of headlamps or other light sources (such as diffuse peripheral lights) used by researchers and results showed that prey detection and foraging performance was negatively affected. These findings could be related to the presence of artificial lighting at boat ramps, bathrooms, along a dam, etc… (Buchanan, 1993)

Garbage

Researchers studied the characteristics and management of black bears that feed in garbage dumps, campgrounds, or residential areas in Michigan. Bears were captured and ear-tagged and physical characteristics were measured. Researchers concluded that the number of nuisance bears in campgrounds and residential areas could be reduced if garbage was made less available through prompt removal or bear-proof garbage cans and if garbage dumps were located at least a mile from campgrounds or residential areas. (Rogers et al.)

A summary of the effects of recreational activity on wildlife in wildlands finds that the closure of garbage dumps in Yellowstone National Park resulted in the expansion of home range size, and a decrease in body size, reproductive rate, and average litter size for bears that had become somewhat dependent on the food supply. Therefore, the presence of garbage dumps alters the behavior of bears. (Knight and Cole, 1991)

Noise

The author provides a description of the hearing capabilities of animals, the way noise is perceived (damage, disturbance, harassment), and a review of studies of wildlife responses to noise. Noise is defined as any human-made sound that alters the behavior of animals or interferes with their normal functioning. Harassment is defined as disturbances that threaten or cause discomfort. Background, or meaningless, noises can be ignored if they are not directed at an animal. Noise that is harassment tends to sensitize the animal to that noise. In laboratory experiments, animals tended to react to noise in the same way that humans do; continuous loud noise causes irritability and can result in increased agonistic behavior, suppressed food intake, altered social interactions, and reduced parenting skills. Nocturnal mammals have the most sensitive hearing among terrestrial vertebrates. Some birds may be able to detect very low-frequency noise. Turtles, tortoises, and snakes have very poor hearing. Lizards have slightly better hearing. Birds, reptiles, and amphibians are highly sensitive to vibration, which low-frequency noise can produce. Noise can mask meaningful sounds, affecting communication and predator detection. Noise can startle and arouse an animal, increasing its metabolic rate and depleting energetic reserves. Many other summaries of responses are noted in the article. (Bowles, 1995)

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Oroville Facilities Relicensing Project
SP-T9: Recreation and Wildlife
Appendix B
CWHR Species Occurrence Predictions Associated With Major Recreation Facilities

CALIFORNIA WILDLIFE HABITAT RELATIONSHIPS SYSTEM 6/ 2/2004
Supported by
CALIFORNIA INTERAGENCY WILDLIFE TASK GROUP
and maintained by the
CALIFORNIA DEPARTMENT OF FISH AND GAME
Database Version: 8.0

SPECIES SUMMARY REPORT

I=Introduced
N=Native
1=Federal Endangered
2=Federal Threatened
3=California Endangered
4=California Threatened
5=California Fully Protected
6=California Protected
7=California Species of Special Concern
8=Federally-Proposed Endangered
9=Federally-Proposed Threatened Candidate
10=Federal Candidate
11=BLM Sensitive
12=USFS Sensitive
13=CDF Sensitive
14=Harvest

Note: Any given status code for a species may apply to the full species or to only one or more of its subspecies.

ID	SPECIES NAME	STATUS
A001	CALIFORNIA TIGER SALAMANDER	6 7 10
A039	PACIFIC CHORUS FROG	
A046	BULLFROG	14
R046	RUBBER BOA	4 6 12
R049	SHARP-TAILED SNAKE	
R051	RACER	
R057	GOPHER SNAKE	
R061	COMMON GARTER SNAKE	1 3 5 6 7
B006	PIED-BILLED GREBE	
B009	EARED GREBE	
B010	WESTERN GREBE	
B548	CLARK'S GREBE	
B042	AMERICAN WHITE PELICAN	7
B044	DOUBLE-CRESTED CORMORANT	7
B049	AMERICAN BITTERN	
B051	GREAT BLUE HERON	13
B052	GREAT EGRET	13
B053	SNOWY EGRET	
B057	CATTLE EGRET	
B062	WHITE-FACED IBIS	7
B108	TURKEY VULTURE	
B070	GREATER WHITE-FRONTED GOOSE	14
B071	SNOW GOOSE	14
B072	ROSS' GOOSE	14
B075	CANADA GOOSE	14
B067	TUNDRA SWAN	
B087	AMERICAN WIGEON	14
B079	MALLARD	14

B082	BLUE-WINGED TEAL	14
B084	NORTHERN SHOVELER	14
B080	NORTHERN PINTAIL	14
B077	GREEN-WINGED TEAL	14
B089	CANVASBACK	14
B091	RING-NECKED DUCK	14
B101	COMMON GOLDENEYE	14
B105	COMMON MERGANSER	14
B107	RUDDY DUCK	14
B111	WHITE-TAILED KITE	5
B114	NORTHERN HARRIER	7
B121	SWAINSON'S HAWK	4 12
B123	RED-TAILED HAWK	
B124	FERRUGINOUS HAWK	7 11
B125	ROUGH-LEGGED HAWK	
B126	GOLDEN EAGLE	5 7 11 13
B127	AMERICAN KESTREL	
B129	PEREGRINE FALCON	3 5 13
B131	PRAIRIE FALCON	7
B133	RING-NECKED PHEASANT	14
B138	WILD TURKEY	14
B140	CALIFORNIA QUAIL	14
B145	VIRGINIA RAIL	
B146	SORA	
B148	COMMON MOORHEN	14
B149	AMERICAN COOT	14
B151	BLACK-BELLIED PLOVER	
B156	SEMIPALMATED PLOVER	
B158	KILLDEER	
B163	BLACK-NECKED STILT	
B164	AMERICAN AVOCET	
B166	LESSER YELLOWLEGS	
B168	WILLET	

B170	**SPOTTED SANDPIPER**					
B173	**LONG-BILLED CURLEW**			**7**		
B183	**WESTERN SANDPIPER**					
B185	**LEAST SANDPIPER**					
B648	**BAIRD'S SANDPIPER**		**7**			
B649	**PECTORAL SANDPIPER**					
B191	**DUNLIN**					
B196	**SHORT-BILLED DOWITCHER**					
B197	**LONG-BILLED DOWITCHER**					
B199	**COMMON SNIPE**					**14**
B213	**MEW GULL**					
B216	**HERRING GULL**					
B217	**THAYER'S GULL**					
B221	**GLAUCOUS-WINGED GULL**					
B227	**CASPIAN TERN**					
B233	**FORSTER'S TERN**					
B235	**BLACK TERN**	**7**				
B250	**ROCK DOVE**					
B255	**MOURNING DOVE**					**14**
B260	**GREATER ROADRUNNER**					
B262	**BARN OWL**					
B263	**FLAMMULATED OWL**					
B264	**WESTERN SCREECH OWL**					
B265	**GREAT HORNED OWL**					
B267	**NORTHERN PYGMY OWL**					
B269	**BURROWING OWL**		**7**		**11**	
B272	**LONG-EARED OWL**		**7**			
B273	**SHORT-EARED OWL**		**7**			
B274	**NORTHERN SAW-WHET OWL**					
B275	**LESSER NIGHTHAWK**					
B276	**COMMON NIGHTHAWK**					
B286	**BLACK-CHINNED HUMMINGBIRD**					
B287	**ANNA'S HUMMINGBIRD**					

B291	**RUFOUS HUMMINGBIRD**					
B293	**BELTED KINGFISHER**					
B294	**LEWIS' WOODPECKER**					
B296	**ACORN WOODPECKER**					
B300	**WILLIAMSON'S SAPSUCKER**					
B299	**RED-BREASTED SAPSUCKER**					
B302	**NUTTALL'S WOODPECKER**					
B307	**NORTHERN FLICKER**		**3**			
B311	**WESTERN WOOD-PEWEE**					
B315	**WILLOW FLYCATCHER**	**1**		**3**		**12**
B321	**BLACK PHOEBE**					
B323	**SAY'S PHOEBE**					
B326	**ASH-THROATED FLYCATCHER**					
B333	**WESTERN KINGBIRD**					
B554	**PLUMBEOUS VIREO**					
B415	**CASSIN'S VIREO**					
B417	**HUTTON'S VIREO**					
B418	**WARBLING VIREO**					
B345	**GRAY JAY**					
B348	**WESTERN SCRUB-JAY**				**7**	
B352	**YELLOW-BILLED MAGPIE**					
B353	**AMERICAN CROW**					**14**
B354	**COMMON RAVEN**					
B337	**HORNED LARK**			**7**		
B338	**PURPLE MARTIN**			**7**		
B339	**TREE SWALLOW**					
B340	**VIOLET-GREEN SWALLOW**					
B341	**NORTHERN ROUGH-WINGED SWALLOW**					
B342	**BANK SWALLOW**		**4**			
B343	**CLIFF SWALLOW**					
B344	**BARN SWALLOW**					
B358	**OAK TITMOUSE**					
B360	**BUSHTIT**					

B362	WHITE-BREASTED NUTHATCH					
B366	ROCK WREN					
B367	CANYON WREN					
B368	BEWICK'S WREN					
B369	HOUSE WREN					
B372	MARSH WREN					
B373	AMERICAN DIPPER					
B376	RUBY-CROWNED KINGLET					
B377	BLUE-GRAY GNATCATCHER					
B380	WESTERN BLUEBIRD					
B381	MOUNTAIN BLUEBIRD					
B386	HERMIT THRUSH					
B404	AMERICAN PIPIT					
B407	CEDAR WAXWING					
B408	PHAINOPEPLA					
B425	ORANGE-CROWNED WARBLER					
B430	YELLOW WARBLER	7				
B436	BLACK-THROATED GRAY WARBLER					
B461	COMMON YELLOWTHROAT			7		
B463	WILSON'S WARBLER					
B483	SPOTTED TOWHEE	7				
B487	RUFOUS-CROWNED SPARROW				7	
B489	CHIPPING SPARROW					
B495	LARK SPARROW					
B512	DARK-EYED JUNCO	7				
B475	BLACK-HEADED GROSBEAK					
B476	BLUE GROSBEAK					
B477	LAZULI BUNTING					
B519	RED-WINGED BLACKBIRD					
B520	TRICOLORED BLACKBIRD		7			11
B521	WESTERN MEADOWLARK					
B528	BROWN-HEADED COWBIRD					
B530	HOODED ORIOLE					

B532	**BULLOCK'S ORIOLE**	
B538	**HOUSE FINCH**	
B544	**LAWRENCE'S GOLDFINCH**	
M003	**VAGRANT SHREW**	**7**
M018	**BROAD-FOOTED MOLE**	**7**
M032	**BIG BROWN BAT**	
M038	**PALLID BAT**	**7 1112**
M042	**WESTERN MASTIFF BAT**	**7 11**
M045	**BRUSH RABBIT**	**1 3 14**
M049	**SNOWSHOE HARE**	**7**
M051	**BLACK-TAILED JACKRABBIT**	**7 14**
M066	**YELLOW-BELLIED MARMOT**	
M072	**CALIFORNIA GROUND SQUIRREL**	
M081	**BOTTA'S POCKET GOPHER**	
M087	**SAN JOAQUIN POCKET MOUSE**	**7 11**
M105	**CALIFORNIA KANGAROO RAT**	**7 11**
M113	**WESTERN HARVEST MOUSE**	
M120	**PINON MOUSE**	
M142	**HOUSE MOUSE**	
M134	**CALIFORNIA VOLE**	**1 3 7**
M136	**LONG-TAILED VOLE**	
M139	**COMMON MUSKRAT**	**14**
M146	**COYOTE**	**14**
M151	**BLACK BEAR**	**14**
M157	**LONG-TAILED WEASEL**	**14**
M158	**AMERICAN MINK**	**14**
M160	**AMERICAN BADGER**	**14**
M163	**NORTHERN RIVER OTTER**	**7 11**
M162	**STRIPED SKUNK**	**14**

Total Number of Species:189