COVER SHEET

FEDERAL ENERGY REGULATORY COMMISSION

DRAFT ENVIRONMENTAL IMPACT STATEMENT
FOR THE KLAMATH HYDROELECTRIC PROJECT
Docket No. P-2082-027

Section 3
Environmental Consequences
Pages 3-230 to 3-368
DEIS

3.3.3.2 Environmental Effects

3.3.3.2.1 Instream Flows

Instream flows affect the quantity and quality of habitat available to aquatic species including water depth and velocity, water quality conditions, and the quality of spawning gravel for resident and anadromous species of fish. Flow fluctuations can reduce invertebrate productivity and the available food supply and cause fish stranding. Fry and juvenile fish are especially susceptible to stranding due to their weak swimming ability and preference for shallower, nearshore habitats. In the following sections we evaluate the effect of recommendations related to flows for each project-affected reach from Link River dam to the reach downstream of Iron Gate dam. Monthly flow statistics for releases from each project development are presented in table 3-17.

Link River Flows

PacifiCorp has an agreement with Oregon Fish & Wildlife to maintain an instantaneous flow of 90 cfs downstream of Reclamation's Link River dam. This minimum flow is increased to 250 cfs from July 27 through October 17 to comply with provisions of the 2002 FWS BiOp to protect the federally listed Lost River and shortnose suckers when water quality conditions are adverse. The 2002 FWS BiOp also requires shutdown of West Side development from July 27 through October 17, and that flows passed through the East Side diversion be reduced to 200 cfs at night from July 27 through October 17 to limit sucker entrainment. FWS reports that the minimum flow agreement of 90 cfs has not always been followed, with an estimated 23-30 cfs of flow from leakage and flow through the fish ladder observed on occasion (letter from Interior dated March 27, 2006).

Current ramp rates at Link River dam were put in place in the 1980s through collaboration with Oregon Fish & Wildlife. Ramping rates below Link River dam are limited to 20 cfs per 5 minutes when flows are between 0 and 300 cfs; 50 cfs per 30 minutes when flows are between 300 and 500 cfs; and 100 cfs per 30 minutes when flows are between 500 and 1,500 cfs.

PacifiCorp proposes to decommission the East Side and West Side facilities to eliminate entrainment of federally listed suckers from Upper Klamath Lake. The gates that supply water to the East Side diversion at Link River dam would be rendered inoperable, the back side of the gates would be sealed with concrete, and the existing forebay for each development would be filled. Because the dam is owned by Reclamation, if East Side and West Side developments are decommissioned, PacifiCorp would not by necessity have control over any portion of the flow that passes the dam. Other than rendering the East Side and West Side facilities inoperable, PacifiCorp does not propose any flow-related measures associated with Reclamation's Link River dam.

If East Side and West Side developments are not decommissioned, Oregon Fish & Wildlife recommends that there be no diversions to those developments when flows below Link River dam are 500 cfs or less. NMFS recommends that PacifiCorp consult with them on a flow and facilities operations schedule that minimizes impacts on anadromous fisheries. Oregon Fish & Wildlife and FWS recommend that if the projects are not decommissioned that ramping rates not exceed 1 inch per hour. The Hoopa Valley Tribe recommends that when native salmonid fry and federally listed sucker juveniles are present (about May 1- September 30), ramp rates not exceed 1.2 inches per hour in the bypassed, peaking, or project-regulated reaches. During the rest of the year, ramping would not exceed 2.4 inches per hour. These ramp rates would apply to all project operations including load following, re-regulating, and project start-ups and shutdowns.

NMFS recommends that, if East Side and West Side developments are not decommissioned, PacifiCorp operate hydroelectric facilities and other controlling structures in a manner that avoids fluctuations in river flow, and cease hydroelectric peaking and load following operations.

Our Analysis

Currently, the Link River supports fish populations including blue chub, tui chub, and fathead minnows that are tolerant of high water temperatures, low DO levels, and high pH levels (see table 3-38). Shortnose suckers and Lost River suckers also are present.

PacifiCorp's proposal to decommission East Side and West Side developments would increase the amount of flow in the currently bypassed portion of the Link River, and the recommendation by Oregon Fish & Wildlife to establish minimum flows in the Link River by not diverting flows to the East Side and West Side developments when flows are 500 cfs or less would both benefit aquatic resources by reducing the incidence of reach de-watering and increase available habitat for fish in the Link River. NMFS' recommendation for consultation would similarly likely result in an increase in minimum flow releases over existing conditions and improve habitat quality.

Increasing the minimum flow in the Link River, however, could conflict with the provision in NMFS and Interior's preliminary fishway prescription to construct a new fish screen and bypass facility at East Side and West Side developments as close as possible to the beginning of each diversion for effective downstream passage of Chinook salmon, steelhead, Pacific lamprey, federally listed suckers, and redband trout. As we discuss in section 3.3.3.2.2, *Fish Passage*, the intent of this facility would be to collect outmigrating anadromous fish to allow them to be transported downstream during periods when water quality conditions are adverse in Keno reservoir. If this facility were constructed, a minimum flow release provided from Link River dam would allow outmigrating smolts to bypass the screening facility and expose them to poor water quality conditions in Keno reservoir, and would likely reduce their survival rate. PacifiCorp's alternative prescription also includes a provision to construct a smolt collection facility upstream of J.C. Boyle dam if studies indicate that it is possible to establish self-sustaining runs of anadromous fish. This facility could potentially be located at Link River dam to enable the transport of outmigrating smolts past Keno reservoir. We conclude that increasing the minimum flow release at Link River dam would likely impede the restoration of anadromous fish to areas upstream of Link River dam if a smolt collection facility were to be constructed at East Side or West Side developments.

Oregon Fish & Wildlife and FWS recommend a maximum ramp rate of 1 inch per hour and 300 cfs per day if East Side and West Side developments are not decommissioned, and the Hoopa Valley Tribes' recommendation is for 1.2 inches per hour or 2.4 inches per hour depending on the time of year. Meeting this ramping rate would likely require modifications to the civil structures at East Side and West Side developments. A down-ramp rate of 2 inches per hour is generally regarded as a conservative rate for the protection of salmon fry under most conditions (Hunter, 1992) and is often recommended for non-peaking hydroelectric projects. However, there is no evidence in the record that current down-ramp releases from East Side and West Side developments are resulting in fish stranding, and we consider the existing ramp rates to be sufficiently gradual that adverse effects are unlikely. Link River dam is not part of the existing or proposed project, and therefore the Commission has no authority to control releases at the dam, other than by modifying operations at the powerhouses or intake canals. We consider it most appropriate, and likely much more feasible, for Reclamation to be responsible for maintaining protective ramping rates of flows released at Link River dam by operating gates at the dam. However, coordination of operations at Link River dam with operation of East Side and West Side developments could be addressed in a project operations management plan, should these developments not be decommissioned

Keno Dam

Although Keno development does not provide generation, it does serve to regulate the reservoir elevations in Keno reservoir to support irrigation withdrawals. The Keno reservoir receives nearly 80 percent of its inflow from the Link River, with agricultural returns accounting for about 20 percent of flow, and municipal and industrial inflows about 1 percent. Inflow quantities may vary widely on a day-to-day or week-to-week basis. PacifiCorp operates Keno reservoir in accordance with an agreement with

Reclamation that specifies that water surface elevation of the Keno reservoir be maintained between 4,085.0 and 4,086.5 feet. At the request of irrigators, PacifiCorp generally operates Keno dam to maintain the reservoir at elevation 4,085.4 +/-0.1 foot from October 1 to May 15 and elevation 4,085.5 +/-0.1 foot from May 16 to September 30 (see figure 3-7) to allow consistent operation of irrigation canals and pumps. PacifiCorp also has an agreement with Oregon Fish & Wildlife to release a minimum flow of 200 cfs at the dam. PacifiCorp currently adheres to a 500 cfs per hour ramp rate at Keno dam, which equates to about 9 inches per hour. PacifiCorp proposes to exclude Keno dam from the project (see section 4.7, *Keno Development Analysis*), and has not proposed any measures related to minimum flows or ramping rates for the development.

NMFS, FWS, Oregon Fish & Wildlife, and Cal Fish & Game recommend that Keno development be operated as a modified run-of-river facility and not be used to re-regulate flows to support peaking operations at downstream developments. They recommend that PacifiCorp hold river flows below Keno dam to within 10 percent of the measured project inflow, including inflows from Link River and irrigation return flows, less irrigation withdrawals. FWS recommends that outflows be based on a 3-day running average of the combined flow from Link River and the Reclamation project (including Klamath Straits drain, Lost River, and North/Ady canal). Oregon Fish & Wildlife and Cal Fish & Game include a recommended minimum flow release of 625 cfs below Keno dam, or inflow if inflows are less than 625 cfs, with flows above 625 cfs to be held within 10 percent of inflow. The Hoopa Valley Tribe recommends that PacifiCorp discharge a continuous minimum flow of 500 cfs or 70 percent of inflow to the project, whichever is greater, except that the minimum flow would be equal to inflow when inflows are less than 500 cfs.

Oregon Fish & Wildlife recommends that controllable ramp rates at Keno not exceed 1 inch per hour at any time, with a maximum daily controllable ramp rate of no more than 300 cfs per day up-ramp or down-ramp. Ramp rates would apply to all operations, including start-ups and planned shutdowns, load following and re-regulating. As previously described, the Hoopa Valley Tribe recommends a ramping rate that ranges from 1.2 to 2.4 inches per hour.

Our Analysis

The fish population in the Keno reach is dominated by marbled sculpin, fathead minnows, blue chub, speckled dace, and tui chub (table 3-40). Of the federally listed sucker species, only the Lost River sucker was observed (in 1 out of 2 years of sampling conducted) by PacifiCorp in the Keno reach. Although summer water temperatures in the Keno reach are generally warmer than optimum for trout (the 7-day mean maximum daily water temperature in the Keno reach can rise as high as 25°C), turbulence maintains DO levels that support a fishery for rainbow trout, and the Keno reach is a popular area for angling in the Klamath River. Catch records indicate good angler success, and Oregon Fish & Wildlife manages the trout fishery in the Keno reach for natural production.

Flows in the Keno reach can fluctuate on a 24-hour basis, particularly in average or above-average flow years (figures 3-62 through 3-64). Although available information indicates that the Keno reach already supports a high quality trout fishery, decreasing the magnitude of flow fluctuations by reducing ramping rates from the current 9 inch per hour rate and establishing minimum flows that are greater than the current minimum flow of 200 cfs would provide more stable habitat for trout and suckers present in the reach. Reducing flow fluctuations may also help increase productivity of benthic invertebrates in the fluctuation zone, and provide more prey for the trout fishery there. Regulating the minimum flow releases based on a 3-day running average of the inflow would further help decrease the daily magnitude of fluctuations caused by irrigation withdrawals and return flows.

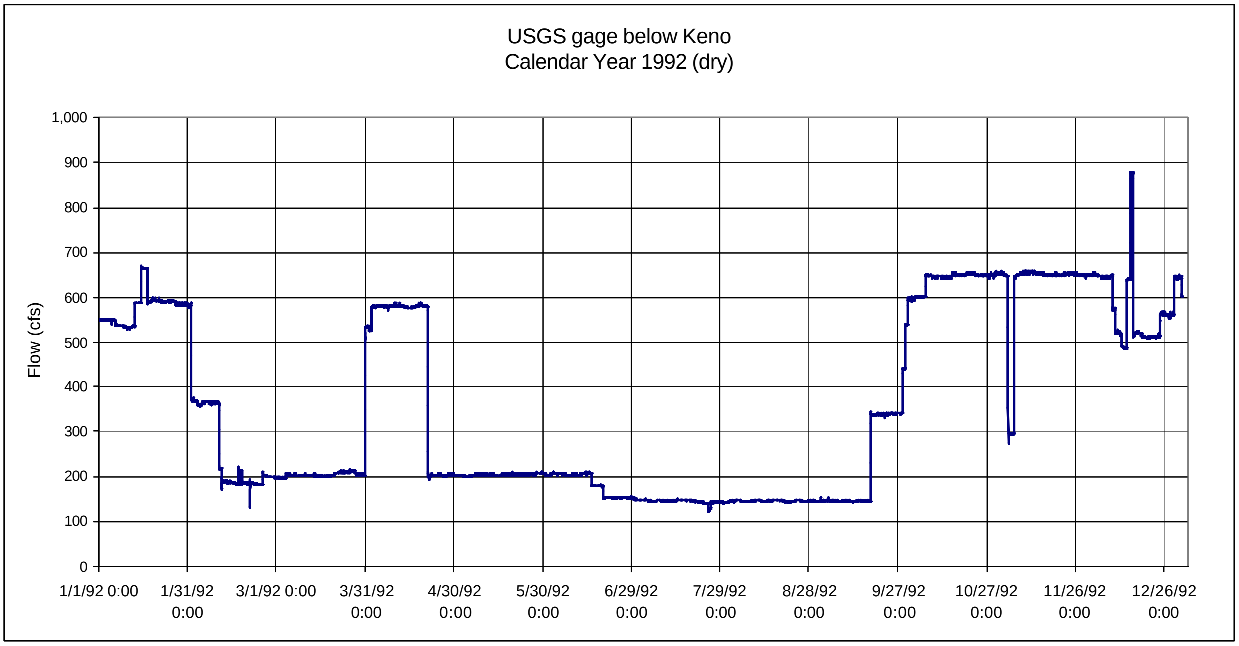


Figure 3-62. Flows measured below Keno dam in 1992 (dry year). (Source: PacifiCorp, 2005f; USGS, 2006)

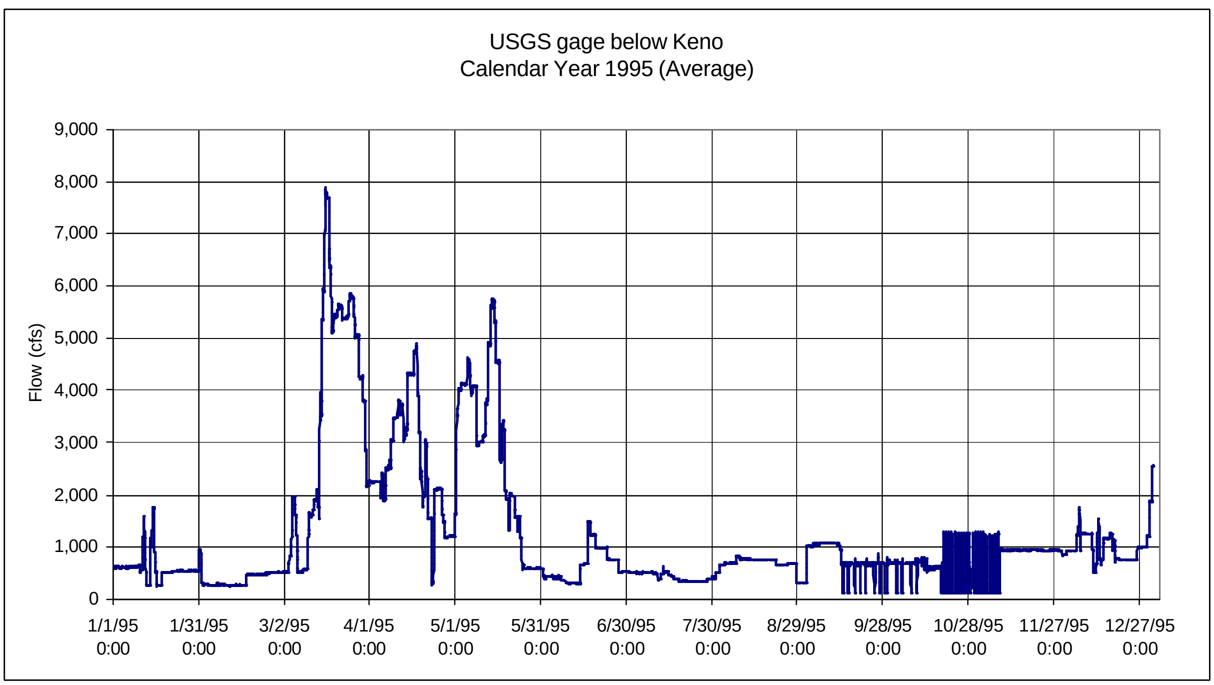


Figure 3-63. Flows measured below Keno dam in 1995 (average year). (Source: PacifiCorp, 2005f; USGS, 2006)

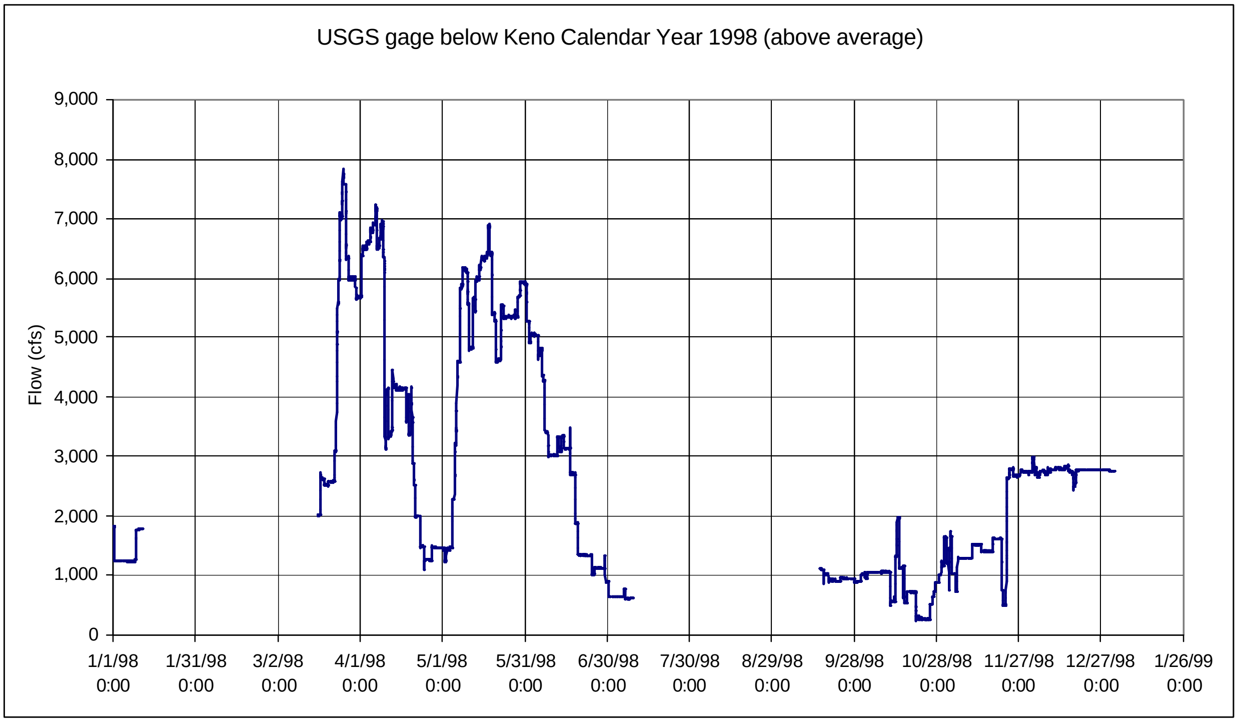


Figure 3-64. Flows measured below Keno dam in 1998 (above average year). (Source: PacifiCorp, 2005f; USGS, 2006)

J.C. Boyle Bypassed Reach

The river channel in the J.C. Boyle bypassed reach is about 100 feet wide, consisting of rapids, runs, and pools among large boulders with some large cobbles interspersed. Gravel is scarce, and the gradient is relatively steep (see figure 3-2). When spill from the dam is substantial (as typically occurs on average from 5 to 8 days a month during February through May as shown in table 3-18), habitat in the bypassed reach consists of a series of rapids and fast runs.

Currently, PacifiCorp releases a 100 cfs minimum flow at the dam, and of this flow approximately 80 cfs comes from the J.C. Boyle fish ladder and 20 cfs from the juvenile bypass facility. An additional 220 to 250 cfs of spring flow accrues in the upper mile of the bypassed reach, beginning about 0.5 mile downstream from the dam.

PacifiCorp proposes to continue the minimum 100 cfs flow release at the dam, and to construct a gage at the top of the bypassed reach to monitor flows. PacifiCorp also proposes to release an additional 100 cfs from either J.C. Boyle dam into the bypassed reach or at the J.C. Boyle powerhouse. If the additional 100 cfs release were made from the dam it would result in a total flow of about 420 to 450 cfs of flow at the lower end of the bypassed reach.

Down-ramping in the J.C. Boyle bypassed reach does not occur for power production purposes, but occurs primarily when coming off of spill mode or during maintenance events, both of which are infrequent. The existing license includes a ramp rate restriction of 9 inches per hour, which is equivalent to about 700 cfs per hour when river flows are between 400 and 3,000 cfs, as measured at USGS gage no. 11510700 just downstream of the powerhouse. Standard operating procedure, however, is to change flows by 135 cfs per 10 minutes (or 810 cfs per hour), which is equivalent to about 7.2 inches per hour at the USGS gage. PacifiCorp proposes to limit down-ramping in the bypassed reach to 150 cfs per hour (about 1.2 inches per hour), except for flow conditions beyond the project's control. PacifiCorp also proposes to conduct down-ramping at night to the extent possible.

Oregon Fish & Wildlife, NMFS, and Cal Fish & Game recommend that PacifiCorp release a minimum flow of 640 cfs or 40 percent of inflows, whichever is more, into the J.C. Boyle bypassed reach. If inflows are less than 640 cfs, all available flow would be released into the bypassed reach. They further recommend that inflow be computed as a running average of flows at the Keno gage (no. 11505900) added to flows at Spencer Creek gage (no. 11510000) during the prior 3 days. The Bureau of Land Management specifies a similar flow, except that the minimum flow threshold would be 470 cfs rather than 640 cfs.

The Hoopa Valley Tribe recommends that PacifiCorp discharge a continuous minimum flow of 500 cfs or 70 percent of inflow to the project, whichever is greater. The allowed minimum flow would be reduced to inflow when inflows are less than 500 cfs.

Oregon Fish & Wildlife recommends that controllable up-ramp and down-ramp rates not exceed 1 inch per hour or 300 cfs per day. The Bureau of Land Management specifies that up-ramp and down-ramp rates not exceed 2 inches per hour (measured at a new gage to be installed downstream of J.C. Boyle dam at RM 225) during controlled flow events, except during implementation of the seasonal high flow. As previously described, the Hoopa Valley Tribe recommends a ramping rate that ranges from 1.2 to 2.4 inches per hour.

Our Analysis

The fish community in the J.C. Boyle bypassed reach is dominated by rainbow trout, speckled dace, and marbled sculpin (table 3-42). This reach and the Keno reach are the two most popular angling reaches of the Klamath River between Link River and Iron Gate dams. Catch records indicate good angler success, although fish in this reach are typically smaller than fish caught in the Keno reach and rarely exceed 16 inches.

The influx of about 220 to 250 cfs of cool water from springs in the J.C. Boyle bypassed reach combined with the minimum flow release of 100 cfs provide much cooler water temperatures in the lower 3 miles of the bypassed reach compared with the flows released from J.C. Boyle dam and in other downstream reaches (table 3-58 and figure 3-65). The colder water from the bypassed reach then flows into the J.C. Boyle peaking reach, and serves to cool the water in the peaking reach, especially during the night when flows from the powerhouse are reduced during peaking operations.

The various proposals to increase minimum flows releases in the bypassed reach by 100 cfs to 640 cfs would affect the current temperature regime as well as the physical amount of habitat for trout in the reach. Increasing the volume of warm water released from J.C. Boyle reservoir would decrease the cooling effect of the spring water accretion flows in the reach (table 3-58). Although redband trout are more tolerant of higher temperatures than other salmonids (Behnke, 1992), the springs in the J.C. Boyle bypassed reach currently provide water temperatures that are near-optimal for salmonids (13 to 16°C (Behnke, 1992)), and thus likely provide thermal refugia for trout throughout the summer months.

The results of an instream flow study conducted by PacifiCorp show that the amount of physical habitat as represented by weighted usable area (WUA)[55] available to trout in the bypassed reach generally increases as flows increase up to 400 cfs for the juvenile and adult life stages, and then levels off at further flow increases. WUA for fry increases up to 800 cfs before leveling off (figure 3-66, table 3-58). Physical habitat for trout juveniles and adults reaches its maximum at 650 and 3,000 cfs, respectively.

[55]WUA is a measure of physical habitat available at a specified streamflow for a given life stage and species of fish.

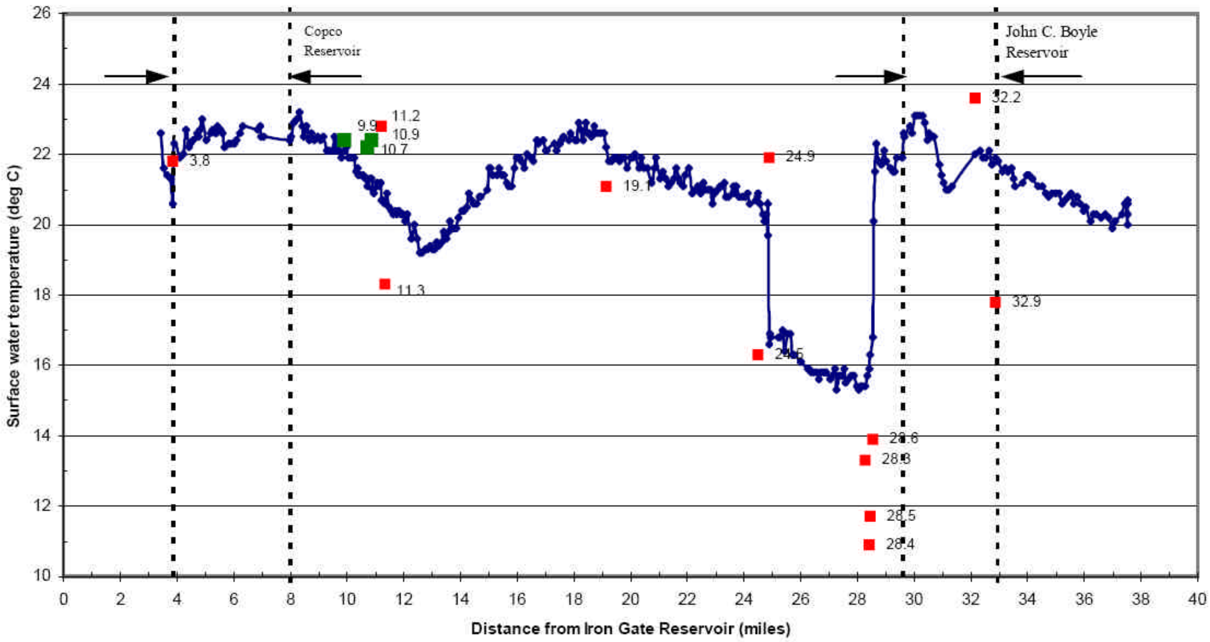


Figure 3-65. Median channel temperatures versus river mile for Klamath River, CA/OR, along with the location of surface water inflows (represented by red squares) on July 15, 2001. (Source: Watershed Sciences, 2003)

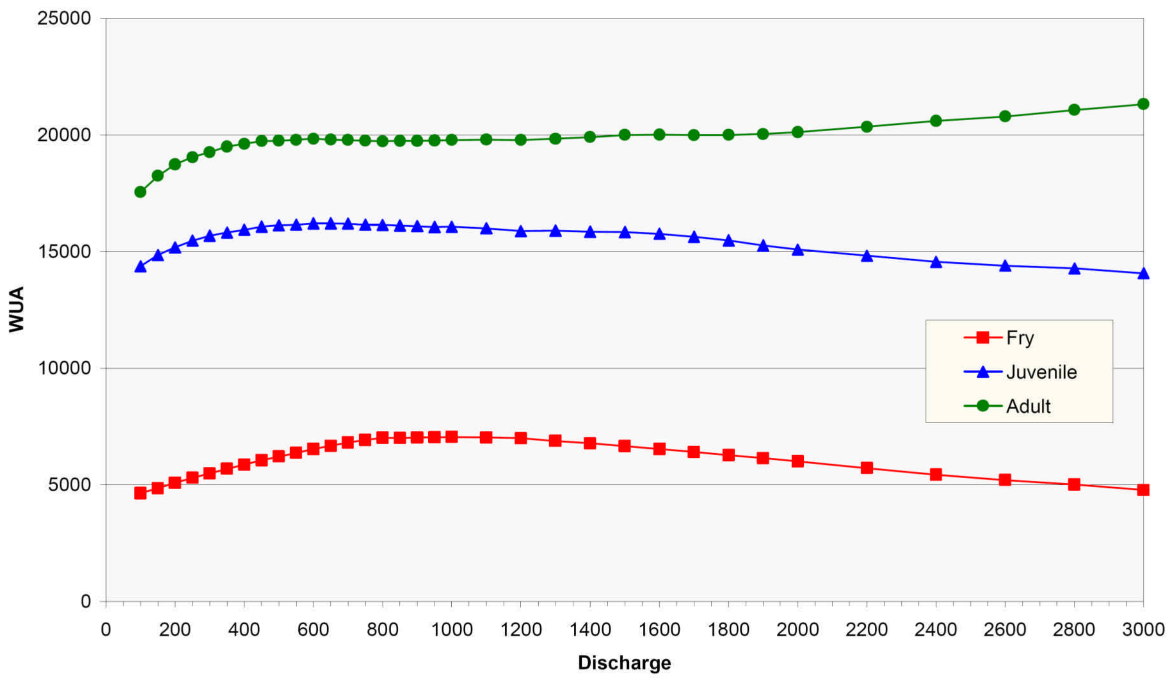


Figure 3-66. Rainbow/redband trout WUA for the J.C. Boyle bypassed reach. Discharge equals release from J.C. Boyle dam. (Source: PacifiCorp, 2005m)

Table 3-58. Estimated water temperatures, wetted perimeter, and modeled rainbow trout WUA in the lower J.C. Boyle bypassed reach based on the volume of water released at J.C. Boyle dam. (Source for WUA: PacifiCorp, 2005m, and water temperatures estimated by staff)

Discharge at J.C. Boyle dam (cfs)	**Total flow after spring flow accretion (cfs)**	**Estimated[a] temp in lower end of bypassed reach (°C)**	**Estimated[b] average wetted area (square ft)**	**Rainbow Trout WUA (square ft)[b] *[percent of maximum WUA[c]]***		
				Fry[c]	***Juveniles[c]***	***Adults[c]***
100 cfs (existing)	335	14.3	76,542	4,638 [66]	14,367 [89]	17,553 [82]
200 cfs (PacifiCorp proposed if 200 cfs released from dam)	435	16.1	86,420	5,084 [72]	15,184 [94]	18,740 [88]
470 cfs (Bureau of Land Management specified)	705	18.3	95,454 *(at 450 cfs)*	6,050 [86]	16,068 [99]	19,737 [93]
500 cfs (Hoopa Valley Tribe recommended)	735	18.5	95,804	6,220 [88]	16,127 [99]	19,756 [93]
640 cfs (Oregon Fish & Wildlife, NMFS, Cal Fish & Game recommended)	875	19.0	99,935 *(at 650 cfs)*	6,674 [95]	16,211 [100]	19,804 [93]

[a] Temperatures shown reflect mixing only, and assume dam release flow temperatures of 22ºC, spring accretion flow temperatures of 11ºC, and spring accretion flow of 235 cfs.

[b] Data are from PacifiCorp (2005m).

[c] Maximum modeled WUA for fry at 1,000 cfs (7,050 square feet), for juveniles at 650 cfs (16,211 square feet), and for adults at 3,000 cfs (21,321 square feet).

Although the results of PacifiCorp's instream flow study indicate that higher instream flow releases would increase the amount of physical habitat that is available to rainbow trout in the bypassed reach, these higher release flows would also increase water temperatures. As shown in figure 3-65, under existing conditions, water temperatures in mid-July decreased from around 22°C below J.C. Boyle dam to 15.5°C about 1 mile downstream of the dam as a result of accretion of cool groundwater from spring sources. Downstream of this point, water temperatures increased to about 16.5°C by the downstream end of the bypassed reach. To evaluate the effect of increased dam releases on water temperatures, we calculated the water temperature that would result from mixing different volumes of release flows at 22°C with an assumed accretion flow of 235 cfs at 11°C. Using this method, we estimated that the temperature below the primary area of groundwater accretion would be increased from 14.3°C at the 100 cfs release flow to 16.1°C at a 200 cfs release flow, which is still nearly within the optimal range of 13 to 16°C for salmonid growth given by Behnke (1992). Further increases in dam releases would raise water temperatures below the accretion area to 18.3°C with the 470 cfs release specified by the Bureau of Land Management to 19.0°C for the 640 cfs release recommended by Oregon Fish & Wildlife, NMFS, and Cal Fish & Game. We conclude that a release of 200 cfs at the dam would strike a reasonable balance between temperature and physical habitat needs for trout, because it would increase the amount of physical habitat for all three life stages of trout without causing water temperatures to exceed the optimal growth range for salmonids.

Flow down-ramping has the potential to strand fish in areas of the channel that are relatively low-gradient, or where pockets or side channels exist in the river channel. Fry and smaller juvenile fish are the most vulnerable to potential stranding due to weak swimming ability and preference for shallower, nearshore habitats. River channel configuration, channel substrate type, time of day, and flow level before down-ramping are also factors that determine stranding incidence. Trout spawn in the J.C. Boyle bypassed reach, and trout fry occur along the stream margins from early June through the summer, thus it is possible that some stranding of small fish could occur at the current down ramp rates under certain flow conditions and times of the year. When release flows drop from about 1,000 cfs to the 100 cfs minimum flow, dewatering of streambed areas and a few side channels can pose a risk of stranding to small fish.

PacifiCorp indicates that under current conditions, down-ramping at J.C. Boyle dam occurs rarely, primarily after high flow events, which as indicated in table 3-18, mostly occur prior to fry being present. PacifiCorp's proposed down ramp rate of 150 cfs reflects a substantial reduction from the current licensed rate of 9 inches (approximately 700 cfs) per hour. We estimate that the proposed rate of flow change would equate to a stage change of approximately 1.9 inches per hour, which is similar to the 2 inch per hour ramping rate specified by the Bureau of Land Management. Compared to current operations, the proposed ramping rate would reduce the risk of stranding fry and juvenile fish, and would provide a more gradual transition time for adult trout to relocate as river levels change. This could be important during pre-spawn staging and during spawning. PacifiCorp also proposes that down ramping occur at night to the extent possible as a result of studies indicating that juvenile trout are less vulnerable to stranding at night during winter conditions (PacifiCorp, 2004e). During such cold-water winter conditions, juvenile trout tend to hide in interstitial areas of substrate during the day, whereas during night they move out of the substrate and can respond to dropping flows.

Oregon Fish & Wildlife and the Hoopa Valley Tribe's recommended ramping rate of 1 inch per hour reflects a more substantial decrease in current ramping rate of 9 inches per hour, and is more restrictive than PacifiCorp's proposed tramping rate of 1.9 inches per hour. However, stranding has not been identified as a problem in this reach, and, as stated above, ramping in this reach is an infrequent event, and a down-ramp rate of 2 inches per hour is generally regarded as a conservative rate for the protection of salmon and trout fry under most conditions.

J.C. Boyle Bypassed Reach Flushing Flows

Oregon Fish & Wildlife recommends that, at least once a year between February 1 and April 15, no water be diverted to the J.C. Boyle or Copco No. 2 power canals when inflow to J.C. Boyle reservoir (including Spencer Creek) exceeds 3,300 cfs, and that this diversion cessation be maintained for at least 7 full days. Oregon Fish & Wildlife and the Bureau of Land Management recommend the down ramp rate for this seasonal high flow not exceed 2 inches per hour or 300 cfs per 24 hour period, as measured at a new gage to be installed downstream of J.C. Boyle dam. NMFS and Cal Fish & Game make the same recommendation, except they do not specify an hourly ramp rate.

Our Analysis

Provision of annual flushing flows as recommended by the agencies could help to ensure that spawning areas used by trout remain sufficiently free of silt to support egg incubation and trout recruitment. However, as shown in table 3-18, on average, spill events of up to 8 days a month that release up to 2,803 cfs of flow occur under existing conditions. Flows in this range should be sufficient to flush fine-grained sediments from spawning gravels in most years. Furthermore, the bypassed and peaking reaches currently support high densities of trout, as reflected by angler catch rates reported by Oregon Fish & Wildlife and by PacifiCorp (tables 3-59 and 3-60, respectively). PacifiCorp reports that the population of redband trout exceeding 7.8 inches was estimated to be 890 fish per mile in the upper 6 miles of the peaking reach and 1,911 fish per mile in the next 5 miles of the river in 1984. They report that these population densities are comparable to those in the lower Deschutes River, which is noted to be one of the most productive rivers in the state. Furthermore, PacifiCorp proposes to augment spawning gravel in the bypassed reach and to eliminate agricultural diversions on Shovel and Negro creeks, which should enhance recruitment of trout fry from both of the locations where most of the spawning between J.C. Boyle and Copco No. 1 dams is thought to occur.

Table 3-59. Rainbow trout catch per hour from Oregon Fish & Wildlife angler survey data from 1978 to 1984 for the Keno, J.C. Boyle bypassed, and J.C. Boyle peaking reaches. (Source: PacifiCorp, 2004e)

	Reach		
Year	**Keno**	**J.C. Boyle Bypass**	**J.C. Boyle Peaking**
1979	0.33	0.41	0.74
1980	0.27	0.67	0.71
1981	0.09	0.47	1.31
1982	0.13	0.87	0.56
1983	0.08	0.62	0.56
1984	0.49	0.69	0.77
Average	0.23	0.62	0.78

Table 3-60. Rainbow trout catch per hour from PacifiCorp hook-and-line sampling conducted in 2002 in the Keno, J.C. Boyle bypassed, and J.C. Boyle peaking reaches. (Source: PacifiCorp, 2004e)

Reach	**Total**	**Spring**	**Summer**	**Fall**	**Upper**	**Lower**
Keno	0.6	0.6	0.2	1.1	0.5	0.8
J.C. Boyle Bypass	1.1	0.8	0.7	1.3		
J.C. Boyle Peaking	1.2	0.9	1.1	2.7	1.1	1.3

J.C. Boyle Peaking Reach

Flows passing from the J.C. Boyle bypassed reach and those released from the J.C. Boyle powerhouse affect aquatic habitat in the 17.3-mile-long reach between the powerhouse and Copco reservoir, referred to as the J.C. Boyle peaking reach. The upstream 11.1 miles of this reach are in Oregon, and this segment has been federally designated as a Wild and Scenic River (discussed further in section 3.3.6, *Recreational Resources*, and section 3.3.7, *Land Use and Aesthetic Resources)*. The downstream 6.2 miles are in California, and this segment is designated by Cal Fish & Game as a Wild Trout Area. Both sections are managed for wild trout.

PacifiCorp proposes to limit flow up-ramp rates to 9 inches per hour and down-ramp rates to 9 inches per hour for flows exceeding 1,000 cfs, and 4 inches per hour for flows less than 1,000 cfs in the J.C. Boyle peaking reach. Furthermore, it proposes to limit the maximum daily flow change to 1,400 cfs as measured at USGS gage no. 11510700 downstream of the J.C. Boyle powerhouse. This limit of the total flow change to 1,400 cfs per 24-hour period would eliminate full two-unit peaking (420 to 3,420 cfs at the gage), but one-unit peaking still would occur. PacifiCorp also proposes to install synchronized bypass valves on each of the two J.C. Boyle powerhouse units to eliminate use of the emergency overflow spillway which has caused extensive erosion (see section 3.3.1, *Geology and Soils*). Installation of the bypass valves would help to ensure that ramping rates can be met when a unit trips off-line.

PacifiCorp also proposes to increase the current 100 cfs minimum flow release into the peaking reach by releasing a minimum of 200 cfs plus J.C. Boyle bypass accretion as measured at the USGS gage downstream of the J.C. Boyle powerhouse (no. 11510700). This would provide a minimum flow of approximately 420 to 450 cfs in the J.C. Boyle peaking reach. The new minimum flow would be met through an additional release of 100 cfs from J.C. Boyle dam or a release of 100 cfs at the powerhouse (plus the current release of 100 cfs from J.C. Boyle dam and 220 to 250 cfs from accretion in the bypassed reach).

NMFS recommends that PacifiCorp operate the J.C. Boyle development in run-of-river mode to protect fish and wildlife resources, with gages installed where needed to monitor inflow and outflow from each facility. Cal Fish & Game also recommends that PacifiCorp operate the J.C. Boyle development in run-of-river mode, with no peaking operations, in conjunction with meeting minimum target flows.

Oregon Fish & Wildlife and Cal Fish & Game recommend ramp rates of 1 inch per hour in the peaking reach. The Bureau of Land Management specifies that PacifiCorp not exceed up-ramp or down-ramp rates of 2 inches per hour as measured at the existing USGS gage downstream of the J.C. Boyle powerhouse during controlled flow events (e.g., scheduled maintenance, power generation, and changes in minimum flow requirements), except during implementation of seasonal high flow releases. As previously described, the Hoopa Valley Tribe recommends a ramping rate that ranges from 1.2 to 2.4 inches per hour.

Oregon Fish & Wildlife recommends that PacifiCorp provide a minimum flow of 720 cfs to the peaking reach. Cal Fish & Game recommends a minimum flow to the peaking reach of 720 cfs, or inflow if inflow is less than 720 cfs. The Hoopa Valley Tribe recommends that PacifiCorp discharge a continuous minimum flow of 500 cfs or 70 percent of inflow to the project, whichever is greater. The allowed minimum flow would be reduced to inflow when inflows are less than 500 cfs.

The Bureau of Land Management specifies that PacifiCorp operate the J.C. Boyle development to provide a streamflow of 1,500 to 3,000 cfs to the peaking reach a maximum of once a week, with a priority set for Saturday, Sunday, and then Friday.

Our Analysis

The J.C. Boyle powerhouse is typically operated as a peaking facility. Under current operations, when inflow to J.C. Boyle reservoir is below 3,000 cfs, water is typically stored at night and flows during the day are ramped up to either one unit operation (up to 1,500 cfs) or two unit operation (typically 2,750 cfs). Hourly flow fluctuations that occurred in the J.C. Boyle peaking reach in 3 recent years representing dry (1992), average (1995), and wet (1998) conditions are shown in figure 3-67. When ramping is initiated at the J.C. Boyle powerhouse it generally takes 5 to 6 hours for the flow change to arrive at

Copco reservoir, 16 miles downstream. Current rates of stage decline are generally between 4.8 and 9 inches per hour (PacifiCorp 2004e).

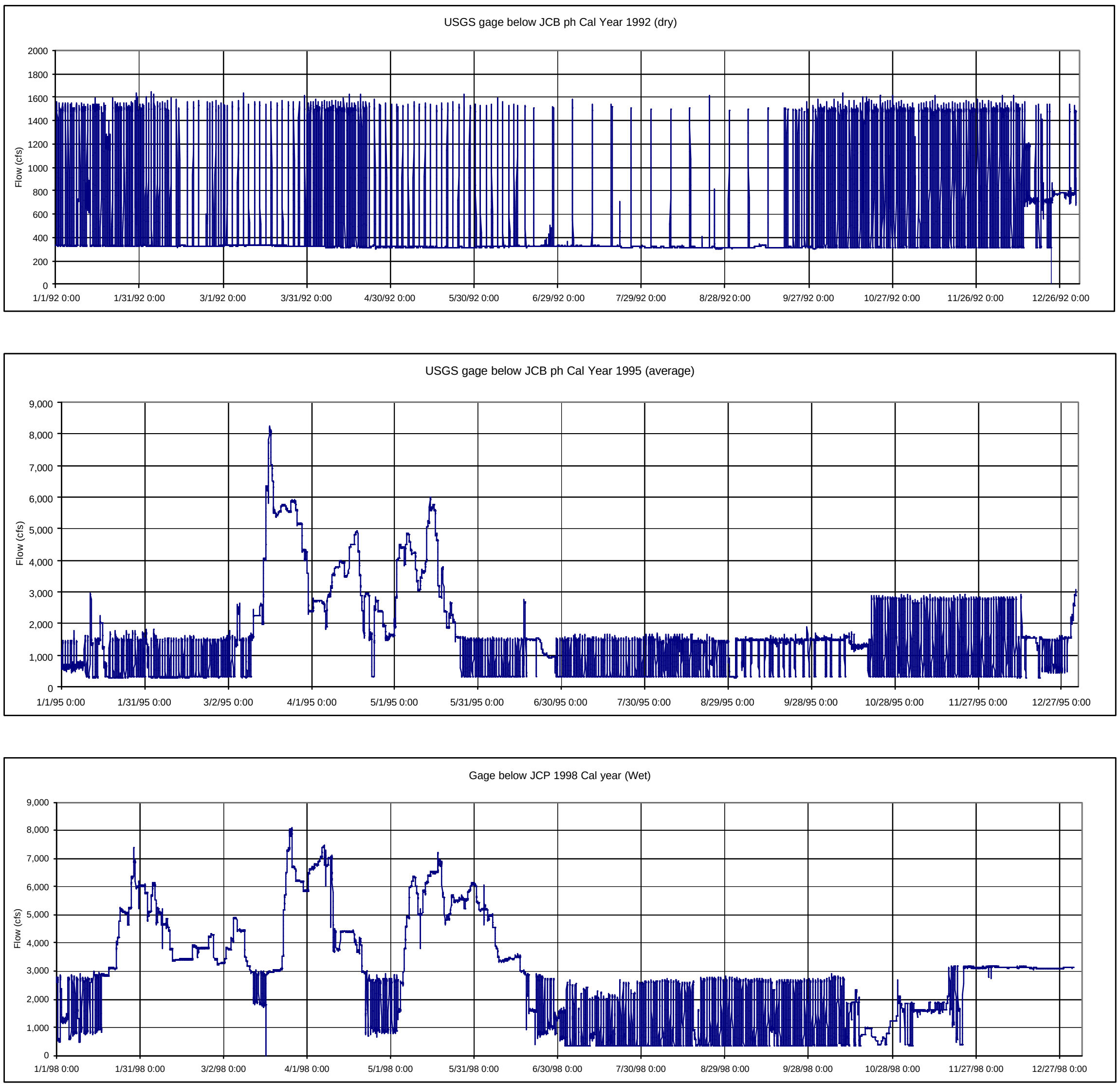


Figure 3-67. Hourly flows in the J.C. Boyle peaking reach for representative dry (1992), average (1995), and wet (1998) years. (Source: USGS, 2006, as modified by staff)

PacifiCorp conducted several different studies to evaluate the effect of peaking operations on aquatic resources in the J.C. Boyle peaking reach, including an instream flow analysis to evaluate effects on habitat for trout and suckers, a wetted perimeter analysis to evaluate potential effects on invertebrate production, a bioenergetics study, and stranding surveys. However, agency comments on the flow modeling indicated there was disagreement on the modeling approach used by PacifiCorp to model rainbow trout habitat, and none of the stakeholders relied on the results of the instream flow study to support their flow recommendations. Accordingly, we focus most of our analysis of effects on food (invertebrate) production and stranding potential.

Figure 3-68 shows redband/rainbow trout habitat (WUA) versus flow relationships developed during the instream flow study. The habitat versus flow relationship for trout adult and juvenile WUA in the J.C. Boyle peaking reach follow the same general pattern – a gradual increase before leveling off in the 400 to 600 cfs range then declining over the upper range of flows. The study results indicate that the proposed base (minimum) flow[56] of 420 to 450 cfs would provide 64 percent, 100 percent, and 97 percent of the maximum modeled WUA for fry, juvenile, and adult trout, respectively (table 3-61). Increasing minimum flows up to 720 cfs would provide only minimal changes in WUA compared to the proposed minimum flow.

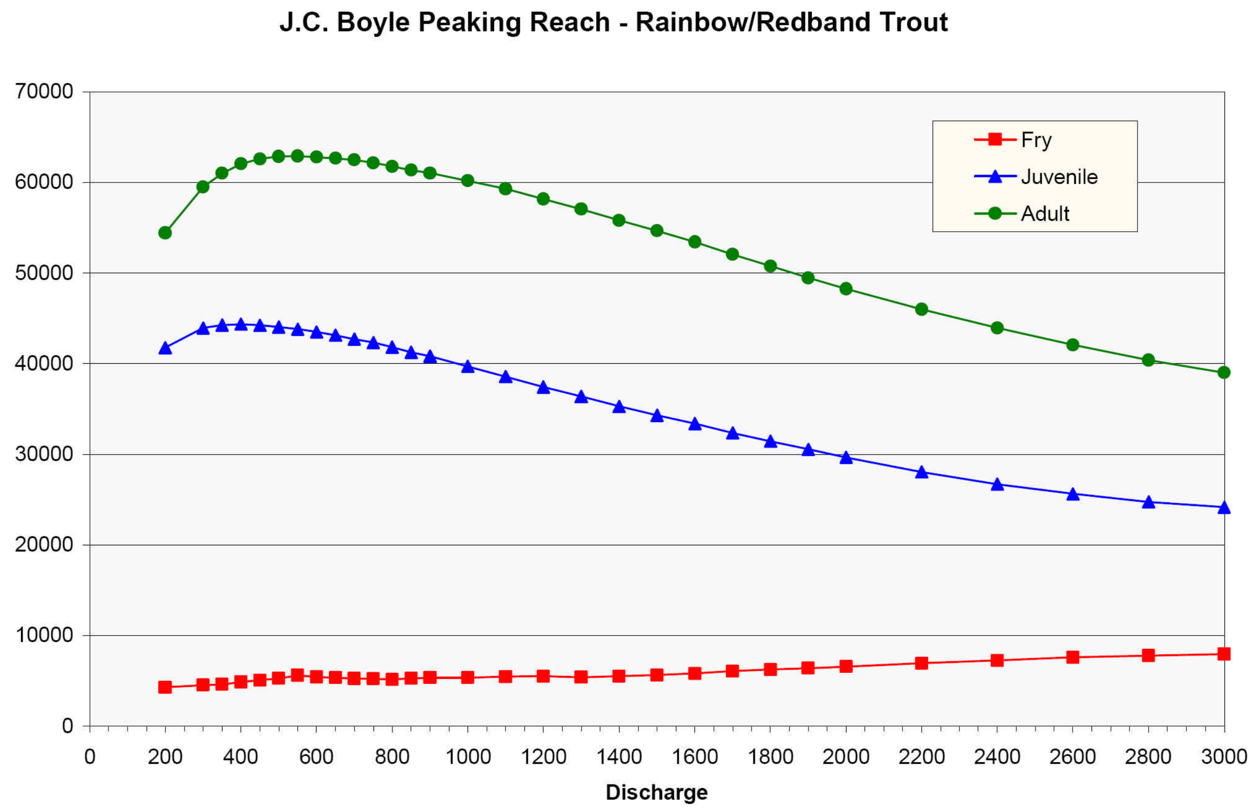


Figure 3-68. Rainbow/redband trout WUA versus discharge for the J.C. Boyle peaking reach. (Source: PacifiCorp, 2005m)

[56]A base flow is the minimum flow that would occur during peaking operations. Although this term has the same meaning as a minimum flow, we use this term because it is more descriptive, and to differentiate from a minimum flow applied to a non-peaking reach.

Table 3-61. Modeled wetted area and rainbow trout WUA modeled for the J.C. Boyle peaking reach. (Source: PacifiCorp, 2005m, as modified by staff)

Simulated Discharge	Average Wetted Area (square feet)	Rainbow Trout WUA (square feet) [*percent of maximum WUA*[a]]		
		Fry	***Juveniles***	***Adults***
320 to 350 cfs (existing minimum)	121,419 *(at 350 cfs)*	4,621 [58]	44,269 [100]	60,993 [97]
420 to 450 cfs (PacifiCorp proposed min)	127,073 (at 450 cfs)	5,076 [64]	44,227 [100]	62,579 [97]
500 cfs (Hoopa proposed min.)	129,317	5,280 [66]	44,031 [99]	62,856 [100]
720 cfs (Oregon Fish & Wildlife, Cal Fish & Game proposed min.)	137,167 *(at 750 cfs)*	5,230 [66]	42,322 [95]	62,144 [99]
1,500 cfs (one unit)	149,597	5,640 [71]	34,299 [77]	54,652 [87]
2,750 cfs (typical 2 unit)	162,400 *(at 2,800 cfs)*	7,766 [98]	24,754 [56]	40,384 [64]

[a] Maximum modeled for fry at 3,000 cfs (7,961 square feet), for juveniles at 400 cfs (44,365 square feet), and for adults at 550 cfs (62,922 square feet).

PacifiCorp also conducted a study to assess the effects of proposed operations on trout growth (Addley et al., 2005). A bioenergetics model was developed that evaluated growth rates based on food availability and ingestion rates compared to energy losses from basic and active metabolism and excretion. A second model was also used that examined food and water temperature effects of growth rates for trout under different flow scenarios. The results of both modeling approaches indicate that food availability is more important than water temperature and physical habitat (WUA) as a factor limiting trout growth in the J.C. Boyle peaking reach. This suggests that current flow fluctuations may account for the smaller size of trout in the peaking reach, as compared with the Keno reach, as a result of decreased benthic macroinvertebrate production (figures 3-69 and 3-70). However, PacifiCorp also reports that the average condition factor (length-weight relationship) of trout larger than 2 inches in the J.C. Boyle peaking reach was 1.20, similar to the 1.18 condition factor of trout in the Keno reach, with condition factors greater that 1.0 for trout considered indicative of healthy fish (Carlander, 1969).

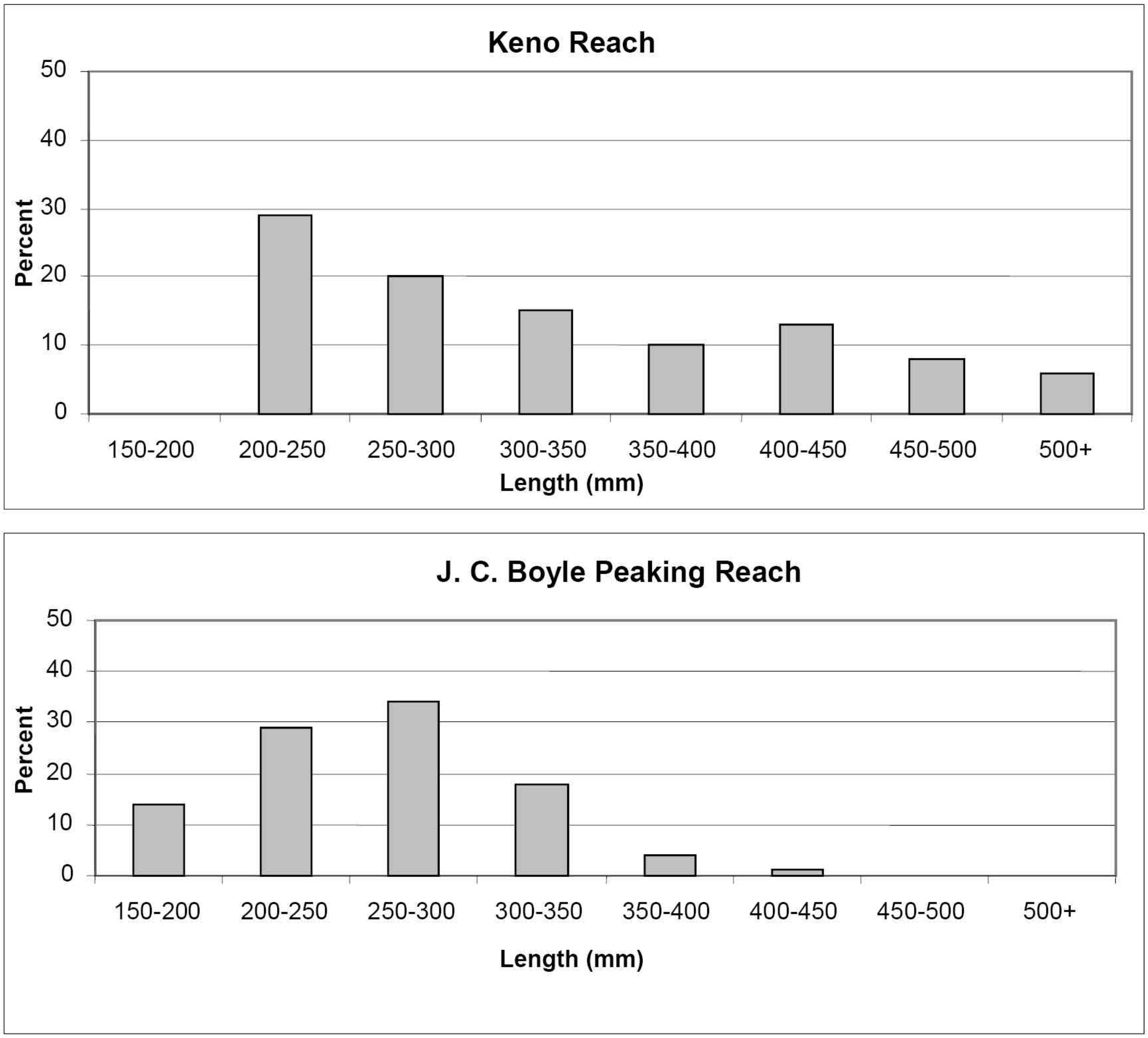


Figure 3-69. Length frequency of sampled trout, from 1979 to 1982 Oregon Fish & Wildlife angler surveys. (Source: PacifiCorp, 2005d)

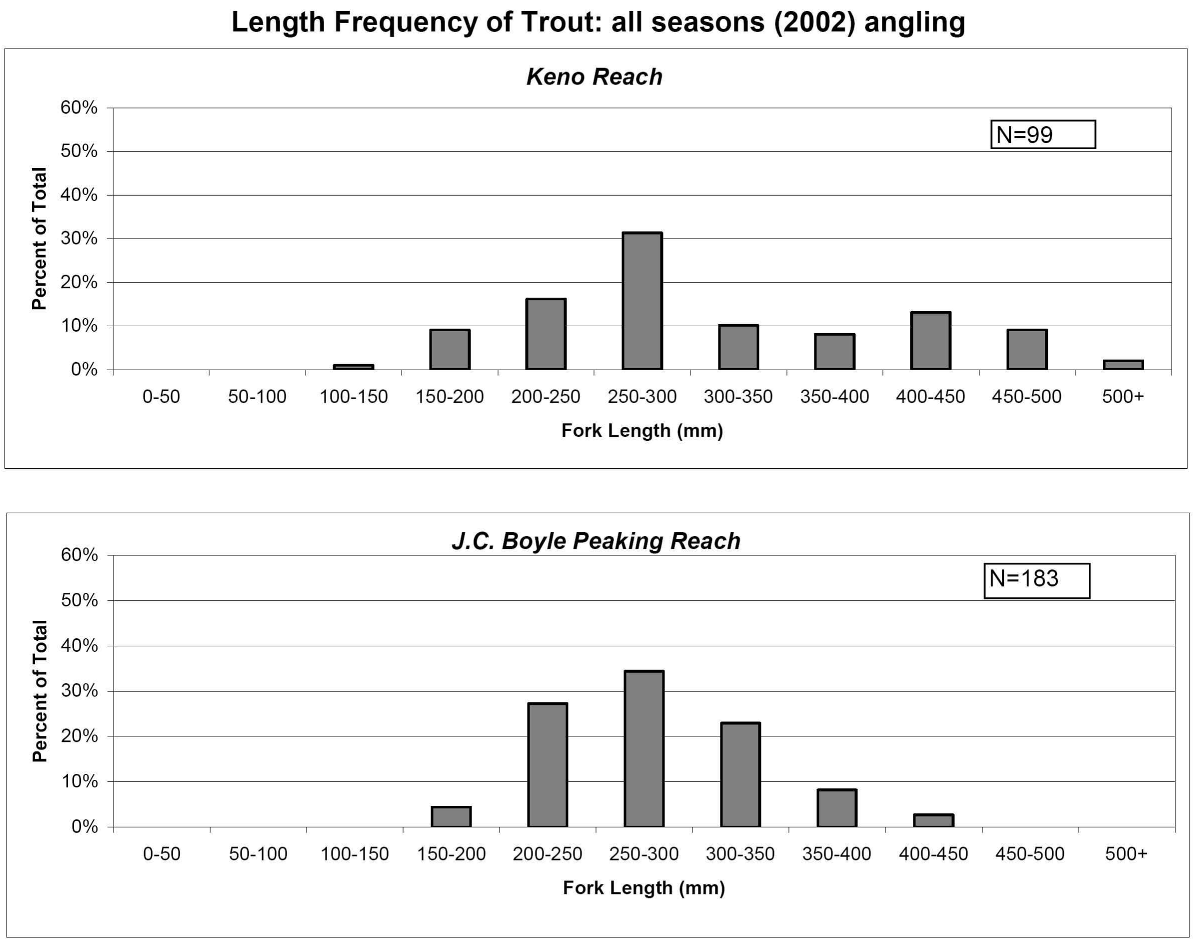


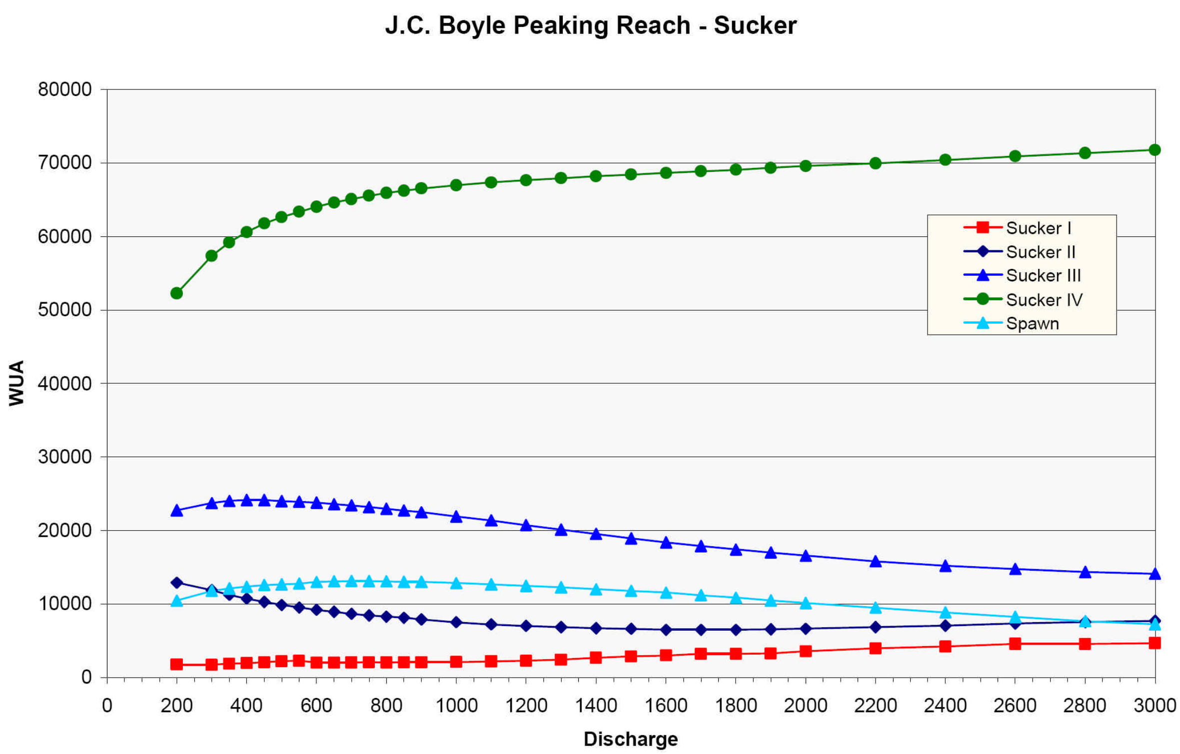
Figure 3-70. Length frequency of trout collected by hook-and-line sampling in 2002. (Source: PacifiCorp, 2005d)

The wetted area versus flow relationships from PacifiCorp's instream flow study indicate that the proposed base flow of 420 to 450 cfs would increase food production by increasing the average wetted area by about 5 percent compared to the current base flow (see table 3-61). Increasing the base flow to the Hoopa Valley Tribe recommended flow of 500 cfs would provide about a 6 percent increase in average wetted area compared to the current base flow, and the Oregon Fish & Wildlife and Cal Fish & Game recommended flow of 720 cfs would provide about an 11 percent increase average wetted area compared to the current base flow. By increasing the area of permanently watered stream channel, these additional increases in base flow would be expected to increase food production and benefit trout production.

However, available information indicates that the redband/rainbow trout population in this river reach is highly productive, and we expect that this fishery would be sustained and improved under PacifiCorp's proposed flow regime, which would increase base flows and reduce the total range of flow change that would occur under peaking operations. As previously noted, the population of redband trout exceeding 7.8 inches was estimated to be 890 fish per mile in the upper 6 miles of the peaking reach and 1,911 fish per mile in the next 5 miles of the river in 1984. These population estimates are comparable to those in the lower Deschutes River in central Oregon, another wild trout stream noted as one of the most productive in the state (National Park Service, 1994). Annual angler catch rates in the Oregon portion of the peaking reach varied from 0.56 to 1.31 redband/rainbow trout per hour during the years 1979 through

1984 and averaged 0.77 redband/rainbow trout per hour. PacifiCorp reported similar catch rates during hook-and-line sampling conducted in 2004 (see tables 3-59 and 3-60). These catch rates are comparable to or exceed those of other high quality trout streams in Oregon, including the Deschutes and Metolius Rivers (City of Klamath Falls, 1986). Annual angler catch rates in the California portion of the peaking reach were slightly lower, from 0.44 to 0.88 trout per hour during 1974 to 1977, 1981, and 1982, and averaging 0.59 redband/rainbow trout per hour. However, Cal Fish & Game (2000) reported that this reach had the highest overall catch rate among the wild trout rivers that it monitors in California.

PacifiCorp reports that some Lost River suckers from Copco reservoir have been observed moving into the lower end of the J.C. Boyle peaking reach, and some spawning may occur in the first riffle upstream of Copco reservoir. PacifiCorp’s instream flow modeling results for sucker species indicate that their proposed minimum flow of 420 to 450 cfs would maximize spawning habitat for suckers, and would increase the amount of rearing habitat for most rearing life stages (figure 3-71). Implementing run-of-river operations would provide more stable habitat conditions, which could provide some benefit to suckers that spawn in this reach. However, Desjardins and Markle (2000) conclude that predation rates on larval suckers entering Copco reservoir are likely very high due to the abundance of introduced warmwater species in the reservoir. This suggests that the population of Lost River and shortnose suckers Copco reservoir is supported primarily by the downstream movement of juvenile and adult suckers from Upper Klamath Lake and J.C. Boyle reservoir. Accordingly, it appears unlikely that implementing run-of-river operations would provide a discernable benefit to the populations of Lost River and shortnose suckers in Copco reservoir.



Note: WUA is shown for the following sucker life stages: (I) non-demersal (bottom dwelling) larvae <26 mm; (II) young-of-year suckers 26-75 mm; (III) juveniles 75-150 mm; and (IV) adults >150 mm.

Figure 3-71. Sucker WUA versus discharge for the J.C. Boyle peaking reach. (Source: PacifiCorp, 2005m)

Flow fluctuations in the J.C. Boyle peaking reach have the potential to cause fish stranding, especially for smaller fish that favor shallow-water habitats. During stranding surveys conducted at 10 study sites in the peaking reach, PacifiCorp found a total of four sculpin, one dace, and one unidentified sucker that were stranded, and 8 to 10 trout fry that were trapped in a pothole (table 3-62). Although few trout fry were observed along the stream margins during the surveys, the lack of stranded trout suggests that the stranding potential in this reach is low at the current ramping rate.

Table 3-62. Peaking reach fish stranding and entrapment observations, 2002. (Source: PacifiCorp, 2005d)

Site	? Flow	Number Stranded	Number Trapped	Notes
		May 31, 2002		
Island Complex	1,500 – 350	0	0	
Miller Bridge	1,500 – 350	0	0	
Foam Eddy	1,500 – 350	0	0	
Caldera	1,500 – 350	0	0	
Point BAR	1,500 – 350	0	0	
		July 11, 2002		
Island Complex	1,500 – 350	0	0	Numerous dace along margins.
Miller Bridge	1,500 – 350	0	0	Several trout fry in side channel. Numerous dace at Shovel Creek mouth.
Foam Eddy	1,500 – 350	0	8-10 trout fry	Trapped fry in 10 foot x 3 foot pothole. Several trout fry observed along river margin.
Caldera	1,500 – 350	0	0	100s of dace along river margin.
Point BAR	1,500 – 350	0	0	Numerous dace in river above Shovel Creek.
		August 8-9, 2002		
Island Complex	1,500 – 350	0	0	Hundreds of 1-inch to 1.5-inch dace along margins. Several trout fry along margin.
Miller Bridge	1,500 – 350	0	0	Several trout fry in side channel.
Foam Eddy	1,500 – 350	0	0	
Caldera	1,500 – 350	0	0	
Point BAR	1,500 – 350	0	0	

In most areas of the J.C. Boyle peaking reach, the toe-of-bank, which defines the edge of the predominant active stream bed, occurs at the water's edge at flows of about 1,000 cfs. As a result, flow reductions below 1,000 cfs have a higher stranding potential than reductions from higher flows, because the area dewatered for a given change in stage increases. Accordingly, PacifiCorp's proposed reduction in the down-ramp rate to 4 inches per hour when flows at the gage are less than 1,000 cfs would reduce the risk of fish stranding compared to the existing ramp rate of 9 inches per hour. The 4 inches per hour ramp rate would attenuate to about 3 inches per hour at Frain Ranch (RM 214.3) and to about 2 inches per hour near Shovel Creek (RM 201.5), further reducing the stranding potential in downstream areas.

The Bureau of Land Management's specified 2 inch per hour ramping rate, and Oregon Fish & Wildlife, Cal Fish & Game, and the Hoopa Valley Tribe's recommendation of a 1 inch per hour ramping rate may reduce the stranding potential even further. However, this additional benefit would likely be minor based on the limited amount of stranding that was observed during PacifiCorp's surveys. A similar benefit would be provided by run-of-river operation. Bureau of Land Management's specified release of 1,500 to 3,000 cfs 1 day a week would not benefit the aquatic resources in the peaking reach, but would provide flows for whitewater boating.

Copco No. 1 and 2

Copco No. 1 powerhouse has a maximum hydraulic capacity of 3,200 cfs. The powerhouse is operated as a peaking facility, discharging directly into the Copco No. 2 forebay. Because discharges occur directly into the Copco No. 2 forebay, there is no riverine habitat directly affected by Copco No. 1 peaking operations. Copco No. 2 powerhouse is a peaking facility that operates synchronously with Copco No. 1. The powerhouse, located about 1.5 miles downstream of the Copco No. 2 diversion dam, discharges into Iron Gate reservoir. Consequently, there is no riverine habitat affected by Copco No. 2 peaking operations. Currently there are no ramp rate or minimum flow restrictions for the 1.5-mile-long bypassed reach between Copco No. 2 dam and Copco No. 2 powerhouse. Ramping of flows in the bypassed reach is infrequent and occurs only when maintenance requires spill at the dam, during a forced outage, or when inflows are greater than the hydraulic capacity of the powerhouse.

Currently, PacifiCorp voluntarily provides about 10 cfs of flow into the Copco No. 2 bypassed reach via leakage of the spill gates and from a small sluiceway. PacifiCorp proposes to maintain a minimum flow of 10 cfs in the Copco No. 2 bypassed reach, and to make improvements to the Copco No. 2 bypass flow gate so that the 10 cfs would be regulated through an automated gate that allows for changes in water surface elevation in the Copco No. 2 reservoir. They also propose to limit flow down-ramp rates to 125 cfs per hour (equivalent to less than 2 inches per hour) in the Copco No. 2 bypassed reach, except for flow conditions beyond the project's control.

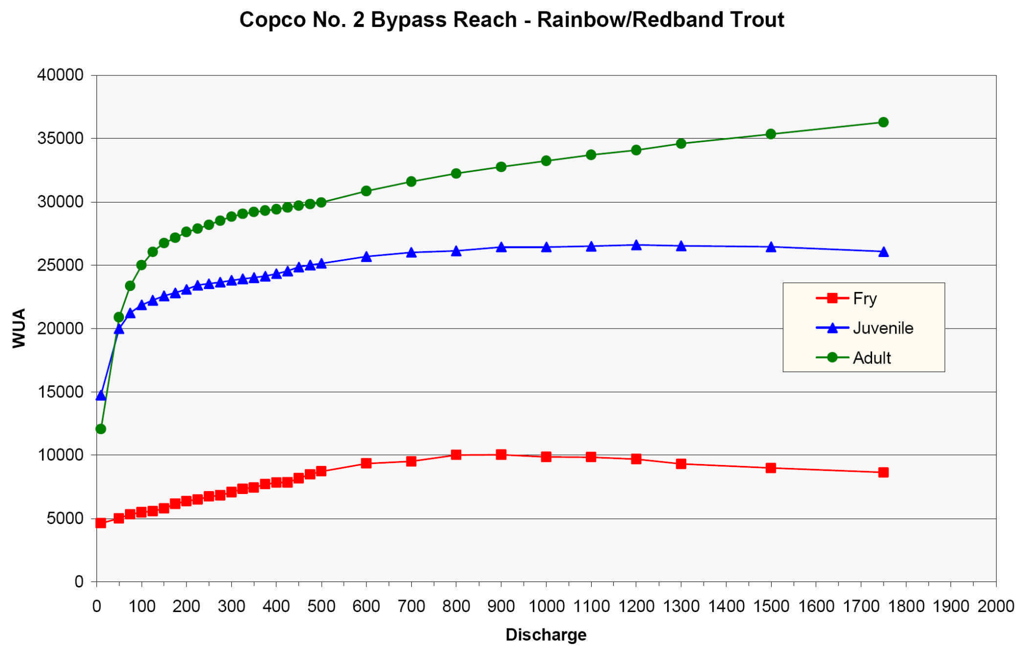
Oregon Fish & Wildlife, Cal Fish & Game, NMFS and FWS all recommend that PacifiCorp release a minimum instantaneous minimum flow of 730 cfs or 40 percent of the inflow, whichever is greater. Inflow would be computed as a 3-day running average of flows at the J.C. Boyle powerhouse gage added to the flow from Shovel Creek, as measured by a new gage. The Hoopa Valley Tribe recommends that PacifiCorp discharge a continuous minimum flow of 500 cfs or 70 percent of inflow to the project, whichever is greater, or total project inflow when the inflow is less than 500 cfs. However, in its alternative Section 18 prescription, Hoopa Valley Tribe recommends the same flow regime as Oregon Fish & Wildlife, Cal Fish & Game, NMFS, and FWS.

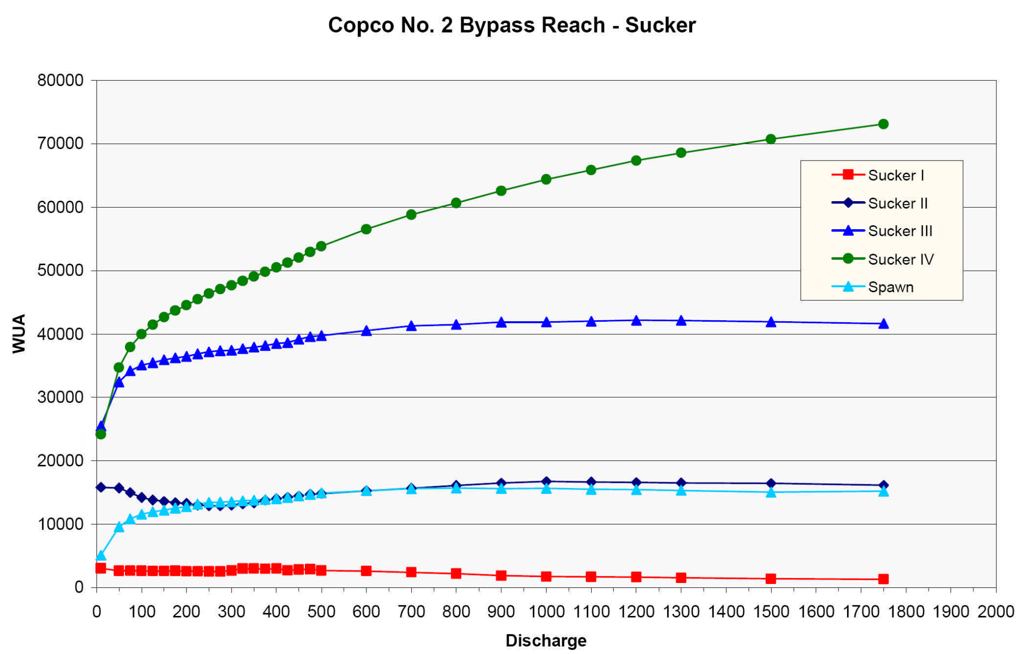
Our Analysis

Fish sampling performed in the Copco No. 2 bypassed reach in 2001 and 2002 indicates that speckled dace and marbled sculpin are the most abundant fish in the reach, with much smaller numbers of rainbow trout, chubs, largemouth bass, crappie, and yellow perch. With the exception of speckled dace and marbled sculpin, most of the fish in the reach likely originate from downstream movement of fish out of Copco reservoir or from upstream movement of fish out of Iron Gate reservoir.

The 10 cfs flow that PacifiCorp voluntarily releases and proposes as a minimum flow provides limited habitat for fish and other aquatic biota, with water temperatures in this reach during the summer favoring warmwater species. Although fish use of this reach is limited, the occasional down-ramping that occurs when Copco No. 1 is coming off spill and during other maintenance events has the potential to cause stranding of small fish.

An instream flow study conducted by PacifiCorp in the Copco No. 2 bypassed reach indicates that there is little instream habitat (WUA) for the adult and juvenile life stages of rainbow trout and suckers at the current minimum flow of 10 cfs (figure 3-72). Modeling results indicate that available habitat for juvenile and adult trout increases rapidly at flows of up to 75 to 100 cfs. Habitat at 10 cfs is only 55 and 33 percent of maximum WUA for juvenile and adult trout, but increases to 80 and 63 percent of maximum WUA, respectively, at flows of 75 cfs (table 3-63). Habitat for trout fry increases very gradually, from 46 percent of maximum at 10 cfs to 53 percent, 67 percent, 87 percent, and 95 percent of maximum WUA at flows of 75, 250, 500, and 730 cfs, respectively. Although flows in excess of 500 cfs increase the available habitat for trout, other physical constraints such as water quality conditions, especially water temperature, would continue to be a limiting factor for trout productivity in the reach.





Note: WUA is shown for the following sucker life stages: (I) non-demersal (bottom dwelling) larvae <26 mm; (II) young-of-year suckers 26-75 mm; (III) juveniles 75-150 mm; and (IV) adults >150 mm.

Figure 3-72. WUA for rainbow trout and suckers in the Copco No. 2 bypassed reach. (Source: PacifiCorp, 2005m)

Table 3-63. Estimates of wetted perimeter and rainbow trout WUA habitat modeled for the Copco No. 2 bypassed reach. (Source: PacifiCorp, 2005m, as modified by staff).

Simulated Discharge	**Average Wetted Area (square feet)**	**Rainbow Trout WUA (square feet) [percent of maximum WUA[a]]**		
		Fry	***Juveniles***	***Adults***
10 cfs (existing minimum – PacifiCorp proposed)	54,695	4,634 [46]	14,757 [55]	12,058 [33]
75 cfs	58,601	5,323 [53]	21,234 [80]	23,356 [63]
250 cfs	70,146	6,749 [67]	23,543 [89]	28,184 [78]
500 cfs (Hoopa Valley Tribe recommended)	87,157	8,722 [87]	25,143 [95]	29,952 [83]
730 cfs (Oregon Fish & Wildlife, Cal Fish & Game, NMFS, FWS recommended)	92,399 *(at 700 cfs)*	9,509 [95]	26,026 [98]	31,591 [87]

[a] Maximum modeled for fry at 900 cfs (10,028 square feet), for juveniles at 1,200 cfs (26,602 square feet), and for adults at 1,750 cfs (36,290 square feet).

The results of the instream flow study indicate that habitat for most life stages of suckers, and spawning habitat, would increase substantially if flows were increased to 70 to 100 cfs, while the rate of habitat increase tapers off at higher flows (see figure 3-72). However, we found no evidence in the record to indicate that the federally listed shortnose or Lost River suckers spawn in the Copco No. 2 bypassed reach. Although Desjardin and Markle (2000) did capture larval suckers in Iron Gate reservoir, their abundance declined rapidly over the rearing season and no juvenile suckers were collected, suggesting that predation limits recruitment and that adult suckers found in Iron Gate reservoir were probably recruited as juvenile or adult migrants from Upper Klamath Lake or from J.C. Boyle reservoir. Accordingly, we conclude that any benefits to shortnose or Lost River suckers from increased flows in the Copco No. 2 bypassed reach would be negligible.

Copco No. 2 Flushing Flows

Oregon Fish & Wildlife recommend that, at least once a year between February 1 and April 15 when inflow to J.C. Boyle reservoir (including Spencer Creek) exceeds 3,300 cfs, PacifiCorp not divert water to the J.C. Boyle or Copco No. 2 power canals for at least 7 full days. The down-ramp rate for the seasonal high flow would not exceed 2 inches per hour and 300 cfs per 24-hour period, as measured at the new gage to be installed downstream of Boyle dam. FWS makes a similar recommendation, but specifies that diversion to the Copco No. 2 powerhouse would stop when inflow to Copco reservoir exceeds 3,300 cfs, as measured from the new gage below J.C. Boyle dam at RM 225 and a new gage to be installed at Shovel Creek, combined. The down-ramp rate would not exceed 300 cfs per 24 hours, measured at a new gage to be installed below the Copco No. 2 powerhouse.[57]

[57]Two of the stated FWS gage locations appear to be typographical errors, since a gage located at RM 225 would only measure flow in the J.C. Boyle bypassed reach (unlike the existing USGS gage downstream of the J.C. Boyle powerhouse) and a gage downstream of the Copco No. 2 powerhouse would be in Iron Gate reservoir, and could not be used as a compliance point for a down-ramping rate in the Copco No. 2 bypassed reach.

Our Analysis

Provision of annual flushing flows as recommended by the agencies could help to ensure that spawning gravel areas used by trout remain sufficiently free of silt to support egg incubation and trout recruitment. Our review of the average spill duration and quantity information presented in table 3-18 indicates that spillage to the Copco No. 2 bypassed reach is sufficient to flush fine-grained sediment in many years. The hydraulic capacity of the Copco No. 1 powerhouse is 2,360 cfs. When inflow to Copco reservoir exceeds the hydraulic capacity of the powerhouse, spillage would typically occur. A reasonable estimate of inflow to Copco No. 2 reservoir under average conditions can be obtained by adding the average spill flow at Copco No. 1 to the hydraulic capacity of Copco No. 1 powerhouse. Based on information in table 3-18, inflow to Copco No. 2 reservoir during spill events at Copco No. 1 dam ranged from 6,042 cfs in January to 4,391 cfs in May. The hydraulic capacity of the Copco No. 2 powerhouse is 2,676 cfs, which means that spillage to the Copco No. 2 bypassed reach under average conditions would range from about 3,366 cfs in January to about 1,715 cfs in May. Such flows should be sufficient to mobilize fine-grained sediment that may be embedded in spawning gravel in the Copco No. 2 bypassed reach. We expect the duration of average spill events at Copco No. 2 dam to be similar to that shown for Copco No. 1 dam (up to about 8 days). These spill characterizations represent average conditions from 1990 to 2004, so during some years, there would have been spills of longer duration and higher flows, whereas during other years, there could be little if any spill at Copco No. 1 and No. 2 dams.

Prior to construction of Iron Gate dam, this reach did support spawning by fall Chinook salmon (Coots and Wales, 1952). If access to this reach is restored for anadromous fish, spawning habitat for anadromous species could be enhanced by gravel augmentation. If such a program were to be implemented, we conclude that there would likely be sufficient flushing flows to maintain the suitability of gravel for spawning, but monitoring of spawning habitat would serve to confirm our prediction and provide a basis for supplemental gravel augmentation, if flushing flows transport gravel through the bypassed reach.

Copco No. 2 Ramp Rates

PacifiCorp proposes to limit down-ramping to 125 cfs per hour. Ramping flows through the Copco No. 2 bypassed reach would be accomplished by regulating flows at the Copco No. 1 development, except that flows less than 3,200 cfs would be controlled at the Copco No. 2 dam. To the extent possible, flow changes would occur during the night to reduce the potential for fish stranding.

The Oregon Fish & Wildlife, Cal Fish & Game and Forest Service recommend that ramp rates at Copco No. 2 dam not exceed 1 inch per hour at any time, and not exceed 300 cfs in any one 24-hour period. These ramp rates would apply to all hydro-controlled operations including load following, re-regulating, project start-up, and planned shutdowns. Cal Fish & Game also recommends that PacifiCorp operate the J.C. Boyle, Copco No. 1 and Copco No. 2 developments as run-of-river facilities in conjunction with meeting minimum target flows. As previously described, the Hoopa Valley Tribe recommends a ramping rate that ranges from 1.2 to 2.4 inches per hour.

Our Analysis

Fish use of the Copco No. 2 bypassed reach is limited, most likely due to low flows and high water temperatures during the summer months. Down ramping in this reach is rare and occurs primarily when Copco No.1 is coming off of a spill event or during scheduled maintenance shutdown of the Copco No. 2 powerhouse. Such events may strand some fish in the bypassed reach.

The PacifiCorp proposed ramp rate of 125 cfs per hour is equivalent to less than 2 inches per hour in most flow ranges. In addition, the proposal to down ramp at night would further minimize the potential for fish stranding, especially during the winter when small trout, and perhaps other species, tend to be less closely associated with the bottom substrate than during the day. A ramp rate of 1 inch per hour as proposed by Oregon Fish & Wildlife, Cal Fish & Game, and the Forest Service would also be protective of smaller fish and reduce the incidence of stranding, but may be more restrictive than is needed to protect fish in the reach, given the limited nature of the fishery and the infrequent need for ramping.

Fall Creek

Fall Creek, which originates from headwater spring sources, has an extremely stable flow regime. Flows routed to the Fall Creek powerhouse run almost continuously, passing either through the turbines or the flow-continuation valve. Cal Fish & Game operates a salmon rearing facility at Fall Creek downstream of the powerhouse that requires continuous flow. Although there is no prescribed down-ramp rate for the diversion dam, the need to reduce flows is rare, only occurring when canal maintenance is required. The rate at which flow is returned to the canal affects the rate at which flows decrease in the bypassed reach. Fish stranding has not been documented during these maintenance activities.

The diversion dam on Fall Creek diverts up to 50 cfs of flow that bypasses 1.2 miles of a very steep gradient section of Fall Creek leading to the Fall Creek powerhouse. The project's current license requires a minimum flow of 0.5 cfs below the Fall Creek diversion and a minimum flow of 15 cfs (or natural stream flow, whichever is less) downstream of the powerhouse. Roughly 99 percent of the streamflow is diverted except during infrequent and brief storm events when flows exceed 50 cfs.

PacifiCorp proposes to increase the minimum flow release to 5 cfs into the Fall Creek bypassed reach, and to continue to maintain a minimum flow of 15 cfs downstream of the bypass confluence with the powerhouse tailrace. Flow release control structures associated with the proposed fish passage facilities (discussed later in section 3.3.3.2.2, *Fish Passage*), at the dam would be constructed to maintain the continuous 5 cfs release at the dam.

Cal Fish & Game, Oregon Fish & Wildlife, and FWS recommend that a minimum of 40 percent of the instantaneous flow measured above the Fall Creek power canal diversion be released into the Fall Creek bypassed reach, which when applied to historic USGS data (gage no. 1151200 on Fall Creek just above Iron Gate reservoir), would provide a minimum flow between 14 and 22 cfs (letter from Interior dated March 27, 2006). Cal Fish & Game, Oregon Fish & Wildlife, and FWS also recommend installing new gages above and below the diversion dam.

Oregon Fish & Wildlife, Cal Fish & Game and FWS recommend that ramp rates at Fall Creek diversion not exceed 1 inch per hour any time day or night, and not exceed 300 cfs in any 24 hour period. The ramp rates would apply to all hydro-controlled operations including load following, re-regulating, project start-up, and planned shutdowns.

Our Analysis

The Fall Creek bypassed reach supports a population of rainbow trout, nearly all of which are smaller than 6 inches. Results of fish sampling conducted by PacifiCorp in July 2005 in Fall Creek (PacifiCorp, 2005a) found only one trout (4 to 6 inches) in the power canal. Fifteen trout were caught in the bypassed reach, ranging in size from 2 to 8 inches, with an average size of 4 inches. Above the diversion, 9 trout were collected, ranging in size from 2 to 6 inches, with an average size of 4.5 inches (PacifiCorp, 2005a). PacifiCorp reported that the catch per unit effort between the Fall Creek bypassed reach and above the Fall Creek diversion exhibited a fairly wide range (81.8 to 187.5 fish per hour), however, the catch per 100 feet of stream was less variable, at 3.1 and 3.6, respectively. These results indicate that the trout populations in the two reaches are similar, despite the difference in flows.

PacifiCorp's instream flow analysis indicates that its proposed 5 cfs minimum flow would increase the available habitat in the bypassed reach by about 16 percent for fry, 32 percent for trout juveniles (less than 6 inches), and 28 percent for adult trout (figure 3-73, table 3-64). Increasing minimum flows to 14 cfs as recommended by Cal Fish & Game, Oregon Fish & Wildlife, and FWS would increase the available habitat over current conditions by about 21 percent for trout fry, about 52 percent for juveniles, and 66 percent for adults. Increasing available habitat would potentially result in an increase in populations in the bypassed reach. However, given the similarity of trout populations upstream and downstream of the diversion, the higher flows recommended by Cal Fish & Game, Oregon Fish & Wildlife, and FWS probably would provide only a limited benefit to the fishery compared to PacifiCorp's proposed 5-cfs minimum flow.

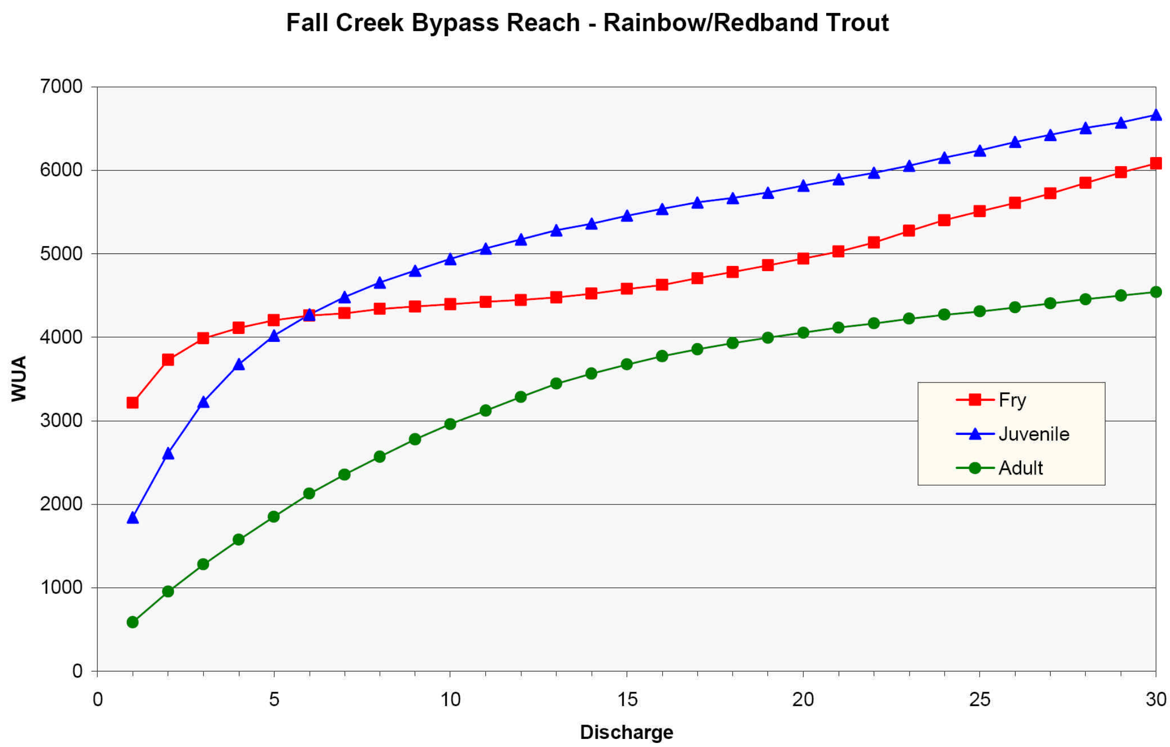


Figure 3-73. WUA versus discharge for rainbow trout in Fall Creek. (Source: PacifiCorp, 2005m)

Table 3-64. Estimates of wetted perimeter and rainbow trout WUA modeled for the Fall Creek bypassed reach. (Source: PacifiCorp, 2005m, as modified by staff)

		Rainbow Trout WUA (ft) [*percent of maximum WUA*[b]]		
Discharge	**Average wetted perimeter (ft)**	***Fry***	***Juveniles***	***Adults***
0.5 cfs (existing min)	11,747 (at 1 cfs)	3,214 [53]	1,843 [28]	586 [13]
5 cfs (PacifiCorp proposed)	13,795	4,204 [69]	4,022 [60]	1,851 [41]
14 cfs[a]	15,813	4,523 [74]	5,362 [80]	3,565 [79]
22 cfs[a]	18,370	5,135 [84]	5,971 [90]	4,166 [92]

[a] Cal Fish & Game, Oregon Fish & Wildlife, and FWS minimum flow of 40 percent of inflows would likely be between 14 and 22 cfs.

[b] Maximum modeled WUA for all life stages occurred at 30 cfs - 60,882 square feet for fry, 6,667 square feet for juveniles, and 4,540 square feet for adults. Maximum flow modeled was 30 cfs.

PacifiCorp's proposed 15 cfs minimum flow for the stream reach downstream of the tailrace confluence with the bypass channel is the same as the current license requirement. This flow-related measure is largely moot because of the powerhouse flow continuation valves, which maintain flow in lower Fall Creek even if the powerhouse is not operating. The minimum flow would only pertain to rare occasions when the powerhouse or diversion canal is in the process of being shut down and flow is being returned to the bypass channel. This process must be done slowly enough to allow the required 15 cfs to reach the lower creek before the canal diversion is completely shut off.

The Oregon Fish & Wildlife, Cal Fish & Game, and FWS recommendation to limit the ramping rate at Fall Creek to 1 inch per hour and 300 cfs per 24 hours would be protective of fish resources. Given that ramping is infrequent and ramp rates are limited by the requirement to maintain a minimum flow of 15 cfs downstream, however, a 1 inch per hour ramp rate would provide little additional benefit.

Spring Creek

PacifiCorp maintains an earthen dam on Spring Creek, and has a water right for 16.5 cfs. The Spring Creek diversion is located 0.5 mile upstream from its confluence with Jenny Creek, and the diverted flow is carried through a 1.7-mile-long canal where it enters Fall Creek about 1.7 miles upstream of the Fall Creek power canal diversion. There are several unnamed springs that are captured in the Spring Creek canal. The Spring Creek diversion directs up to 16.5 cfs of flow into Fall Creek, and the Fall Creek diversion diverts up to 50 cfs into the power canal that leads to the Fall Creek powerhouse. In the summer, when flow from Spring Creek is diverted to Fall Creek, only about 0.22 cfs is returned to Spring Creek, and the downstream third of the creek is dewatered (letter from Interior, March 27, 2006).

PacifiCorp proposes to shut the Spring Creek diversion dam canal headgate so that no flow is diverted during July and August. For the remainder of the year they propose to position the slide gate to release 1 cfs of flow into the bypassed reach, if available.

Oregon Fish & Wildlife, Cal Fish & Game, and FWS recommend that no flow diversion occur from June 1 through September 15, and that 50 percent of inflows be released to the reach downstream of the diversion dam during the remainder of the year. Oregon Fish & Wildlife, Cal Fish & Game, and FWS also recommend that ramp rates at Spring Creek diversion not exceed 1 inch per hour at any time, and not exceed 300 cfs in any 24-hour period. The ramp rates would apply to all hydro-controlled operations including load following, re-regulating, project start-up, and planned shutdowns.

Our Analysis

The Jenny Creek watershed supports several native fish species including the Jenny Creek sucker, rainbow trout, and Klamath speckled dace. Sampling conducted in Spring Creek resulted in the collection of 16 rainbow trout upstream of the diversion dam, 1 rainbow trout downstream of the diversion dam, and 6 trout in the diversion canal (PacifiCorp, 2005a). Closing off the Spring Creek diversion in the summer months would alleviate dewatering of the Spring Creek bypassed reach, and facilitate cooling in Jenny Creek by allowing the much colder water from Spring Creek to flow into Jenny Creek. However, there are two non-project diversions on Spring Creek, so the amount of water from Spring Creek that actually flows into Jenny Creek is unknown.

Comparing data collected by the Bureau of Land Management in Jenny Creek above and below the Spring Creek confluence in 1995, 1996, and 1997 shows that inflows from Spring Creek reduce water temperatures in lower Jenny Creek. Average temperature difference from June through September was 0.5, 0.8, and 1.1°C for 1995, 1996, and 1997, respectively (figures 3-74 through 3-76) (PacifiCorp, 2004i). In 1995 and 1996, the cooling effect was most pronounced in July and August, but in 1997 the cooling effect extended from June through mid-September. Shutting down PacifiCorp's Spring Creek diversion from June 1 to September 15, as agencies recommend, would improve summer water temperatures for trout rearing in Jenny Creek, especially in hot and dry years.

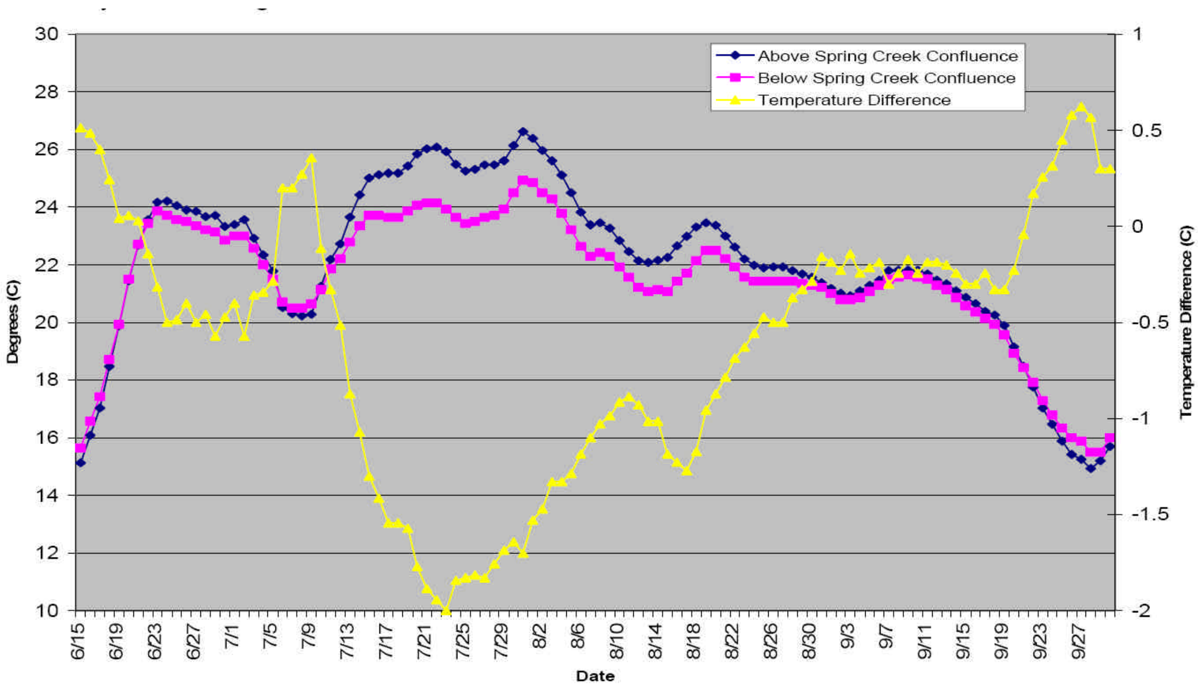


Figure 3-74. Seven-day moving average water temperatures from 1995 recorded in Jenny Creek above and below the confluence with Spring Creek. (Source: PacifiCorp, 2004i).

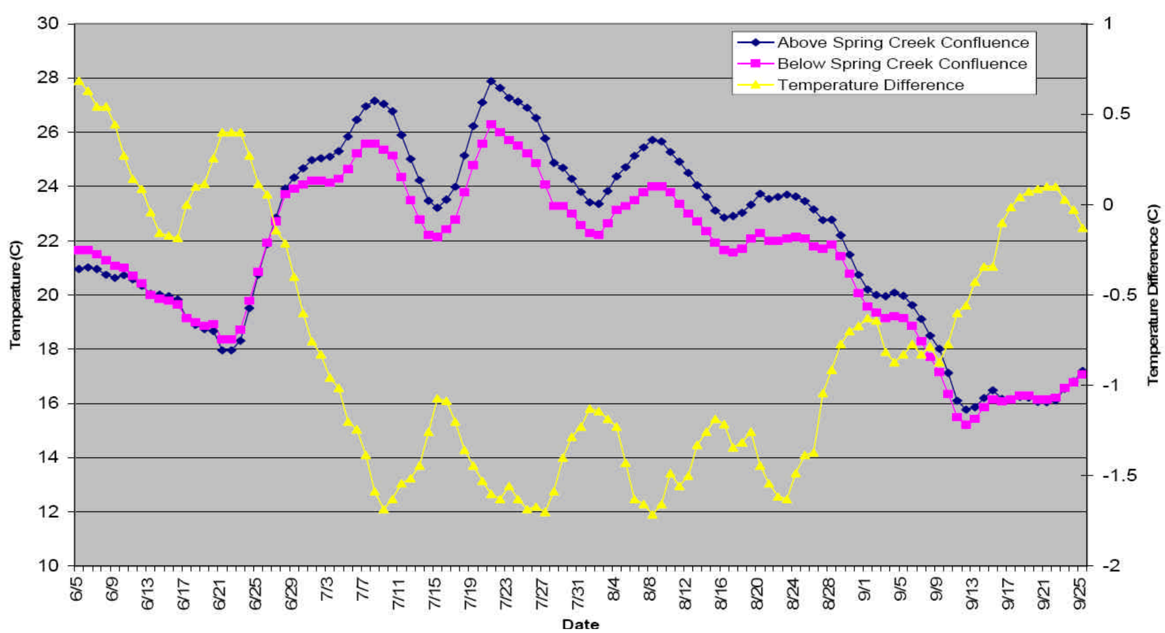


Figure 3-75. Seven-day moving average water temperatures from 1996 recorded in Jenny Creek above and below the confluence with Spring Creek. (Source: PacifiCorp, 2004i).

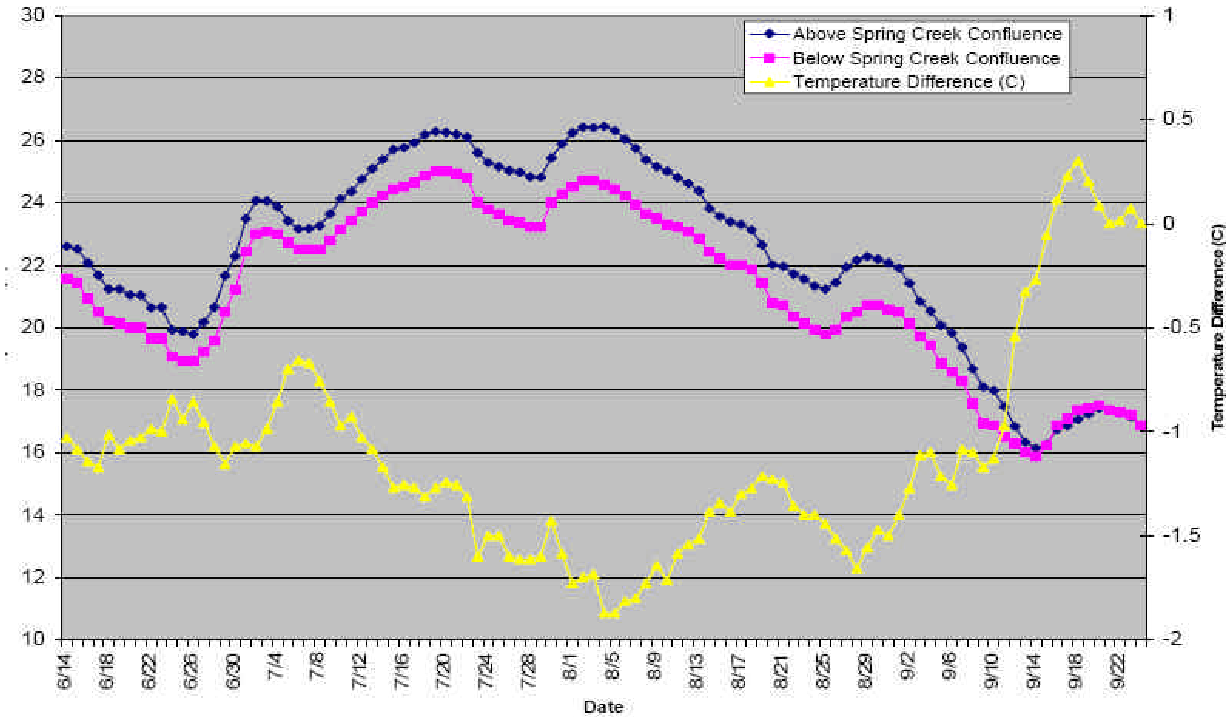


Figure 3-76. Seven-day moving average water temperatures from 1997 recorded in Jenny Creek above and below the confluence with Spring Creek. (Source: PacifiCorp, 2004i).

PacifiCorp's proposal of releasing a 1 cfs minimum flow (or inflow, if inflow is less than 1 cfs) at all other times would help to prevent dewatering in Spring Creek and help to maintain some aquatic habitat downstream of the diversion, although as stated above there are other diversions on Spring Creek that are beyond PacifiCorp's control. The Oregon Fish & Wildlife, Cal Fish & Game, and FWS recommendation that 50 percent of the flow above the diversion be released to the reach downstream of the diversion dam from September 16 through May 31 regardless of flow volume would likely increase available habitat over current conditions; however, due to a lack of data we are unable to quantify the extent of such benefit. Releasing 50 percent of the inflow would require some type of monitoring facility to determine the instantaneous release requirement as well as installation of facilities to accommodate changing release flows. Given the limited amount of habitat and small size of trout in Spring Creek upstream of the diversion, we expect that the benefit to the fishery from the higher flows proposed by the agencies would be limited.

The Oregon Fish & Wildlife, Cal Fish & Game, and FWS recommendation to limit the ramping rate at Spring Creek to 1 inch per hour and 300 cfs per 24 hours would be protective of the fish resources in the stream. Flows in Spring Creek are too low for the 300 cfs restriction to apply. However, given that flow down-ramping is likely to occur only once each year when diversion restarts in September, any adverse effects due to ramping are likely to be minor.

Iron Gate

Iron Gate development is operated to re-regulate peaking flows from the upstream J.C. Boyle and Copco developments to provide stable flows in the Klamath River downstream of the dam. At flows less than about 1,735 cfs, the Iron Gate turbine can be regulated closely to control ramping rates. At flows more than 1,735 cfs, Iron Gate dam spills and the ability to control downstream flow fluctuations become more difficult because the spillway is an ungated overflow type structure. The concrete spillway has no flow control gates; therefore, spill at Iron Gate is controlled to some degree by operation of the upstream Copco No. 1 and No. 2 developments. Flow control becomes complicated in this flow range (1,735 to 3,200 cfs) because of the influence of turbine discharges, reservoir retention time, reservoir-induced flow attenuation, and tributary inflow between Copco and Iron Gate reservoirs. At flows exceeding 3,200 cfs, flows at Copco No. 1 dam can be controlled only via 13 sets of spill gates, 11 of which are manually operated. The precision of flow control when operating these gates is hindered by their overall size, and, if Copco reservoir is full, control of spill is difficult.

Iron Gate Minimum Flows. The flow regime downstream of Iron Gate dam affects aquatic resources through its influence on physical habitat (depth, velocity, substrate and cover), water quality (especially water temperature), sediment transport processes (including effects on spawning habitat), and conditions that may influence the prevalence of disease pathogens and the spread of fish diseases. Since 1997, PacifiCorp has operated the project to provide instream flow releases that are established in Reclamation's annual operating plans. Operating plans developed since 2002 have been developed to comply with flows specified in the 2002 NMFS BiOp on Reclamation's Klamath Irrigation Project operations (NMFS, 2002). As we describe in section 3.3.2, *Water Resources*, Phase III flows specified in the 2002 NMFS BiOp (see table 3-22) went into effect in 2006, as ordered in a March 26, 2006, ruling by the U.S. Ninth Circuit Court of Appeals.

PacifiCorp proposes to maintain the instream flow schedule and ramp rates below Iron Gate dam according to Reclamation's Klamath Irrigation Project Operations Plans, consistent with the 2002 NMFS BiOp.

The Hoopa Valley Tribe, Oregon Fish & Wildlife, Cal Fish & Game, and Forest Service recommend monthly flows that are based on the Hardy Phase II flow study conducted under contract to Interior (Hardy and Addley, 2001). The Hardy Phase II flow recommendations and variations from the Hardy Phase II flows recommended by the agencies and tribes are shown in table 3-65. Monthly flows recommended by the Hoopa Valley Tribe match the Hardy Phase II flow recommendations for each water year type, which are based on annual flow exceedance values of 10, 30, 50, 70, and 90 percent.

To minimize disease risk associated with low flows, Cal Fish & Game recommend that an absolute minimum flow of 1,200 cfs be released in all months and water year types. Oregon Fish & Wildlife applies the same minimum flow of 1,200 cfs in dry years, but not in below average water years. The Forest Service applied the 1,200 cfs minimum flow to all year types, but only for the months of August and September.

Table 3-65. Hardy Phase II and agency flow recommendations. (Source: Staff)

<table>
<tr><th></th><th colspan="8">Water Year Type, Recommending Party, and Flow (cfs)</th></tr>
<tr><th></th><th>Wet</th><th>Above Normal</th><th>Average</th><th colspan="2">Below Average</th><th colspan="3">Dry</th></tr>
<tr><th>Month</th><th>(Hardy)</th><th>(Hardy)</th><th>(Hardy)</th><th>(Hardy)</th><th>(Forest Service/Cal Fish & Game)</th><th>(Hardy)</th><th>(Oregon Fish & Wildlife/Cal Fish & Game)</th><th>(Forest Service)</th></tr>
<tr><td>April</td><td>5,200</td><td>4,100</td><td>3,300</td><td colspan="2">2,200</td><td>1,500</td><td colspan="2">1,600</td></tr>
<tr><td>May</td><td>4,500</td><td>3,700</td><td>3,100</td><td colspan="2">2,100</td><td>1,600</td><td colspan="2">1,600</td></tr>
<tr><td>June</td><td>3,800</td><td>2,900</td><td>2,300</td><td colspan="2">1,800</td><td>1,600</td><td colspan="2">1,350</td></tr>
<tr><td>July</td><td>2,300</td><td>1,970</td><td>1,530</td><td colspan="2">1,250</td><td>1,600</td><td>1,200</td><td>1,000</td></tr>
<tr><td>August</td><td>1,800</td><td>1,470</td><td>1,250</td><td>1,000</td><td>1,200</td><td>1,600</td><td colspan="2">1,200</td></tr>
<tr><td>September</td><td>1,840</td><td>1,570</td><td>1,350</td><td>1,100</td><td>1,200</td><td>1,350</td><td colspan="2">1,200</td></tr>
<tr><td>October</td><td>1,900</td><td>1,660</td><td>1,470</td><td colspan="2">1,200</td><td>1,000</td><td>1,200</td><td>1,100</td></tr>
<tr><td>November</td><td>2,200</td><td>1,970</td><td>1,710</td><td colspan="2">1,400</td><td>1,000</td><td>1,200</td><td>NS</td></tr>
<tr><td>December</td><td>3,500</td><td>2,400</td><td>2,030</td><td colspan="2">1,600</td><td>1,000</td><td>1,300</td><td>NS</td></tr>
<tr><td>January</td><td>4,200</td><td>2,970</td><td>2,400</td><td colspan="2">2,000</td><td>1,100</td><td>1,500</td><td>NS</td></tr>
<tr><td>February</td><td>5,000</td><td>3,500</td><td>2,720</td><td colspan="2">2,200</td><td>1,200</td><td>1,600</td><td>NS</td></tr>
<tr><td>March</td><td>5,400</td><td>4,300</td><td>3,400</td><td colspan="2">2,400</td><td>1,300</td><td>1,600</td><td>NS</td></tr>
</table>

NS: Not specified (Forest Service only recommended flows from May through October in all water year types)

Although Oregon Fish & Wildlife and Cal Fish & Game indicate that application of the 1,200 cfs absolute minimum flow was their only change from the Hardy Phase II flows, the monthly flows that they provided in tabular form deviate substantially from the Hardy Phase II flows in dry water years. This may be a typographical error, however, because their dry year flow recommendations appear to correspond with the Hardy Phase II flows, with the exception of the 1,200 cfs absolute minimum flow, if they are shifted by 3 months.

Oregon Fish & Wildlife states that its flow recommendations are target flows, and that if the target flows are not available, PacifiCorp should pass inflows to Iron Gate reservoir downstream of Iron Gate dam. Cal Fish & Game recommends that, if inflows drop below the recommended minimum flows, PacifiCorp draft Iron Gate reservoir to elevation 2,322 feet, using the available active storage to maintain the minimum flow. After the reservoir elevation drops to below 2,322 feet, Cal Fish & Game recommends that operations at Iron Gate dam convert to run-of-river, with outflow equal to the 3-day running average of inflow. Forest Service recommends that, when the recommended flows are not available, Iron Gate dam be operated as a run-of-river facility. NMFS and FWS recommend that, with the exception of biologically based pulse releases, the project be operated as a run-of-river facility. Releases from Iron Gate dam would equal the combined instantaneous inflow to the project including tributary inflow, spring accretion flow, irrigation return flows, and releases made by Reclamation from its Klamath Irrigation Project. Oregon Fish & Wildlife recommends generally operating Iron Gate dam run-of-river.

Our Analysis

Based on our estimate of the current storage capacity of the project reservoirs (see table 3-16), PacifiCorp controls a total of 12,244 acre-feet of storage in the five mainstem reservoirs that are part of the current project. This represents only 2.5 percent of the storage that is controlled by Reclamation in Upper Klamath Lake, or enough water to augment river flows by about 200 cfs for 30 days. This volume of water may be useful for contributing flow during short-term events, but is not sufficient to allow substantial or long-term augmentation over inflows.

Based on our analysis in section 3.3.3.2.3*, Disease Management*, we conclude that development of an effective disease management plan may be essential to prevent the further decline of populations of fall Chinook salmon in the Klamath River Basin, and the potential spread of disease to other salmonid species. Two components that could be included in such a plan would be evaluating the use of high flow releases prior to the juvenile fall Chinook outmigration to reduce pathogen densities, and increasing flows during the migration season to reduce the density of pathogens, expedite fish movement, and reduce water temperatures during the juvenile fall Chinook outmigration season.

To evaluate what range of flows might be needed to reduce the incidence of disease-related losses of juvenile fall Chinook and other salmonids, we examined flow releases that were made from Iron Gate dam in years when substantial mortality of juvenile fall Chinook migrants have been reported (1997, 2000, 2002, 2004, and 2005), and compared these to average flows for these months from 1997 through 2006, and flows that have occurred in 2006 to date. We include 2006 because of the low incidence of disease that has been reported for 2006 through at least early June (True, 2006), which may be related to high flow conditions in 2006. Figure 3-77 shows average monthly flows for these years. Although we found little information in the record on disease incidence in 1997 and 2000, we include those years based on substantial mortality rates reported by Scheiff et al. (2001) during screw-trap sampling at Big Bar.

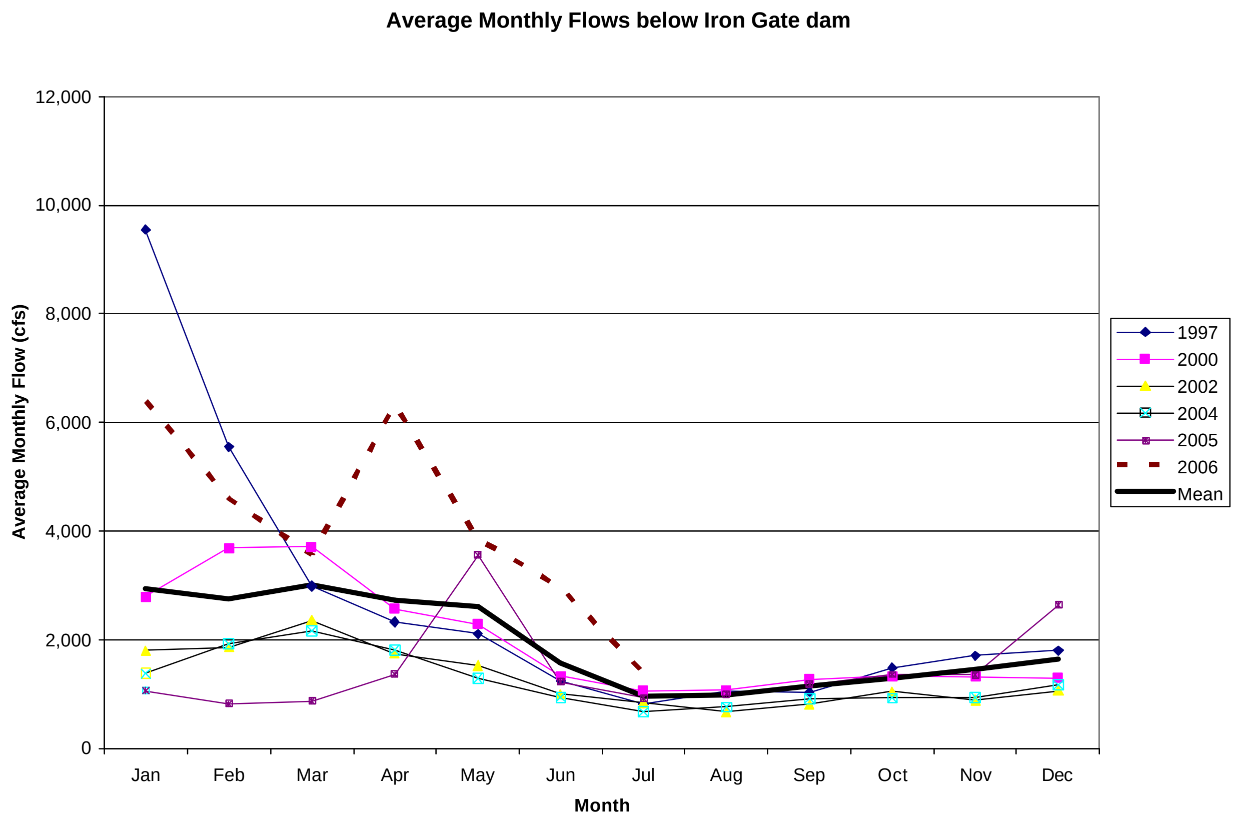


Figure 3-77. Average monthly flows below Iron Gate dam for 1997, 2000, 2002, 2004, 2005 and 2006 to date. (Source: Accessed on August 2, 2006, from http://waterdata.usgs.gov/nwis/sw [flows through September 2005] and http://www.usbr.gov/mp/kbao/operations/water/kopage.cfm [flows from October 2005 to July 2006])

In years where substantial juvenile mortality or disease incidence was reported (1997, 2000, 2002, 2004, and 2005), flows below Iron Gate dam were below the long-term average for nearly all months during the primary juvenile fall Chinook migration period (May through July). In 2006, flows during the outmigration period were substantially above average, remaining above 3,000 cfs through mid-June. Based on this information, we conclude that maintaining flows of 3,000 cfs or higher may assist with reducing disease-related losses of juvenile migrants in the lower river, which we view to be essential to preventing further decline of the fall Chinook fishery in the Klamath River. This risk appears to extend to fish produced in tributaries, based on the observed infection rates on fall Chinook emigrating from the Trinity River, which we discuss in section 3.3.3.2.3*, Disease Management*.

Maintaining flows on the order of 3,000 cfs is clearly beyond the flow volumes that can be provided using the active storage that is available in the project reservoirs. Accordingly, in section 3.3.3.2.3*, Disease Management,* we discuss the potential for PacifiCorp to develop a disease management plan in consultation with Reclamation and other stakeholders to consider opportunities for coordinating the use of available storage in the most effective manner possible.

Because of the limited storage capacity that is under PacifiCorp's control, we conclude that PacifiCorp's proposal to maintain the instream flow schedule below Iron Gate dam according to Reclamation's Klamath Irrigation Project Operations Plans is reasonable and appropriate, since Reclamation controls 97.5 percent of the storage. We see little benefit in Cal Fish & Game's recommendation that PacifiCorp use the active storage in Iron Gate reservoir to maintain target flows when inflows drop below their recommended monthly flow regime. The limited storage that is available in PacifiCorp's reservoirs would be most valuable for use during short-term emergencies when immediate flow releases are needed to avert impending fish losses based on observed increases in fish losses or adverse water quality conditions. Because of Iron Gate reservoir's proximity to the lower Klamath River, it could be used to augment flows more quickly in emergency situations than flows released from Upper Klamath Lake. These could include releases of cool water from the hypolimnion to provide some short-term cooling of flows below Iron Gate dam. The potential for using releases from the hypolimnion could be evaluated under the temperature management plan that we discuss in section 3.3.2.1.2, *Water Quality*.

We also see little benefit in Forest Service's recommendation that Iron Gate dam be operated as a run-of-river facility when inflows drop below their recommended flows or Oregon Fish & Wildlife's recommendation that Iron Gate dam should be generally operated as run-of-river. Iron Gate dam serves an important re-regulating function to smooth out flow fluctuations from peaking operations at the upstream J.C. Boyle and Copco developments. Implementing run-of-river operations at Iron Gate dam while continuing peaking operations at the upstream developments would result in substantial flow fluctuations downstream of Iron Gate dam; would violate ramping rates specified in the 2002 NMFS BiOp; and could adversely affect aquatic resources through fish stranding, reduced invertebrate production, disruption of spawning activity, and dewatering of salmon redds.

We also see little benefit in the recommendation made by NMFS and FWS that, with the exception of biologically based pulse releases, the project should be operated run-of-river with releases from Iron Gate dam equal the combined instantaneous inflow to the project including tributary inflow, spring accretion flow, irrigation return flows, and releases made from the Klamath Irrigation Project. Because irrigation return flows to Keno reservoir can vary by up to 775 cfs over a 24-hour period, this could result in substantial flow variations downstream of Iron Gate dam and violation of ramping rates specified in the NMFS 2002 BiOp.

Iron Gate Ramping Rates. The ramp rate restriction in the current license at Iron Gate dam is a maximum change of 3 inches per hour (as measured at the USGS gage downstream of the dam) or 250 cfs per hour, whichever is less, "provided that the licensee shall not be responsible for conditions beyond its control." Currently, ramp rates at Iron Gate are consistent with those specified in the 2002 NMFS BiOp. The rates are as follows: (1) decreases in flow to be 300 cfs or less per 24-hour period and not more than

125 cfs per 4-hour period when Iron Gate dam flows are above 1,750 cfs; and (2) decreases in flow to be of 150 cfs or less per 24-hour period and no more than 50 cfs per 2-hour period when Iron Gate dam flows are 1,750 cfs or less.

PacifiCorp proposes to maintain the instream flow schedule and ramp rates downstream of Iron Gate dam according to Reclamation's Klamath Irrigation Project Operations Plans consistent with the 2002 NMFS BiOp. NMFS also recommends the ramping rates specified in the 2002 NMFS BiOp.

Oregon Fish & Wildlife and FWS recommend the same ramp rates, except that, when flows are above 1,750 cfs, down-ramping would be limited to 125 cfs per hour instead of 125 cfs per 4 hours. Cal Fish & Game and Forest Service recommend that controllable ramp rates not exceed 1 inch per hour at any time.

Our Analysis

Down-ramping of flow has the potential to result in fish stranding, especially for fry and juvenile salmonids that favor shallow-water habitats along river margins. PacifiCorp reports that only one fish stranding incident has been documented downstream of Iron Gate dam, at a site about 20 miles downstream of Iron Gate dam.[58]

PacifiCorp reports that the ramp rates stipulated in the 2002 NMFS BiOp equate to about 0.4 inch per hour at the USGS gage (no. 11516530) about 0.5 mile below the dam. Based on 10 available cross sections between Iron Gate dam and Interstate 5 from Hardy and Addley (2001), PacifiCorp estimates that 0.4 inch per hour at the USGS gage equates to about 0.25 inch per hour in wider areas of the river where stranding potential would be greatest, and that ramping rates become further attenuated downstream.

Because fish stranding is rarely observed at current ramping rates (one reported incident), we conclude that the current rates specified in the 2002 NMFS BiOp appear to be protective of salmonids rearing and emigrating through the lower Klamath River. These rates are considerably more conservative than the ramping rates in effect at many other hydroelectric projects, and are equal to or more conservative than the ramping rates recommended by the agencies for this development. Although it is possible that less conservative ramping rates may be nearly as protective, the conservative ramp rates specified in the 2002 NMFS BiOp appear to be appropriate given the presence of federally listed coho salmon and the importance of the fall Chinook salmon fishery in the mainstem of the Klamath River. In addition, PacifiCorp has not reported any substantial operational difficulties or adverse economic effects related to compliance with the ramping rates specified in the NMFS 2002 BiOp.

<u>Outages and Maintenance Events</u>. PacifiCorp proposes and Oregon Fish & Wildlife and the Hoopa Valley Tribe recommend that PacifiCorp consult with state, federal, and tribal agencies to identify the preferred timing of facility maintenance for project-dewatered reaches. Scheduled maintenance should be planned to occur either (1) during high flow conditions so that resulting high flows would coincide with the high-flow period of the natural hydrograph identified by the agencies and to prevent water quality standard violations or (2) during the extreme low flow period when diversion canals will be at their lowest diversion rate and may already be shut down to meet minimum flow requirements. Any changes in flows would be subject to ramping rate requirements. Emergency maintenance may be conducted, if needed, but ramping rates would apply following unscheduled maintenance.

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[58]PacifiCorp reports that, in April 1998, an artificial spawning channel became isolated from the main river entrapping several hundred salmonid fry, mostly Chinook salmon, in three pools. The channel became isolated as main river flows declined from 4,363 to 1,987 cfs following a high flow event. The total drop in stage in the main river near the spawning channel site exceeded 3 feet. The average rate of flow decline during the 3-day period was 33 cfs per hour, which equates to a 0.4-inch per hour stage drop at the Iron Gate gage.

Our Analysis

Consultation with state, federal, and tribal agencies, as appropriate to identify the preferred timing of facility maintenance for project-dewatered reaches would be an effective means for the licensee to take advantage of resource agency knowledge about affected resources, and should help to minimize any adverse effects on aquatic resources. This recommendation would apply to shutdowns at East Side and West Side (if not decommissioned) and J.C. Boyle and Copco No. 2 developments, which may affect flows in bypassed reaches.

3.3.3.2.2 Fish Passage

Facility-specific Recommendations

Numerous stakeholders have expressed strong interest in restoring passage of anadromous fish to habitat within and upstream of the project area, either through implementing fish passage measures at project facilities or through dam removal. A successful fish passage program has the potential to increase fish production by allowing anadromous fish to use historical production areas within and upstream of the project and would provide access to important thermal refugia, most notably in the J.C. Boyle bypassed reach and in tributaries upstream of Upper Klamath Lake. We evaluate fish passage recommendations for each facility below. We evaluate the effects of dam removal on fish passage in section 3.3.3.2.4, *Dam Removal or Decommissioning*, and we compare alternative approaches for restoring anadromous fish to historic habitats in section 3.3.3.2.5, *Anadromous Fish Restoration*.

<u>East and West Side Developments</u>. PacifiCorp does not propose to provide passage for anadromous fish to any areas upstream of Iron Gate dam or to implement any fish passage measures associated with East and West Side developments. As we discuss in section 3.3.3.2.4, *Dam Removal or Decommissioning*, PacifiCorp proposes to decommission its East Side and West Side developments, and has proposed to exclude these facilities and Keno dam from the project.

NMFS and Interior prescribe that PacifiCorp design and construct fish screen and bypass facilities at East Side and West Side developments as close as possible to the beginning of each diversion canal to provide effective downstream passage for Chinook salmon, steelhead, Pacific lamprey, federally listed suckers, and redband trout. The facilities would divert all fish to a holding, sorting, counting, and tagging facility where fish would either be passed to a volitional fishway or into temporary, seasonal trap and haul facilities for downstream transport between June 15 and November 15. If agreed to by NMFS and FWS, trap and haul would not occur when DO is greater than 6 mg/L and temperature is lower than 15°C at Miller Island, located at RM 246 in Keno reservoir The screen and bypass facility would be operated year-round, designed in accordance with sucker criteria, and include provisions to return suckers to Upper Klamath Lake. NMFS and FWS also prescribe that PacifiCorp construct tailrace barriers and guidance systems within 3 years at the East Side and West Side powerhouses to protect adult fish. As we discuss later in this section, the joint NMFS/Interior prescription also includes the construction of volitional upstream and downstream fish passage facilities at the Keno, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams and the Spring Creek and Fall Creek diversions. Tailrace barriers are prescribed at all powerhouses except at Iron Gate dam. Cal Fish & Game and Oregon Fish & Wildlife both recommend that PacifiCorp install tailrace barriers at all project powerhouses, and evaluate the hydraulic and biological performance of each facility.

PacifiCorp filed an alternative to the joint NMFS/Interior fishway prescription, which includes trapping and hauling adult salmon and/or steelhead from Iron Gate dam to J.C. Boyle reservoir, and potentially to other locations in the upper basin. If fisheries managers decide that self-sustaining runs of anadromous fish can be established, a juvenile trap and haul facility would be constructed at or above J.C. Boyle dam, and smolts would be transported past the project reservoirs and released downstream of Iron Gate dam. We interpret PacifiCorp's alternative prescription to encompass possibly locating the smolt collection facility as far upstream of J.C. Boyle as Link River dam, at the East Side or West Side developments.

Our Analysis

Provision of passage for anadromous fish to areas upstream of Link River dam would provide access to a substantial amount of habitat in tributaries to Upper Klamath Lake, and to potential rearing habitat in spring-influenced sections of Upper Klamath Lake. Huntington (2006) estimates that there are 355.6 miles of existing stream habitat that is currently or was recently capable of supporting anadromous salmonids in tributaries to Upper Klamath Lake and another 70.4 miles that he considers to be recoverable within the next 30 to 50 years (table 3-66). Although much of this habitat has been degraded, substantial portions of the habitat in the Wood and Williamson river systems are considered to be in good conditions (Huntington et al., 2006), and habitat conditions are expected to improve over time, due to numerous ongoing restoration efforts in the upper basin (FWS, 2006c).

Table 3-66. Estimates of existing and recoverable anadromous fish habitat in tributaries to Upper Klamath Lake. (Source: Huntington, 2006, as modified by staff)

Location	Anadromous Fish Habitat (miles)	
	Existing	**Existing plus Recoverable**
Westside tributaries (including the Wood River and Seven mile Creek)	63.3	114.0
Williamson River system (excluding Sprague River)	30.4	30.4
Sprague River system	261.9	281.6
Total	355.6	426.0

Installation of downstream fish passage facilities at East Side and West Side developments, including facilities for trapping and transporting downstream migrating smolts, could facilitate any future efforts to restore upstream anadromous fish runs by allowing smolts to be collected and trucked to the lower river, thereby avoiding sources of mortality associated with passage through the section of the river that would be bypassed. DO levels in Keno reservoir typically diminish to stressful levels (less than 6 mg/L) by early July (figure 3-78), and analysis of water temperatures and DO levels conducted by Dunsmoor and Huntington (2006) indicates that thermal conditions in much of the river between Keno and Iron Gate dams are severely stressful to juvenile salmonids by the middle of June (tables 3-67 through 3-70). Collecting and transporting smolts past the project reservoirs would avoid mortality associated with locally poor water quality conditions, predatory fish in project reservoirs, and injuries while passing through multiple fish screening facilities. Transporting fish past the project reservoirs would be likely to reduce travel time, and could increase the number of smolts that pass through the lower river before water temperatures approach severely stressful levels. Speeding up juvenile outmigration would especially benefit fall Chinook salmon, which migrate downstream later in the season than spring Chinook salmon and steelhead. Releasing transported smolts as close to the estuary as possible also would reduce their exposure to pathogens, which seem especially prevalent in the first 10 or 20 miles downstream of Iron Gate dam (see section 3.3.3.2.3). We note, however, that juvenile and adult anadromous fish that are reintroduced to Upper Klamath Lake could be exposed to *C. shasta* in the basin upstream of Link River dam. Oregon State University (2004) found that the Williamson River, one of the key tributaries to Upper Klamath Lake where habitat is considered to be suitable for anadromous fish restoration, had the second-highest concentration of *C. shasta* of all of the sites that they sampled.

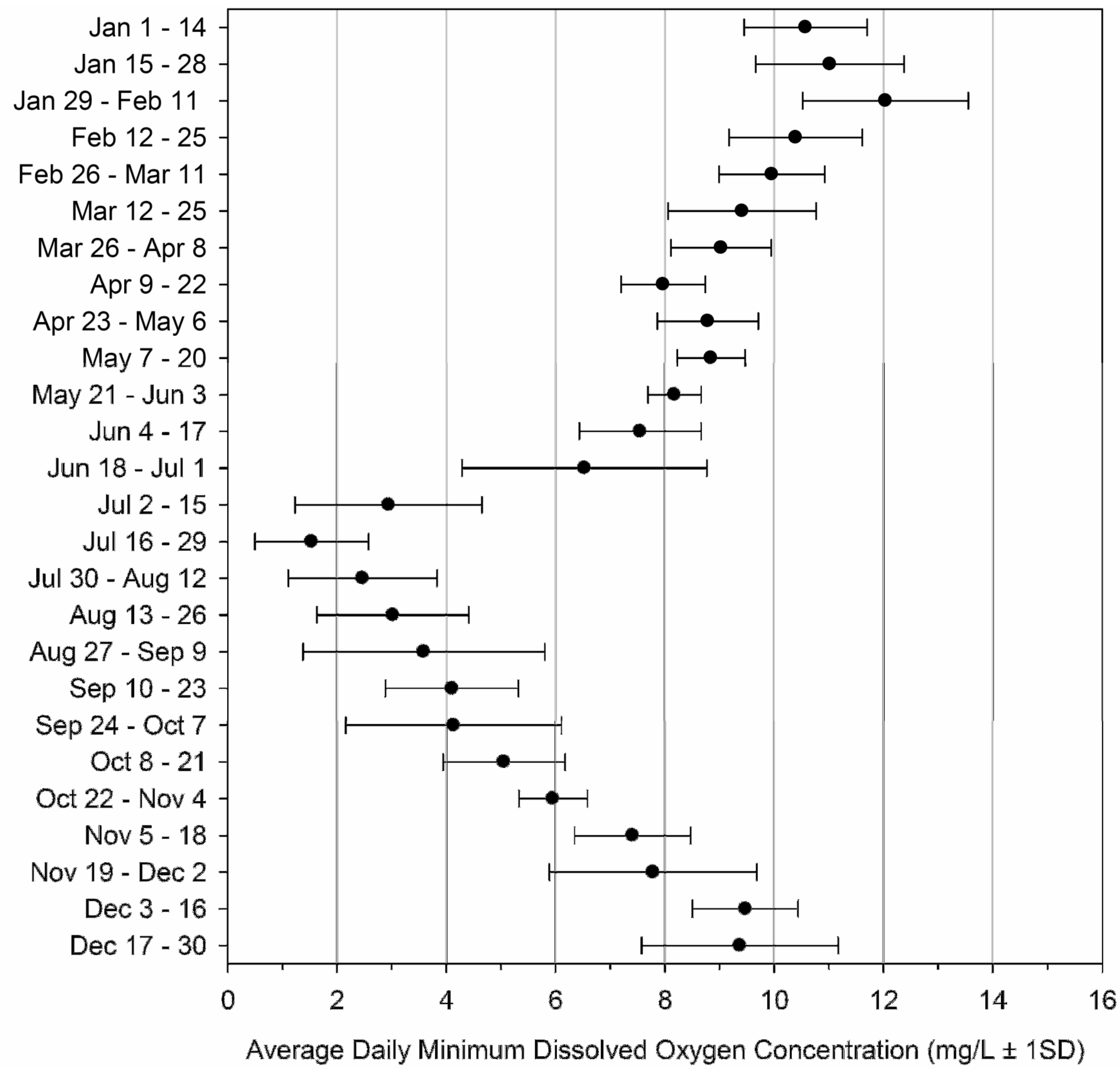

Figure 3-78. Daily minimum DO conditions in Keno reservoir. Daily minima calculated from hourly data and averaged over 1-3 sites in Keno reservoir from January 2002 – December 2004. Standard deviations calculated from daily averages. (Source: Dunsmoor and Huntington, 2006)

Table 3-67. Criteria for water temperature and DO concentration used to classify levels of stress for anadromous salmonids. Thresholds between the four levels of stress are averages of daily minima (7d-min), mean (7d-avg), or maxima (7d-max), calculated for the previous 7 days. (Source: Dunsmoor and Huntington, 2006)

			Upper threshold				Intermediate threshold				Lower threshold			
Constituent	Life stage	Condition	7d-min	7d-avg	7d-max	Condition	7d-min	7d-avg	7d-max	Condition	7d-min	7d-avg	7d-max	Condition
Water temperature (°C)	Adult migration (through July 31)	Optimal (OPT)[1]		16	18	Suboptimal (SUB)[2]		18	20	Stressful (STR)[3]		<2 or >20	21	Severely Stressful - refugial areas critical (SEV)[4]
	Adult migration (from Aug 1)			16	18			19	20			<2 or >21	22	
	Chinook juvenile rearing			15	16			18	21			21	23	
	Steelhead juvenile rearing			16	18			19	22			22	24	
Dissolved oxygen (mg/L)	All life stages		6	8			5.5				5			

[1] Optimal - conditions placing very little or no constraint on the life stage.

[2] Suboptimal - conditions that are mildly to moderately stressful unless there are significant ameliorating factors (e.g. presence of a highly abundant food supply for juvenile fish).

[3] Stressful - conditions that are moderately to severely stressful. Temperature becomes an increasingly critical factor affecting fish distribution, abundance, growth, and/or survival. Thermal refugia and/or ameliorating conditions are important under these conditions.

[4] Severely stressful - conditions under which fish survival is jeopardized to the extent that the ability to find spatial and/or temporal refuge is likely to be essential to fish presence. Fish migrations may be blocked, or fish may well be elsewhere, under these conditions.

Table 3-68. Thermal stress level for juvenile Chinook salmon based on temperature and DO levels predicted by the Klamath River water quality model. Values shown are the percentage of days falling within stress categories for each 2 week period based on simulations from 2000 to 2004. Stress categories are: OPT = optimal, SUB = suboptimal, STR = stressful, and SEV = severely stressful as determined using the criteria shown in table 3-67. (Source: Dunsmoor and Huntington, 2006, as modified by staff)

Keno to J.C. Boyle Powerhouse

Biweekly Period	Fall Chin. Juvenile Migration	At Keno Dam RM 232.86				Abv JC Boyle reservoir RM 227.57				At JC Boyle Dam RM 224.32				Abv JCB Powerhouse RM 220.20				Blw JCB Powerhouse RM 219.40			
		OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV
Apr 23 - May 6	Migration	90	10			80	20			91	9			100				97	3		
May 7 - 20	Peak migration	56	44			44	56			57	43			90	10			77	23		
May 21 - Jun 3	Peak migration	3	53	33	11		57	33	10	6	53	31	10	36	64			23	61	16	
Jun 4 - 17	Peak migration			76	24		1	76	23			79	21		100				71	29	
Jun 18 - Jul 1	Peak migration			31	69			33	67			44	56		100				51	46	3
Jul 2 - 15	Peak migration			14	86			4	96			14	86		100				16	70	14
Jul 16 - 29	Peak migration				100				100			1	99		100				1	56	43
Jul 30 - Aug 12	Migration				100				100			3	97		100				17	49	34
Aug 13 - 26	Migration				100				100			10	90		100				23	70	7
Aug 27 - Sep 9	Migration		3	31	66		4	23	73		4	57	39	6	94				71	29	
Sep 10 - 23	Migration		37	63			46	54			41	59		27	73			1	99		
Sep 24 - Oct 7	Migration	3	91	6			99	1		6	91	3		84	16			31	69		
Oct 8 - 21	Migration	71	29			60	40			80	20			100				96	4		
Oct 22 - Nov 4	Migration	100				100				100				100				100			

J.C. Boyle Powerhouse to above Shasta River

Biweekly Period	Fall Chin. Juvenile Migration	At State Line RM 209.16				Abv Copco Reservoir RM 203.61				At Copco Dam RM 198.57				At Iron Gate Dam RM 190.54				Above Shasta River RM 177.52			
		OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV
Apr 23 - May 6	Migration	80	20			77	23			100				100				100			
May 7 - 20	Peak migration	39	61			33	67			63	37			100				44	56		
May 21 - Jun 3	Peak migration		67	33			59	41		20	66	14		61	37	1		9	87	4	
Jun 4 - 17	Peak migration		36	46	19		37	43	20		40	60			64	36			50	50	
Jun 18 - Jul 1	Peak migration		7	41	51		4	61	34		6	93	1		30	70			3	74	23
Jul 2 - 15	Peak migration			17	83			19	81			41	59			100				1	99
Jul 16 - 29	Peak migration			10	90			13	87			9	91			59	41				100
Jul 30 - Aug 12	Migration			27	73			30	70			7	93			23	77				100
Aug 13 - 26	Migration			19	81			49	51			9	91			20	80				100
Aug 27 - Sep 9	Migration		17	54	29		19	63	19			50	50			43	57			33	67
Sep 10 - 23	Migration		99	1			90	10			4	96				97	3		6	77	17
Sep 24 - Oct 7	Migration	9	91			9	91				74	26			34	66			36	64	
Oct 8 - 21	Migration	76	24			77	23			34	66				100				99	1	
Oct 22 - Nov 4	Migration	100				100				100				90	10			79	21		

above Shasta River to above Salmon River

Biweekly Period	Fall Chin. Juvenile Migration	At Walker Bridge RM 156.79				Above Scott River RM 143.86				At Seiad Valley RM 129.04				Above Clear Creek RM 99.04				Above Salmon River RM 66.91			
		OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV
Apr 23 - May 6	Migration	100				100				97	3			100				100			
May 7 - 20	Peak migration	64	36			59	41			76	24			83	17			90	10		
May 21 - Jun 3	Peak migration	14	69	17		11	66	23		14	69	17		34	51	14		41	54	4	
Jun 4 - 17	Peak migration		47	53			50	50			74	26			89	11			90	10	
Jun 18 - Jul 1	Peak migration			90	10			81	19			86	14		24	63	13		24	60	16
Jul 2 - 15	Peak migration			34	66			26	74			53	47			67	33			67	33
Jul 16 - 29	Peak migration			6	94			3	97			4	96			17	83			24	76
Jul 30 - Aug 12	Migration			10	90			9	91			11	89			24	76			26	74
Aug 13 - 26	Migration			6	94			7	93			14	86			29	71			40	60
Aug 27 - Sep 9	Migration		1	44	54		3	44	53		3	43	54		4	56	40		4	60	36
Sep 10 - 23	Migration		10	90			11	79	10		13	79	9		23	59	19		34	46	20
Sep 24 - Oct 7	Migration		41	59			41	59			40	60		4	40	56		7	40	53	
Oct 8 - 21	Migration	23	76	1		13	84	3		27	70	3		30	67	3		40	57	3	
Oct 22 - Nov 4	Migration	94	6			90	10			93	7			93	7			96	4		

Migration
Peak migration

thermal conditions suboptimal at least 50% of the time
thermal conditions stressful at least 50% of the time
thermal conditions severely stressful at least 50% of the time (temperature refugia critical)

Table 3-69. Thermal stress level for juvenile steelhead based on temperature and DO levels predicted by the Klamath River water quality model. Values shown are the percentage of days falling within stress categories for each 2 week period based on simulations from 2000 to 2004. Stress categories are: OPT = optimal, SUB = suboptimal, STR = stressful, and SEV = severely stressful as determined using the criteria shown in table 3-67. (Source: Dunsmoor and Huntington, 2006, as modified by staff)

Keno to J.C. Boyle Powerhouse

Biweekly Period	Steelhead Juvenile Migration	At Keno Dam RM 232.86				Abv JC Boyle reservoir RM 227.57				At JC Boyle Dam RM 224.32				Abv JCB Powerhouse RM 220.20				Blw JCB Powerhouse RM 219.40			
		OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV
Apr 23 - May 6		97	3			99	1			99	1			100				100			
May 7 - 20		76	24			79	21			77	23			100				90	10		
May 21 - Jun 3		27	40	29	4	23	50	27		27	44	29		100				53	37	10	
Jun 4 - 17			21	63	16		34	49	17		24	61	14	83	17			3	77	20	
Jun 18 - Jul 1			3	60	37		7	41	51		4	70	26	63	37				79	21	
Jul 2 - 15				19	81			14	86			21	79	21	79				26	73	1
Jul 16 - 29				3	97				100			16	84	11	89				30	49	21
Jul 30 - Aug 12				6	94				100			16	84	27	73				36	53	11
Aug 13 - 26				23	77			7	93			43	57	53	47				60	40	
Aug 27 - Sep 9			6	90	4		7	63	30		7	91	1	99	1			4	96		
Sep 10 - 23			71	29			74	26		6	74	20		100				47	53		
Sep 24 - Oct 7		30	67	3		13	87			41	59			100				97	3		
Oct 8 - 21		93	7			87	13			96	4			100				100			
Oct 22 - Nov 4		100				100				100				100				100			

J.C. Boyle Powerhouse to above Shasta River

Biweekly Period	Steelhead Juvenile Migration	At State Line RM 209.16				Abv Copco Reservoir RM 203.61				At Copco Dam RM 198.57				At Iron Gate Dam RM 190.54				Above Shasta River RM 177.52			
		OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV
Apr 23 - May 6		97	3			97	3			100				100				100			
May 7 - 20		79	21			74	26			93	7			100				100			
May 21 - Jun 3		20	64	16		13	59	29		54	40	6		80	20			41	59		
Jun 4 - 17			70	16	14		73	13	14		76	24		23	76	1			97	3	
Jun 18 - Jul 1			27	51	21		29	49	23		34	66			63	37			33	61	6
Jul 2 - 15			3	34	63		4	34	61		3	96	1		13	87				54	46
Jul 16 - 29				39	61		6	31	63			59	41			93	7			6	94
Jul 30 - Aug 12			6	40	54		13	37	50			39	61			61	39			4	96
Aug 13 - 26			1	71	27		4	81	14			51	49			70	30			9	91
Aug 27 - Sep 9		1	36	63		3	43	54				99	1			100			1	47	51
Sep 10 - 23		13	87			19	81				46	54			10	90			19	81	
Sep 24 - Oct 7		63	37			53	47				97	3			87	13			84	16	
Oct 8 - 21		97	3			99	1			66	34			30	70			41	59		
Oct 22 - Nov 4		100				100				100				100				100			

above Shasta River to above Salmon River

Biweekly Period	Steelhead Juvenile Migration	At Walker Bridge RM 156.79				Above Scott River RM 143.86				At Seiad Valley RM 129.04				Above Clear Creek RM 99.04				Above Salmon River RM 66.91			
		OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV	OPT	SUB	STR	SEV
Apr 23 - May 6		100				100				100				100				100			
May 7 - 20		99	1			97	3			84	16			96	4			100			
May 21 - Jun 3		34	63	3		33	60	7		59	27	14		64	36			66	34		
Jun 4 - 17			86	14			90	10		1	90	9		14	81	4		14	81	4	
Jun 18 - Jul 1			20	77	3		17	76	7		27	67	6		47	50	3		50	47	3
Jul 2 - 15				71	29			64	36			73	27			77	23		4	74	21
Jul 16 - 29				26	74			10	90			26	74			54	46			66	34
Jul 30 - Aug 12				26	74			26	74			26	74		4	33	63		4	34	61
Aug 13 - 26				46	64			39	61			49	51		4	66	30		4	69	27
Aug 27 - Sep 9			10	60	30		13	54	33		14	61	24		17	70	13		19	69	13
Sep 10 - 23			34	66			41	59			44	56		1	50	49		1	59	37	3
Sep 24 - Oct 7		6	73	21		7	67	26		9	64	27		9	69	23		9	70	21	
Oct 8 - 21		66	34			67	33			69	31			71	27	1		73	26	1	
Oct 22 - Nov 4		100				100				100				100				100			

Migration

thermal conditions suboptimal at least 50% of the time

thermal conditions stressful at least 50% of the time

thermal conditions severely stressful at least 50% of the time (temperature refugia critical)

Table 3-70. Thermal stress level for adult anadromous salmonids based on temperature and DO levels predicted by the Klamath River water quality model. Values shown are the percentage of days falling within stress categories for each 2 week period based on simulations from 2000 to 2004. Stress categories are: OPT = optimal, SUB = suboptimal, STR = stressful, and SEV = severely stressful as determined using the criteria shown in table 3-67. (Source: Dunsmoor and Huntington, 2006, as modified by staff)

Keno to J.C. Boyle Powerhouse

Biweekly Period	Adult Migration: fall Chin	spr Chin	sthd	coho	At Keno Dam RM 232.86: OPT	SUB	STR	SEV	Abv JC Boyle reservoir RM 227.57: OPT	SUB	STR	SEV	At JC Boyle Dam RM 224.32: OPT	SUB	STR	SEV	Abv JCB Powerhouse RM 220.20: OPT	SUB	STR	SEV	Blw JCB Powerhouse RM 219.40: OPT	SUB	STR	SEV
Apr 23 - May 6		Migration			90	10			80	20			91	9			100				97	3		
May 7 - 20		Migration			56	44			44	56			57	43			90	10			77	23		
May 21 - Jun 3		Migration			3	53	33	11		57	33	10	6	53	31	10	36	64			23	61	16	
Jun 4 - 17		Migration					76	24		1	76	23			79	21		100				71	29	
Jun 18 - Jul 1		Migration					31	69			33	67			44	56		100				51	46	3
Jul 2 - 15		Migration					14	86			4	96			14	86		100				16	70	14
Jul 16 - 29		Migration						100				100			1	99		100				1	56	43
Jul 30 - Aug 12		Migration						100				100			3	97		100				17	49	34
Aug 13 - 26	Migration	Migration						100				100			10	90		100				23	70	7
Aug 27 - Sep 9	Migration	Migration				3	31	66		4	23	73		4	57	39	6	94				71	29	
Sep 10 - 23	Peak migration					37	63			46	54			41	59		27	73			1	99		
Sep 24 - Oct 7	Peak migration		Migration		3	91	6			99	1		6	91	3		84	16			31	69		
Oct 8 - 21	Peak migration		Migration	Migration	71	29			60	40			80	20			100				96	4		
Oct 22 - Nov 4	Peak migration		Migration	Migration	100				100				100				100				100			

J.C. Boyle Powerhouse to above Shasta River

Biweekly Period	Adult Migration: fall Chin	spr Chin	sthd	coho	At State Line RM 209.16: OPT	SUB	STR	SEV	Abv Copco Reservoir RM 203.61: OPT	SUB	STR	SEV	At Copco Dam RM 198.57: OPT	SUB	STR	SEV	At Iron Gate Dam RM 190.54: OPT	SUB	STR	SEV	Above Shasta River RM 177.52: OPT	SUB	STR	SEV
Apr 23 - May 6		Migration			80	20			77	23			100				100				100			
May 7 - 20		Migration			39	61			33	67			63	37			100				100			
May 21 - Jun 3		Migration				67	33			59	41		20	66	14		80	19	1		41	43	16	
Jun 4 - 17		Migration				36	46	19		37	43	20		40	60		23	41	36			37	44	19
Jun 18 - Jul 1		Migration				7	41	51		4	61	34		6	93	1		30	70				4	96
Jul 2 - 15		Migration					17	83			19	81			41	59			53	47				100
Jul 16 - 29		Migration					10	90			13	87			9	91				100				100
Jul 30 - Aug 12		Migration					27	73			30	70			7	93			14	86				100
Aug 13 - 26	Migration	Migration					19	81			49	51			9	91			20	80				100
Aug 27 - Sep 9	Migration	Migration				17	54	29		19	63	19			50	50			43	57			13	87
Sep 10 - 23	Peak migration					99	1			90	10			4	96			10	87	3		3	44	53
Sep 24 - Oct 7	Peak migration		Migration		9	91			9	91				74	26			87	13			29	70	1
Oct 8 - 21	Peak migration		Migration	Migration	76	24			77	23			34	66			30	70			41	56	3	
Oct 22 - Nov 4	Peak migration		Migration	Migration	100				100				100				100				100			

above Shasta River to above Salmon River

Biweekly Period	Adult Migration: fall Chin	spr Chin	sthd	coho	At Walker Bridge RM 156.79: OPT	SUB	STR	SEV	Above Scott River RM 143.86: OPT	SUB	STR	SEV	At Seiad Valley RM 129.04: OPT	SUB	STR	SEV	Above Clear Creek RM 99.04: OPT	SUB	STR	SEV	Above Salmon River RM 66.91: OPT	SUB	STR	SEV
Apr 23 - May 6		Migration			100				100				100				100				100			
May 7 - 20		Migration			99	1			97	3			84	16			96	4			100			
May 21 - Jun 3		Migration			34	49	17		33	44	20	3	59	24	4	13	64	21	14		66	30	4	
Jun 4 - 17		Migration				47	53			47	50	3	1	73	19	7	14	74	11		14	76	10	
Jun 18 - Jul 1		Migration					66	34			20	80			40	60		24	27	49		24	37	39
Jul 2 - 15		Migration						100				100				100			7	93			17	83
Jul 16 - 29		Migration						100				100				100				100				100
Jul 30 - Aug 12		Migration					4	96			3	97			4	96			11	89			14	86
Aug 13 - 26	Migration	Migration						100			3	97			4	96			14	86			20	80
Aug 27 - Sep 9	Migration	Migration				10	31	59		3	21	76		9	21	70		9	34	57		13	43	44
Sep 10 - 23	Peak migration					26	74			13	54	33		23	49	29	1	37	27	34	1	46	21	31
Sep 24 - Oct 7	Peak migration		Migration		6	73	21		7	41	50	1	9	53	39		9	51	39	1	9	59	31	1
Oct 8 - 21	Peak migration		Migration	Migration	66	34			67	31	1		69	30	1		71	27	1		73	26	1	
Oct 22 - Nov 4	Peak migration		Migration	Migration	100				100				100				100				100			

Migration
Peak migration

thermal conditions suboptimal at least 50% of the time
thermal conditions stressful at least 50% of the time
thermal conditions severely stressful at least 50% of the time (temperature refugia critical)

Installation of fish screens at East Side and West Side developments could protect juvenile and adult suckers from mortality that may be caused during turbine passage. The survival rate of larval suckers, however, could be reduced if fish screens are installed. Because of the small size and fragility of fish in their larval lifestage, there may be a substantial risk of impingement and mortality of larval fish that are entrained into a fish screening facility. The same risk is present for migrating immature lamprey, which are poor swimmers and have been found to be susceptible to impingement on fish screens, especially at higher velocities (Moursund et al., 2000). Constructing a screening facility that would reduce the risk of impingement for larval suckers and juvenile lamprey could substantially increase the footprint of the facility, thus increasing potential environmental effects during construction. To our knowledge, proven criteria for safely screening these life stages have not yet been developed.

The ability of juvenile anadromous salmonids to successfully rear and emigrate through Upper Klamath Lake is a critical uncertainty that needs to be addressed before the benefits of installing downstream fish passage facilities at East Side and West Side developments can be fully assessed. Based on an assessment of water quality monitoring conducted from 1990 to 2004, Dunsmoor and Huntington (2006) conclude that water quality conditions in Upper Klamath Lake are adequate to support anadromous fish migration during the spring months into early June. Conditions in the main body of the lake become too warm to support salmonids in mid-summer, but conditions become suitable again between mid-August and early September. They note, however, that the available monitoring data has been collected to the west of what they consider the most likely migratory route for juvenile salmonids; a band of water along the eastern shoreline where currents helpful to fish migration are present. We discuss approaches for addressing this uncertainty in section 3.3.3.2.5, *Anadromous Fish Restoration*.

Another uncertainty to be addressed before installing facilities to provide passage for anadromous salmonids at any of the mainstem developments is the future condition of the migratory corridor downstream of Iron Gate dam. As we discuss in section 3.3.3.2.3, *Disease Management*, continuation of current warming trends in the basin would be likely to exacerbate conditions that are causing substantial losses of juvenile fall Chinook during the outmigration season, and that caused the major die-off of adult anadromous salmonids that occurred in September 2002. In the same section, we evaluate measures that could help to alleviate disease-related fish losses in the downstream migratory corridor. High water temperatures and low DO levels within and downstream of the project are particularly problematic for fall Chinook salmon, since their upstream and downstream migration period overlaps with the summer period when stressful conditions are most severe (tables 3-68 and 3-70).

With regard to Cal Fish & Game and Oregon Fish & Wildlife's recommendation to install tailrace barriers at all project powerhouses and NMFS/Interior's prescription to install tailrace barriers at most developments including East Side and West Side, none of the agencies have provided any specific evidence of injury or migration delay of upstream migrating fish that would indicate the need for a tailrace barrier at any of the project powerhouses. We conclude that the potential need for and benefits of installing tailrace barriers cannot be fully assessed at this time. If and when passage of adult anadromous fish to any project reaches is provided, radio telemetry studies could be used to determine the ability of upstream migrating adults to negotiate river reaches and passage facilities on their migration route to suitable spawning and rearing habitats. These studies could be used to determine whether delayed migration occurs from attraction of fish to powerhouse outflows or whether any injuries are caused to fish that enter turbine draft tubes. If such delays or injuries are observed, construction of a tailrace barrier may be warranted.

Keno Development. PacifiCorp has not proposed to implement any fish passage measures associated with Keno dam. PacifiCorp proposes to continue current operations, which we assume would include continued operation of the existing fish ladder, but the dam would be operated under the jurisdiction of the state of Oregon.

Cal Fish & Game recommends that PacifiCorp equip all project dams with volitional upstream passage facilities within 6 years. The fishways would be designed in consultation with the management agencies and tribes to operate year-round and to provide for uninterrupted passage of fish over the full range of river flows under which PacifiCorp has control. Oregon Fish & Wildlife and the Hoopa Valley Tribe recommend that PacifiCorp design and construct a fish ladder at Keno dam with a maximum gradient of 4 percent, two entrances, a screened auxiliary water system, and provisions for visual monitoring or a fish trap and counting system. Oregon Fish & Wildlife recommends that the ladder be constructed within 3 years, and the Hoopa Valley Tribe recommends that the ladder be constructed within 5 years.

Cal Fish & Game also recommends that all project spillways be modified in consultation with the management agencies to improve downstream passage within 6 years, including a post-construction performance evaluation. Oregon Fish & Wildlife recommends that PacifiCorp prepare a biological evaluation plan to determine whether spillway modifications are necessary at Keno dam and implement any needed modifications within 4 years.

NMFS and Interior prescribe that PacifiCorp modify the existing fish ladder at Keno dam to accommodate passage for Chinook and coho salmon, steelhead, and Pacific lamprey, including a screened auxiliary water system that provides forebay water of the correct water quality and quantity to effectively attract fish. The facility would include a holding and sorting facility to accommodate seasonal trap and haul for anadromous salmonids. NMFS and Interior also prescribe that PacifiCorp evaluate and implement spillway modifications to improve downstream passage for the same species listed for upstream passage.

Our Analysis

Provision of upstream passage at Keno dam as part of a future restoration effort could provide access to 20.1 miles of reservoir habitat and 1.2 miles of riverine habitat between the Keno and Link River dams. Much of this habitat, however, has been channelized, and suffers from very poor water quality conditions including extremely low DO levels from July through September (see figure 3-78). As a result of the poor water quality conditions, the habitat between Keno and Link River dams currently has little potential for producing anadromous fish and would seasonally create a barrier for anadromous fish passage. The existing fish ladder at Keno dam does not meet current agency criteria, and its ability to pass anadromous fish species is unknown, since anadromous fish were blocked from the area when Copco No. 1 dam was built in 1918, before the Keno dam and fish ladder were constructed.

Installation of a fish ladder with a gradient of 4 percent, as recommended by Oregon Fish & Wildlife and the Hoopa Valley Tribe, would facilitate upstream passage for sucker species, including the federally listed shortnose and Lost River suckers. However, provision of upstream passage over Keno dam would expose upstream migrating suckers to some of the worst water quality conditions in the basin, where DO can drop to lethal levels during the summer months. Other methods of returning suckers to Upper Klamath Lake, such as transporting suckers collected in any downstream fish passage facilities that may be constructed at downstream developments, could involve less risk of mortality. There may also be a conservation benefit provided by allowing suckers that emigrate downstream from Upper Klamath Lake as juveniles to grow to maturity in the reservoirs where they take up residence. Both of the listed species are long-lived (20+ years), and the existence of some adult fish in the downstream reservoirs could serve as a source of broodstock if they are needed for future restoration efforts. Given the occurrence of several massive fish kills in Upper Klamath Lake that resulted in federal listing of the Lost River and shortnose suckers (FWS, 2002), there is some risk that a population collapse could occur.

Installing a lower gradient fish ladder at Keno dam also could improve passage for redband trout. However, redband trout residing in the Keno reach have access to suitable spawning habitat in Spencer

Creek, and improving passage over Keno dam would provide little benefit to trout in the Keno reach because there is little known spawning or rearing habitat between the Keno and Link River dams.

Evaluating spillway passage at Keno dam and implementing any changes that are needed to improve downstream passage survival could improve the survival of listed suckers that emigrate downstream past Keno dam, and has the potential to improve the downstream passage survival of anadromous fish if they are restored upstream of Upper Klamath Lake. Even if fish screens were to be installed at the East Side and West Side facilities, and these were used to collect smolts for downstream transport, some fish would bypass the screens when river flows exceed the hydraulic capacity of East Side and West Side developments (1,450 cfs combined) and spills occur at Link River dam. These fish could then be subject to injury when the pass under the spillway gates at Keno dam, especially when the gates are held at narrow openings.

J.C. Boyle Development. PacifiCorp proposes to make minor modifications to the existing fish ladder at J.C. Boyle dam to improve passage, including increasing the bar spacing of the trashrack at the fishway exit pool to facilitate the passage of adult fish and adding a weir to the fishway entrance pool to decrease the height of the existing step. PacifiCorp also proposes to provide downstream fish passage at J.C. Boyle by installing a barrier net, a fish collection device known as a gulper, and a bypass pipe that would deliver collected fish to the river downstream of the dam.

As previously described, Cal Fish & Game recommends that PacifiCorp construct volitional upstream fishways and volitional downstream passage facilities, and modify spillways to improve downstream passage survival at all project dams within 6 years. Cal Fish & Game and Oregon Fish & Wildlife both recommend that PacifiCorp install tailrace barriers at all project powerhouses within 8 years, and evaluate the hydraulic and biological performance of each facility.

Oregon Fish & Wildlife and the Hoopa Valley Tribe recommend that PacifiCorp design and construct a new fish ladder at J.C. Boyle dam with a maximum gradient of 10 percent, two entrances, a screened auxiliary water system, and provisions for visual monitoring or a fish trap and counting system. Oregon Fish & Wildlife recommends that the ladder be constructed within 3 years, and the Hoopa Valley Tribe recommends that the ladder be constructed within 5 years.

Oregon Fish & Wildlife and the Hoopa Valley Tribe recommend that PacifiCorp construct a downstream fish passage facility at J.C. Boyle dam that would operate year-round. Screens would divert fish to a sorting facility, where federally listed suckers would be removed and returned to the J.C. Boyle reservoir on a daily basis, with downstream migrants to be delayed no longer than 8 hours with the exception that fish captured at night would be released at night and fish captured in daylight would be released in daylight. Oregon Fish & Wildlife recommends that the facility be constructed within 4 years, and the Hoopa Valley Tribe recommends that the facility be constructed within 5 years

NMFS and Interior prescribe that PacifiCorp construct a fish ladder to accommodate upstream passage for Chinook and coho salmon, steelhead, Pacific lamprey, and redband trout at J.C. Boyle dam within 4 years. The ladder would include a screened auxiliary water system that provides forebay water of the correct water quality and quantity to effectively attract fish. The ladder would have a maximum drop between pools of 0.5 feet and a slope not to exceed 10 percent. The ladder entrance would be located downstream of the fish screen bypass outfall and of the existing velocity barrier[59] below the existing fish ladder. NMFS and Interior also prescribe that a fish screen and bypass facility designed to meet NMFS screening criteria for the same species, and a tailrace barrier and guidance system be constructed, and that the spillway be modified to improve downstream passage within 4 years. In

[59]The area considered to be a possible barrier to fish migration due to high water velocity is a short, high gradient section of the stream located just downstream of the entrance to the existing fish ladder.

addition, NMFS and Interior prescribe that within 2 years, PacifiCorp should remove the potential fish barrier in the J.C. Boyle bypassed reach that was created by boulders which entered the stream channel during construction of the canal and road, about 2.5 miles upstream of the J.C. Boyle powerhouse.

PacifiCorp's alternative to the joint NMFS/Interior fishway prescription includes a provision to construct an adult trap and haul facility at Iron Gate dam that would be used to collect and transport adult anadromous fish to locations upstream of J.C. Boyle dam or at another location in the upper Klamath basin. If fisheries managers decide that self-sustaining runs of anadromous fish can be established, a juvenile trap and haul facility would be constructed at or above J.C. Boyle dam, and smolts would be transported past the project reservoirs.

Our Analysis

Provision of upstream passage for anadromous fish at J.C. Boyle dam as part of a future restoration effort could provide access to 4.7 miles of mainstem habitat in the Keno reach and about 15 miles of habitat in Spencer Creek. Although the Keno reach supports a good quality trout fishery, its ability to support production of anadromous salmonids is probably limited by the warm temperature and low DO content of water that enters the reach from Keno reservoir.[60] Aquatic habitat in Spencer Creek, however, is reported to be in good condition and has the potential to support coho salmon and other anadromous salmonids. PacifiCorp (2006a) reports that Spencer Creek contains abundant spawning habitat and excellent rearing conditions for coho salmon, providing more than three times the amount of rearing habitat, based on low-flow rearing area, than the combined area available in the tributaries between J.C. Boyle and Iron Gate dams (Jenny, Fall, and Shovel creeks). The existing fish ladder at J.C. Boyle dam does not meet current agency criteria, and its ability to pass anadromous fish species is unknown, since anadromous fish were blocked from the area when Copco No. 1 dam was built in 1918, before J.C. Boyle dam and fish ladder were constructed.

Improving or replacing the existing fish ladder at J.C. Boyle dam would also allow redband trout from below J.C. Boyle dam to better migrate past the dam and access additional spawning habitat in Spencer Creek. However, trout downstream of J.C. Boyle dam in the bypassed and peaking reaches have access to suitable spawning habitat in Shovel and Negro creeks and in the J.C. Boyle bypassed reach, and PacifiCorp has proposed and others recommend measures that should improve fry recruitment in both of these areas. These measures include augmenting gravel in the bypassed reach and screening or eliminating irrigation diversions in Shovel and Negro creeks. Although improving passage at the dam would benefit redband trout populations by increasing connectivity and genetic exchange, there is no indication that population levels of redband trout in either reach have declined due to a lack of access to appropriate spawning and rearing habitat, and both reaches support quality trout fisheries.

The sidecast boulders that NMFS/Interior prescribe to be removed from the J.C. Boyle bypassed reach form a barrier in the river that is likely to block or at least impede upstream passage of fish at existing flows (figure 3-79), and it likely impedes the transport of gravel to the lower half of the bypassed reach. Removing the barrier would increase the transport of gravel to the lower part of the reach, improving spawning habitat in that area, and facilitate passage of redband trout through the reach to access spawning and rearing habitat and the portion of the spring-water fed thermal refugia that are upstream of the sidecast barrier. If passage of anadromous fish to this section of the river is restored, removing the barrier would also improve access for anadromous fish to the thermal refuge in the spring-fed section of the bypassed reach and to upstream passage facilities at J.C. Boyle dam.

[60]Redband trout are more tolerant of high water temperatures than most other salmonids, and conditions in the Keno reach during the summer months appear to be stressful even for redband trout.

Figure 3-79. Potential fish passage and gravel transport barrier formed by boulder sidecast material in the J.C. Boyle bypassed reach, approximately 2.5 miles upstream of the J.C. Boyle powerhouse. (Source: Staff)

The existing fish screen at the J.C. Boyle development does not meet current agency screening criteria, and based on the results of PacifiCorp's radio telemetry studies and collection of trout behind the screens when the canal is dewatered; it does not prevent fish from being entrained into the power canal. Installing an effective screening facility at J.C. Boyle dam could contribute to the restoration of anadromous fish to areas upstream of the dam by eliminating losses that would occur during turbine passage and by providing a means to collect and transport smolts downstream past the project, bypassing additional sources of mortality including predation, losses caused by poor water quality, and dam passage, and potentially limiting their exposure to disease pathogens if they are released close to the estuary. Even if smolt collection facilities were to be installed at East Side and West Side developments and smolts collected at Link River dam are transported downstream, constructing another facility at J.C. Boyle would allow smolts to be collected over a wider range of flows because of the greater hydraulic capacity at J.C. Boyle (3,000 cfs) compared to East Side and West Side developments (1,450 cfs combined). A collection facility at J.C. Boyle could also be used to collect smolts that are produced in Spencer Creek and in the Keno reach.

Installation of a fish screen at J.C. Boyle could protect juvenile and adult suckers from mortality that may be caused during turbine passage, but as discussed previously, losses of larval suckers and juvenile lamprey from impingement may occur if velocities exceed their swimming ability, and to our knowledge, reliable criteria for safely screening these life stages have not yet been developed.

We do not consider installing a barrier net and gulper, as proposed by PacifiCorp, to be a viable option for providing downstream passage at J.C. Boyle development. Given the high primary productivity of project waters during the summer growth season, algae growth would rapidly clog the net and lead to its damage or submergence, which would reduce its effectiveness in precluding fish from being entrained into the powerhouse intake.

Evaluating spillway passage and implementing changes needed to improve downstream passage survival could improve the survival of listed suckers that emigrate downstream from J.C. Boyle reservoir during spill periods, and has the potential to improve the downstream passage survival of anadromous fish if they are restored to areas upstream of J.C. Boyle dam. However, the potential benefit from improving the spillway at J.C. Boyle is limited by a low frequency of spills at that reservoir (see table 3-18). In addition, the benefit to anadromous fish could be further limited by low survival rates that may be experienced by fish that migrate in-river through the downstream developments. Even if fish passage facilities designed to meet current agency criteria were installed at Copco No. 2, Copco No. 1, and Iron Gate dams, cumulative losses during passage through these developments associated with poor water quality, predation, and injuries sustained during passage could be substantial.

Regarding Cal Fish & Game and Oregon Fish & Wildlife's recommendation to install tailrace barriers at all project powerhouses, and NMFS/Interior's prescription to install tailrace barriers at most developments including J.C. Boyle, we again conclude that the potential need for and benefits of installing tailrace barriers cannot be fully assessed at this time. If and when passage of adult anadromous fish to any project reach is provided, radio telemetry studies could be used to determine whether delayed migration occurs from attraction of fish to powerhouse outflows or whether any injuries are caused to fish that enter turbine draft tubes. If such delays or injuries are observed, construction of a tailrace barrier may be warranted.

<u>Copco Nos. 1 and 2 Developments</u>. PacifiCorp has not proposed to implement any fish passage measures associated with Copco No. 1 or Copco No. 2 dams.

As previously described, Cal Fish & Game recommends that PacifiCorp construct volitional upstream fishways, volitional downstream passage facilities, and modify spillways to improve downstream passage survival at all project dams within 6 years. Cal Fish & Game and Oregon Fish & Wildlife both recommend that PacifiCorp install tailrace barriers at all project powerhouses within 8 years, and evaluate the hydraulic and biological performance of each facility.

Oregon Fish & Wildlife and the Hoopa Valley Tribe recommend that PacifiCorp design and construct fish ladders at Copco No. 1 and Copco No. 2 dams that meet applicable criteria for Chinook and coho salmon, steelhead, Pacific lamprey, and redband trout and include provisions for visual monitoring or a fish trap and counting system. Oregon Fish & Wildlife recommends that the ladders be constructed within 6 years, and the Hoopa Valley Tribe recommends that the ladders be constructed within 5 years.

Oregon Fish & Wildlife and the Hoopa Valley Tribe recommend that PacifiCorp construct downstream fish passage facilities at Copco No. 1 and Copco No. 2 dams that would operate year-round. The recommended facilities would include a trap for evaluating screen performance and accommodating long-term monitoring of downstream migrants. Oregon Fish & Wildlife recommends that the facilities be constructed within 6 years, and the Hoopa Valley Tribe recommends that the facility be constructed within 5 years.

FWS and NMFS prescribe that PacifiCorp construct fish ladders to accommodate upstream passage for Chinook and coho salmon, steelhead, Pacific lamprey and redband trout at Copco No. 1 and Copco No. 2 dams within 6 years. The ladders would include screened auxiliary water systems that provide forebay water of the correct water quality and quantity to effectively attract fish. The ladders would have a maximum drop between pools of 0.5 feet and a slope not to exceed 10 percent. FWS and NMFS also prescribe that fish screen and bypass facilities designed to meet NMFS screening criteria for the same species be constructed and that the spillways be modified at both dams to improve downstream passage within 6 years. FWS and NMFS also prescribe that tailrace barriers and guidance systems be constructed at both dams within 8 years. In addition, FWS and NMFS prescribe that PacifiCorp evaluate and develop a construction plan within 1 year to modify a bedrock sill in the Copco No. 2 bypassed reach to improve fish passage. The sill is located about 0.5 miles upstream of the Copco No. 2 powerhouse.

Our Analysis

Provision of upstream passage for anadromous fish at Copco No. 1 dam as part of a future restoration effort could provide access to 4.5 miles of reservoir habitat, 17.3 miles of mainstem riverine habitat in the J.C. Boyle peaking reach, about 3.3 miles of tributary habitat in Shovel Creek, 0.75 miles of tributary habitat in Long Pine Creek, and 4.3 miles of riverine habitat in the J.C. Boyle bypassed reach. Providing upstream passage over the Copco No. 2 dam would provide access to 0.3 miles of reservoir habitat between the Copco No. 1 and Copco No. 2 dams.

Providing fish passage over Copco No. 1 dam could provide anadromous fish with access to the substantial thermal refugium created by about 220 to 250 cfs of spring flow accretion in the J.C. Boyle bypassed reach. This refugium could be especially important for spring Chinook and summer steelhead, which would benefit from the presence of cold pools to hold in during the summer months prior to spawning.

Although there are few redband trout in the Copco No. 2 bypassed reach that would benefit from implementing fish passage at the Copco No. 1 or Copco No. 2 dams, populations could increase if minimum flows are increased in the Copco No. 2 bypassed reach. However, because water temperatures in Copco reservoir are above optimal for salmonids for much of the year, we would not expect a substantial increase in the trout population, which limits the potential benefit of implementing fish passage for resident redband trout.

Evaluating and possibly modifying the bedrock sill in the Copco No. 2 bypassed reach would help ensure that the bypassed reach is passable, which would be important if access to this reach is restored for anadromous fish. Based on the well-documented occurrence of anadromous fish upstream of the Copco dams (Hamilton et al., 2005), it is clear that the bypassed reach was passable to anadromous fish under the historical flow conditions prior to project construction. If this feature is determined to be a barrier at the minimum instream flows that would be implemented in the new license, modifying the sill to enable passage over the expected range of flows would improve passage conditions and the potential for restoration of anadromous fish to upstream habitats.

Installing fish screens at Copco No. 1 and Copco No. 2 dams could contribute to a future anadromous fish restoration effort by reducing losses that could occur during turbine passage. Screening facilities could also reduce mortality to any juvenile and adult shortnose and Lost River suckers that emigrate downstream past the project, although mortality to larval suckers and juvenile lamprey may increase due to the potential for impingement on fish screens.

Evaluating spillway passage and implementing any changes needed to improve downstream passage survival could improve the survival of listed suckers that emigrate downstream, and has the potential to improve the downstream passage survival of anadromous fish if they are restored to areas upstream of Copco No. 1 and Copco No. 2 dams. However, the potential benefit from improving the spillways at the Copco dams is limited by a low frequency of spills (see table 3-18), and the benefit to anadromous fish could be further limited by low survival rates that may be experienced by fish that migrate in-river through Iron Gate reservoir. Even if fish passage facilities that meet current agency criteria were installed at all project dams, cumulative losses during passage associated with segments with poor water quality, predation in project reservoirs, and injuries sustained during dam passage could be substantial.

Regarding Cal Fish & Game and Oregon Fish & Wildlife's recommendation to install tailrace barriers at all project powerhouses, and NMFS/Interior's prescription to install tailrace barriers at most developments including the Copco No. 1 and Copco No. 2 powerhouses, for the reasons that we discuss for East Side and West Side developments, we conclude that the potential need for and benefits of installing tailrace barriers cannot be fully assessed at this time.

Fall Creek Development. PacifiCorp proposes to construct fish ladders and screens at the Spring and Fall Creek diversions to provide passage for resident trout. The fish ladder at Spring Creek would be a timber or concrete pool- and weir-type ladder consisting of eight pools. The pools would be 4 feet by 5 feet with 0.5-foot vertical jumps. A fishway control structure consisting of a 24-inch diameter corrugated metal pipe culvert and manually operated slide gate would provide about 1 cfs of flow to the fishway. The fish ladder at Fall Creek would be a pool- and weir-type ladder consisting of six pools. The pools would be constructed from rock and include a 0.5-foot vertical jump for each pool. The existing flashboards would be notched at the exit pool to permit a flow of 2.5 cfs to the fishway. The screens at both diversions would be diagonal-type screens meeting NMFS Southwest Region criteria for salmonid fry, including a maximum approach velocity of 0.4 fps, a sweeping velocity of 2 times the approach velocity, maximum screen openings of 1.75 mm, and a minimum open area of 27 percent of the total screen area. The bypass pipes would be 12 inches in diameter with 2.5 cfs of flow to each.

Cal Fish & Game recommends that PacifiCorp construct volitional upstream fishways and volitional downstream passage facilities, and modify spillways to improve downstream passage survival at all project dams within 6 years. Cal Fish & Game and Oregon Fish & Wildlife both recommend that PacifiCorp install tailrace barriers at all project powerhouses within 8 years, and evaluate the hydraulic and biological performance of each facility.

Oregon Fish & Wildlife and the Hoopa Valley Tribe recommend that PacifiCorp design and construct fish ladders at the Spring and Fall creek diversions designed to pass juvenile and adult resident trout. Oregon Fish & Wildlife recommends that the ladder be constructed within 3 years, and the Hoopa Valley Tribe recommends that the ladder be constructed within 5 years.

Oregon Fish & Wildlife and the Hoopa Valley Tribe recommend that PacifiCorp construct downstream fish passage facilities at the Spring and Fall creek diversions Oregon Fish & Wildlife recommends that the facility be constructed within 3 years, and the Hoopa Valley Tribe recommends that the facility be constructed within 5 years. Oregon Fish & Wildlife and the Hoopa Valley Tribe recommend that the facility include a trap for evaluating screen performance and accommodating long term monitoring of the downstream migrant population, including holding and sorting of fish by age and species. Downstream migrating fish would be delayed no more than 8 hours, with the exception that fish caught at night shall be released at night and fish caught during daylight shall be released during daylight.

NMFS and Interior prescribe that PacifiCorp construct a fish ladder to accommodate upstream passage for redband trout at the Spring Creek and Fall Creek) diversions within 3 years. The ladders would have a maximum drop between pools of 0.5 feet and maximum slope not to exceed 10 percent. NMFS and Interior also prescribe that fish screen and bypass facilities designed to meet NMFS juvenile fish screen criteria be constructed at the Spring Creek and Fall Creek diversions within 3 years. NMFS and Interior also prescribe that a tailrace barrier and guidance system be installed within 5 years at the Fall Creek powerhouse to protect adult fish.

Our Analysis

Fisheries sampling conducted by PacifiCorp in response to our information request (PacifiCorp, 2005a) indicates that Spring Creek supports a small population of rainbow trout, with few fish exceeding 8 inches in length. Electrofishing conducted above and below the diversion and in the diversion canal resulted in catch rates of 89, 14, and 100 fish per hour, respectively. Fish that are diverted into the Spring Creek diversion canal may either remain in the canal or migrate downstream to where the canal flow enters Fall Creek, about 1.7 miles mile upstream of the Fall Creek diversion.

Construction of upstream and downstream passage facilities at the Spring Creek diversion would prevent trout from being entrained into the diversion canal and would allow trout that pass over the diversion dam to return upstream. There are, however, two other diversions on Spring Creek, which is only 1.2 mile in length from its origin at Shoat Springs to its confluence with Jenny Creek. The other two diversions, which are privately owned, are located 0.1 miles above and 0.3 miles below the PacifiCorp diversion. The two other diversions may also limit upstream passage in this reach, and there is a high gradient section near its confluence with Jenny Creek that PacifiCorp reports is likely a migration barrier for suckers. Fish that migrate or are carried downstream past these potential obstacles may not be able to return upstream, which would limit the benefit of installing a ladder at PacifiCorp's diversion. We also find little indication that the diversion of some trout into the Spring Creek diversion canal is adversely affecting populations, given the relatively high catch per unit effort that was observed and the fact that any fish that are diverted into the diversion canal would have access to suitable habitat both in the earthen canal and in Fall Creek.

Fish that are diverted into the Fall Creek power canal have the potential to be entrained into the powerhouse and killed during passage through the turbines at the Fall Creek powerhouse. However, trout populations upstream and downstream of the diversion appear healthy based on the relatively high catch per unit effort that was observed during PacifiCorp's electrofishing survey, which produced a catch rate of 82 fish per hour upstream of the diversion and 188 fish per hour in the bypassed reach downstream of the diversion. Although the installation of effective upstream and downstream passage at the Fall Creek diversion would improve connectivity between the populations upstream and downstream of the diversion and protect some trout from being killed during turbine passage, we see little evidence that trout populations in Spring or Fall creeks are being adversely affected. Given the low height of the diversion dams, it is unlikely that any fish would be injured during passage over the diversions, so we do not see any need to consider modifying the spillways at these diversions. For the same reasons given for the mainstem developments, the need for constructing a tailrace barrier can be evaluated most effectively if and when anadromous fish are restored to Fall Creek. Due to their weaker swimming ability, it is unlikely that the small resident trout that occur in Fall Creek could ascend into the turbine draft tube and be injured at the Fall Creek powerhouse.

<u>Iron Gate Development</u>. PacifiCorp does not propose to implement any fish passage measures associated with Iron Gate dam. As previously described, Cal Fish & Game recommends that PacifiCorp construct volitional upstream fishways and volitional downstream passage facilities, and modify spillways to improve downstream passage survival at all project dams within 6 years. Cal Fish & Game and Oregon Fish & Wildlife both recommend that PacifiCorp install tailrace barriers at all project powerhouses within 8 years, and evaluate the hydraulic and biological performance of each facility.

Oregon Fish & Wildlife and the Hoopa Valley Tribe recommend that PacifiCorp design and construct a fish ladder at Iron Gate dam within 5 years that meets applicable criteria for Chinook and coho salmon, steelhead, Pacific lamprey, and redband trout and include provisions for visual monitoring or a fish trap and counting system. Oregon Fish & Wildlife and the Hoopa Valley Tribe recommend that PacifiCorp construct a downstream fish passage facility at Iron Gate dam within 5 years that would operate year-round. The screen would include a trap for evaluating screen performance and accommodating long-term monitoring efforts.

NMFS and Interior prescribe that PacifiCorp construct a fish ladder to accommodate upstream passage for Chinook and coho salmon, steelhead, Pacific lamprey and redband trout at Iron Gate dam within 5 years. The ladder would include a screened auxiliary water system that provides forebay water of the correct water quality and quantity to effectively attract fish. The ladder would have a maximum drop between pools of 0.5 feet and a slope not to exceed 10 percent. NMFS and Interior also prescribe a fish screen and bypass facility designed to meet NMFS screening criteria for the same species, and that the spillway be modified to improve downstream passage within 5 years.

PacifiCorp's alternative to the joint NMFS/Interior fishway prescription includes a provision to modify the existing Iron Gate Hatchery fish ladder's collection, sorting and holding facilities to facilitate the collection and transport of Chinook, coho, steelhead, and Pacific lamprey to areas upstream of J.C. Boyle dam. Modifications would include constructing a hopper system to transfer fish from holding ponds to a transport truck and augmenting the existing sorting facility to enable detection and recording of electronic tag data and other identifiers.

Our Analysis

Provision of upstream passage for anadromous fish at Iron Gate dam as part of a future restoration effort would provide access to 6.8 miles of reservoir habitat, 1.4 miles of mainstem riverine habitat in the Copco No. 2 bypassed reach, about 0.9 mile of tributary habitat in Fall Creek, and 1.1 miles of tributary habitat in Jenny Creek. The spawning potential for the Copco No. 2 bypassed reach appears to be relatively high based on a report by Coots and Wales (1952), who estimated that about 300 Chinook salmon spawned in the reach, and reported that a large portion of the available spawning habitat appeared to be unused. The flow in the bypassed reach at the time of their survey was estimated to be 8 cfs.

Installing a fish screen at Iron Gate dam could contribute to a future anadromous fish restoration effort by eliminating losses that would occur during turbine passage. A screening facility could also reduce mortality to any juvenile and adult shortnose and Lost River suckers that emigrate downstream past Iron Gate dam, although mortality to larval suckers and juvenile lamprey may increase due to screen impingement.

Evaluating spillway passage and implementing any changes that are needed to improve downstream passage survival could improve the survival of any listed suckers that emigrate downstream, and has the potential to improve the downstream passage survival of anadromous fish if they are restored to areas upstream of Iron Gate reservoir. However, there is no lake or reservoir habitat downstream of the dam that is suitable for Lost River or shortnose suckers, so there would be little, if any, benefit to improving spillway survival for these species. Modifying the spillway to improve downstream passage survival, if passage mortality is found to occur, could also benefit outmigrating juvenile anadromous fish in a future restoration effort. However, even if fish passage facilities meeting current agency criteria were installed at all project dams, cumulative losses during passage associated with segments with poor water quality, predation in project reservoirs, and injuries sustained during dam passage could be substantial. If a decision was made to bypass these sources of mortality by collecting smolts at an upstream location and transporting them to a location downstream of Iron Gate dam, spillway improvements would provide no benefit to those fish that are transported, but they could benefit fish that bypass the smolt collection facility during spill periods.

Regarding Cal Fish & Game and Oregon Fish & Wildlife's recommendation to install tailrace barriers at all project powerhouses, we have not seen any evidence in the record which indicates that a tailrace barrier is needed at Iron Gate dam. To our knowledge, there have not been any reports of fish injuries caused by fish entering the project draft tubes or of fish being delayed before they can find and enter the hatchery fish ladders.

PacifiCorp's alternative to the NMFS/Interior prescription includes collection of anadromous fish at Iron Gate dam, which would allow adult anadromous fish to be transported above J.C. Boyle dam or to habitat in the upper basin upstream of Link River dam. Fish could also be transported directly to upper basin tributaries during periods when water quality conditions are not suitable for migration through Upper Klamath Lake, or if a decision was made to focus restoration effort for a species on a single tributary. Refer to the first part of this section for a discussion of the potential benefits of providing passage to and from habitat upstream of Link River dam. If coho salmon were transported to Spencer Creek, smolts produced from Spencer Creek could be collected in a smolt collection facility at the mouth of Spencer Creek or at J.C. Boyle dam. Spencer Creek appears to provide more coho habitat than any other tributary upstream of Iron Gate dam.

Facility Design and Post-construction Evaluation

NMFS and Interior prescribe that PacifiCorp should design each upstream fish passage facility to pass migrants over a range of flows, bracketed by a designated high and low fish passage design flow. The low fish passage design flow would be the mean daily average stream discharge that is exceeded 95 percent of the time (based on at least 25 years of daily discharge data or an alternative method approved by NMFS and FWS) during periods when migrating fish were historically present at the site. The high fish passage design flow would be the mean daily average stream discharge that is exceeded 5 percent of the time during periods when migrating fish were historically present at the site. Each fish ladder would be designed to provide a total attraction flow of at least 10 percent of the high fish passage design flow. For fishways at streams with annual mean flows greater than 1,000 cfs, PacifiCorp would determine an optimum attraction flow in consultation with NMFS and FWS. PacifiCorp would ensure that any reduction in attraction flow would not result in reduction in passage efficiency below standards established by NMFS and FWS during important fish migrations. PacifiCorp would test fishway performance, report testing results to NMFS and FWS, and implement appropriate modifications of attraction flow, but to no less than 5 percent of high fish passage design flow, if approved by Services.

NMFS and Interior prescribe that PacifiCorp develop detailed design, construction, evaluation, and monitoring plans for review and approval by NMFS and FWS prior to construction. Facilities should be constructed according to NMFS guidelines for the design of fish screens, fishways, and other fishway structures. All designs would be reviewed by an agency fisheries technical committee, and agency consultation would be required during the conceptual level design. NMFS and FWS would approve conceptual design prior to feasibility and final level design, and PacifiCorp would allow at least 90 days for review and approval. Plans would include provisions for stocking critical spare parts and equipment to provide timely repairs of critical system components. Downstream fishways (screens, bypasses, and spillway modifications) should be complete prior to the completion of upstream fishways. After approval by NMFS and FWS, final designs would be filed with the Commission.

NMFS and Interior prescribe that prior to the completion of construction of new fishways, PacifiCorp, in consultation with a fisheries technical subcommittee, would develop post-construction monitoring and evaluation plans to assess the effectiveness of each fishway, spillway, and tailrace barrier. Plans would include hydraulic, water quality, and biological evaluations using electronic tags of similar technology to detect and record fish passage and assess the performance of the fishway. PacifiCorp would provide a report on the monitoring and evaluation annually for the term of the license, including estimates of the numbers of fish passed by species on a daily basis (including spring and fall-run Chinook, coho, steelhead, Pacific lamprey, Lost River and shortnose suckers, and redband/rainbow trout); sampling of fish size and age class on a daily basis; records of daily observations by a qualified fisheries biologist on the physical condition of fish using the fishways; and a continuous record of DO and water temperature at locations in the fishways determined by NMFS and FWS, and in front of and adjacent to the entrances and exits of the fishways. Evaluation plans would be submitted to NMFS and FWS within 6 months of the date when final designs for fishway construction are approved by Services. At least 60 days would be given for NMFS and FWS to review evaluation plans. PacifiCorp would fund plan implementation and any operational or physical changes necessary for effective fish passage.

NMFS and Interior prescribe that PacifiCorp shall, in consultation with a fisheries technical subcommittee, prepare a fishway evaluation and modification plan for each fishway, spillway, and tailrace barrier. An outline for the plan would be provided to NMFS and FWS no later than 1 year from license issuance, and complete plans would be submitted to NMFS and FWS no later than 18 months from license issuance. Each plan would include: (1) a quantified program to meet NMFS and FWS' fish passage goals, objectives, and strategies; (2) the Services' criteria by which to measure progress towards fisheries management goals; (3) procedures for redirecting effort; (4) a schedule for implementation of activities; (5) a monitoring plan to evaluate progress towards and achievement of Services' goals and objectives; and (6) a format for an annual report and work plan. An annual report detailing work under this plan for previous year would be submitted by February 1. By December 1 of every year, PacifiCorp would submit a proposed work plan for the upcoming year.

Our Analysis

Development of the design of any fish passage facility would benefit from close cooperation with NMFS and other agencies to ensure that the design takes advantage of available expertise and that the facilities are as effective as possible. Given their expertise in this area, we agree that close consultation with NMFS and FWS during design development and review for any fishways that are constructed would be beneficial. We do not concur with NMFS and Interior, however, that it is necessarily appropriate to construct downstream passage facilities before upstream passage is provided. We generally concur with the approach that PacifiCorp lays out in its alternative prescription where upstream passage of adult fish would be provided to assess the capacity of upstream habitat and to address uncertainties regarding losses that may occur in migration corridors before investing in a mainstem smolt collection facility. This may prevent the construction of downstream passage facilities that would never be needed.

Developing and implementing post-construction monitoring and evaluation plans to assess the effectiveness of any fish passage facilities that are constructed, as prescribed by NMFS and Interior, is appropriate for ensuring that facilities function as intended, and that any modifications needed to provide adequate performance can be made. We agree that the elements that NMFS and Interior specify are generally appropriate for use in a post-construction monitoring and evaluation plan, but conclude that the scope of the evaluation plan for a specific facility should be developed in consultation with the agencies. We are less sure of the need and basis for the prescribed evaluation and modification plan, which would require PacifiCorp to evaluate the facility's conformance with NMFS and FWS fish passage goals, objectives, and strategies. We concur that it is appropriate to define performance criteria for the fish passage facility, but conformance with the Service's fish passage goals, objectives, and strategies may involve factors that are beyond PacifiCorp's control, such as the numbers of adult fish that return from the ocean, or losses during migration that are associated with water quality conditions that may result from upstream land use practices.

We concur with NMFS and Interior that it is appropriate to design upstream fish passage facilities to function properly over a typical range of operating flows. We do not see any basis, however, for the requirement that each fish ladder be designed to pass 5 to 10 percent of the high design flow to create sufficient flows to attract and pass targeted species at each fishway. If PacifiCorp can provide a sound basis for using a lower amount of attraction flow and demonstrate via post-construction evaluation studies that the attraction flow is sufficient to attract fish to enter and ascend the facility, the lower attraction flow volumes should be allowed.

Operation and Maintenance

Oregon Fish & Wildlife recommends that PacifiCorp develop and implement written standard operation and maintenance procedures for upstream passage and downstream passage facilities that include procedures for prior notification and coordination with agencies on maintenance scheduling or emergencies that may affect functioning of fish passage facilities. The procedures would also include provisions for daily inspections during peak seasonal migrations of major species (redband trout, suckers, and anadromous fish) and weekly inspections during non-peak migrations. Similarly, NMFS and Interior prescribe that PacifiCorp, in consultation with agencies, develop a fishway operation, inspection, and maintenance plan describing these planned activities and contingencies for each fish passage facility.

Oregon Fish & Wildlife also recommends that PacifiCorp notify agencies at least 2 weeks in advance of any contemplated maintenance shutdowns of upstream passage or downstream passage facilities that may result in dewatered waterways or reduced flows that may result in stress or mortality to fish. Oregon Fish & Wildlife also recommends that PacifiCorp salvage live fish from the waterways during maintenance shutdowns and consult with the agencies to determine where salvaged fish would be relocated.

Oregon Fish & Wildlife and the Hoopa Valley Tribe recommend and NMFS and Interior prescribe that PacifiCorp allow agencies and tribes, including Oregon Fish & Wildlife and the Hoopa Valley Tribe, access to, through, and across project lands and works for the purpose of inspecting fishway facilities and records, including monitoring data, to monitor compliance with fishway requirements that may be included in a new license.

NMFS and Interior prescribe that PacifiCorp keep all fishways in proper order, clear of trash, sediment, logs, debris, and other material that would hinder passage or create a personnel safety hazard, and to perform maintenance well in advance of critical migratory periods. If any fishway becomes seriously damaged or inoperable, PacifiCorp would notify NMFS and FWS within 48 hours and take timely remedial action in a manner satisfactory to NMFS and FWS.

Our Analysis

Developing an operations and maintenance plan in consultation with the fisheries management agencies and tribes, for any fishways or trap and haul facilities that are constructed, would help ensure that the facilities function as intended. We would expect that provisions for notifying agencies of any planned maintenance procedures that would involve dewatering of any facilities and for notifying the agencies of any major operational problems would be part of the operations and maintenance plan.

3.3.3.2.3 Disease Management

As we discuss in section 3.3.3.1.4, *Diseases Affecting Salmon and Steelhead*, disease problems in recent years have contributed to substantial losses of juvenile and adult salmon and steelhead in the migratory corridor downstream of Iron Gate dam. In 2002, a combination of factors including low flows, high water temperatures, and a high density of fish in the river resulted in an outbreak of *Ichthyophthirius multifi* (Ich) and *Flavobacterium columnare* (columnaris disease) that resulted in the death of more than 33,000 adult salmon and steelhead, most of which were fall Chinook salmon, in the lower 36 miles of the river (CDFG, 2004). Although this fish kill had a severe adverse effect on the number of fall Chinook salmon that survived to spawn in 2002, chronic losses of juvenile salmon from disease appear to pose an even greater threat to the health of the fall Chinook salmon population. Nichols and Foott (2005) estimated that 45 percent of the juvenile fall Chinook that outmigrated in 2004 were infected with *C. shasta* and 94 percent of the population was infected with *P. minibicornis*. They concluded that the high incidence of fish infected with both pathogens suggests that the majority of the *C. shasta* infected juvenile Chinook would not survive. Monitoring results in 2005 reported by Nichols (2005) indicate that infection rates of juvenile fall Chinook with *C. shasta* increased to levels that exceeded 70 percent by late April, and infection rates for *P. minibicornis* ranged between 94 and 100 percent from late April through at least mid-May.[61] True (2006) reports that infection rates of juvenile fall Chinook in 2006 have remained at low levels through late April for both *C. shasta* and *P. minibicornis*. The lower infection rates reported in 2006 to date may be related to substantially higher flows compared to 2004 and 2005.

PacifiCorp does not propose any measures related to management of fish diseases in the lower Klamath River. In its alternative to the NMFS/Interior fishway prescription, PacifiCorp includes monitoring of resident and anadromous fish populations for the presence of *F. columnare*, *C. shasta* and *P. minibicornis*, and testing juvenile redband trout for Infectious Hematopoietic Necrosis (IHN).

[61] True (2005) did not report the results of monitoring conducted after mid-May, which were pending at the time that the memo was prepared.

PacifiCorp would also undertake sentinel rainbow trout studies[62] to detect whether disease load and severity increases if anadromous fish are reintroduced into the upper Klamath basin.

Recommendations made by the agencies related to disease management are summarized in table 3-71. Oregon Fish & Wildlife, Cal Fish & Game, NMFS and FWS recommend that PacifiCorp develop juvenile and adult disease risk monitoring and management plans that would be implemented within 2 years after development and agency approval. The plans would include: (1) studies to determine key factors controlling disease risk and pathogen abundance; (2) assessment of benefits through restoration of geomorphic processes and management of flows and water quality to minimize disease risk; (3) conducting test flows of varying extent and magnitude to determine sufficient mobilization of the bed that results in scour of algae mats and then subsequent testing of the abundance of *C. shasta* and *P. minibicornis* and their polychaete intermediate host; and (4) steps to minimize disease risk to reintroduced anadromous species above Iron Gate dam, to resident species, and to fish production at Iron Gate Hatchery. NMFS also recommends that the plans include an assessment of measures for controlling, managing or removing pathogens, vectors, and hosts or their habitats to minimize disease risk. The Forest Service makes a similar recommendation to continue assessment of the habitat requirements of the polychaete secondary host for *C. shasta* and *P. minibicornis*, determine other dynamics which influence these diseases, determine how project operations can be altered to reduce disease incidence, and develop adaptive management measures. Siskiyou County recommends that PacifiCorp fund studies leading to the reduction or elimination of disease problems that currently exist downstream of Iron Gate dam.

Oregon Fish & Wildlife, Cal Fish & Game, NMFS, and FWS also recommend that PacifiCorp develop an emergency response pulse flow plan to temporarily enhance flows, using up to 52,000 acre-feet of storage[63] in Copco and Iron Gate reservoirs when an interagency fish health assessment team determines that enhanced flows would likely decrease the adverse affects of an impending juvenile or adult fish die-off. PacifiCorp would also provide reports summarizing the successes and failures of such attempts and recommendations for future enhanced flow management.

Although the tribes and non-governmental organizations did not provide any similar recommendations for disease management, reducing the incidence of losses from fish disease is a central element of their rationale for recommending removal of the mainstem dams. The Resighini Rancheria and Institute for Fisheries Resources/PacifiCoast Federation of Fishermen's Associations recommend full decommissioning of the project, which we interpret to mean removal of all project dams. The Quartz Valley Indian Community, Klamath Tribes, Karuk Tribes, Yurok Tribe, Conservation Groups, and PFMC all recommend removal of the J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams.

[62]Studies in which trout are held alive in cages placed in the river for a pre-determined period of time and then rates of infection are determined during a post-exposure holding period.

[63]In their response to AIR AR-1(a), PacifiCorp (2005) indicates that the maximum drawdown that would allow continued turbine operation is elevation 2,601 ft at Copco reservoir and elevation 2,319 ft at Iron Gate reservoir, which indicates that the active storage at these reservoirs are 5,713 and 7,238 acre-feet, respectively. This amounts to a total active storage in the two reservoirs of 12,951 acre-feet as opposed to the 52,000 acre-feet stated by NMFS.

1 Table 3-71. Disease management recommendations. (Source: Staff)

Category	Oregon Fish & Wildlife	Cal Fish & Game	NMFS	FWS	Forest Service
Juvenile fish disease risk monitoring and management	Develop and implement a juvenile fish disease risk monitoring and management plan to reduce disease risk for juvenile anadromous salmonids in the Klamath River. Conduct studies to determine key factors controlling disease risk and pathogen abundance and, if appropriate, assess the benefits of using geomorphic processes, management of flows, and water quality to minimize disease risk. Implement the plan within 2 years of development and agency approval.	Essentially the same as Oregon Fish & Wildlife's recommendation 14A, but with less detail. Like Oregon Fish & Wildlife, no time frame is given for developing the plan, but it would be implemented within 2 years of plan development.	Same as Oregon Fish & Wildlife, but plan would include recommended measures for controlling, managing, or removing pathogens, hosts, and vectors; and assessment of the benefits through restoration using physical removal or treatment of pathogens, vectors, hosts, or their habitats.	Essentially the same as Oregon Fish & Wildlife's and NMFS recommendations.	Continue to assess habitat requirements for the polychaete secondary host and determine other dynamics that influence *C. shasta* and *P. minibicornis*. Determine how project operations can be altered to minimize polychaete habitat and reduce disease incidence and develop adaptive management measures.
Adult fish disease risk monitoring and management	Develop and implement an adult fish disease risk monitoring and management plan to reduce disease risk for adult anadromous salmonids below Iron Gate dam. Include recommendations for managing flows, geomorphic processes, and water quality to minimize disease risk, and steps to minimize disease risk to reintroduced anadromous species and resident species above Iron Gate dam. Include studies to assess the role of seasonal flow reductions in	Essentially the same as Oregon Fish & Wildlife's recommendation. Cal Fish & Game does not provide as much detail as Oregon Fish & Wildlife. Like Oregon Fish & Wildlife, no time frame is given for developing the plan, but it would be implemented within 2 years of plan development.	Same as Oregon Fish & Wildlife, but plan would include an assessment of the benefits through restoration using physical removal or treatment of pathogens, vectors, hosts or their habitats to minimize disease risk.	Essentially an abbreviated version of Oregon Fish & Wildlife's and NMFS recommendations	

Category	Oregon Fish & Wildlife	Cal Fish & Game	NMFS	FWS	Forest Service
	increasing habitat and pulse flows in decreasing habitat for the intermediate host of *C. shasta,* test flows of varying extent and magnitude to determine sufficient mobilization of the bed to scour algae mats and subsequent testing of polychaete and pathogen abundance. Implement plan within 2 years of development and agency approval.				
Emergency response pulse flow plan	Develop a plan to provide temporary enhanced flows on an emergency basis using the estimated active storage of Iron Gate and Copco reservoirs of 52,000 acre-feet. These flows would be provided when an interagency fish health assessment team determines that enhanced flows would likely decrease the effects of an impending juvenile or adult fish die-off. Provide reports summarizing the successes and failures of such attempts and recommendations for future enhanced flow management.	Essentially the same as Oregon Fish & Wildlife. Like Oregon Fish & Wildlife, no time frame is given for developing the plan, but it would be implemented within 2 years of plan development.	Same as Oregon Fish & Wildlife recommendation	Same as Oregon Fish & Wildlife's and NMFS recommendations	

Our Analysis

The very high infection rates of *C. shasta* and *P. minibicornis* observed in juvenile fall Chinook migrants in 2004 and 2005, and mortality rates observed during juvenile migration monitoring, indicate that losses of juvenile migrants may be having a substantial effect on fall Chinook salmon populations in the Klamath basin.[64] Migrant sampling conducted by FWS in 2004 indicate that high observed infection rates were associated with high rates of immediate mortality in juvenile fall Chinook salmon (figure 3-80). Monitoring data from both years indicate that both infection and mortality rates tend to increase rapidly with increasing water temperatures, which is consistent with high rates of mortality observed during periods of sustained high water temperatures observed during screw trap sampling conducted in the Klamath River near Big Bar (RM 50) in 1997 and 2000 by Scheiff et al. (2001). Given the general trend of increasing water temperatures in the basin over the last several decades reported by Bartholow (2005), there is strong potential that disease-related mortality of both juvenile and adult migrants could increase in the future.

Disease losses in the mainstem of the Klamath River may affect runs of fall Chinook salmon in the entire Klamath basin, including its major tributaries. As we discussed in section 3.3.3.1.4, *Diseases Affecting Salmon and Steelhead*, Nichols et al. (2003) found that 19 percent of marked fall Chinook smolts outmigrating from the Trinity River became infected with *C. shasta* as they migrated through the lower most 44 miles of the Klamath River. Cal Fish & Game (2004a) reported that losses of adult Trinity River fall Chinook during the 2002 adult fish kill may have exceeded 20,000 fish.

We conclude that disease losses in the lower Klamath River migratory corridor have most likely contributed to recent declines in the number of fall Chinook salmon, and have the potential to cause the fall Chinook population in the basin to decline further, unless measures can be found to reduce losses from disease, particularly in warm years and when low flows occur. Efforts to restore passage of anadromous fish to areas upstream of the project may provide little or no benefit if disease problems in the Klamath River downstream of the project are not effectively addressed.

The Klamath Hydroelectric Project has likely contributed to conditions that foster disease losses in the lower Klamath river by (1) increasing the density of spawning adult fall Chinook salmon downstream of Iron Gate dam; (2) promoting the development of attached algae beds that provide favorable habitat for the polychaete alternate host for *C. shasta* and *P. minibicornis*; and (3) contributing to water quality conditions that increase the stress level of juvenile and adult migrants and increase their susceptibility to disease. We evaluate these three factors in the following section, followed by a discussion of possible approaches for reducing the incidence of fish diseases in the Klamath River downstream of Iron Gate dam.

The lack of fish passage at the project and natural spawning by stray fish produced at the Iron Gate Hatchery has likely contributed to a high density of fall Chinook spawning in the 13-mile long section of the river between Iron Gate dam and the Shasta River and in Bogus Creek. During spawning surveys conducted between 1993 and 2002, an average of 51.9 percent of all mainstem redds were observed in this reach, which constitutes 15.4 percent of the 84.4 miles of river that were surveyed (see table 3-48). Sampling conducted in 2005 indicates that two sites in this reach had a high prevalence of *C. shasta* infection in its polychaete alternate host, which Bartholomew and Stocking (2006, personal communication cited by Resighini Rancheria, 2006), consider to most likely be the result of proximity to spawning areas. Resighini Rancheria (2006) state that returning adult salmon can become infected with *C. shasta* as they move upriver, and that when they spawn and die, the *C. shasta* myxospores contained inside of them are released and can infect polychaetes. The incidence of disease and mortality of juvenile fall Chinook salmon collected downstream of this reach can reach very high levels, as indicated in figure 3-80. Although the effect of these diseases on the federally listed coho salmon is unknown, at least one case of infection of this species has been documented (Foott et al., 2004).

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[64] In their assessment of juvenile disease losses that occurred in 2004, Nichols and Foott (2004) concluded that the effective number of adult salmon lost to *C. Shasta* as juveniles could rival the 33,000+ adult salmon that were lost in the 2002 Klamath River fish dieoff.

The incidence of *C. shasta* and *P. minibicornis* in this reach may be further increased by the presence of *Cladophora*, a genus of an attached filamentous algae that provide a favorable habitat for the polychaete alternate host. As discussed in section 3.3.2.2.2, *Water Quality*, *Cladophora* spp. tend to proliferate in reaches downstream of nutrient sources, and we conclude in that section that its abundance downstream of Iron Gate dam is likely associated with seasonal releases of nutrients associated with blooms of the nitrogen-fixing blue-green algae, *Aphanizomenon flos-aquae*, in Upper Klamath Lake and in Keno, Copco No. 1, and Iron Gate reservoirs. Nutrients (nitrites) from these algal blooms are released as part of the life cycle of this particular algae and can also be released when the algae die and the cells decompose. The resultant nutrient enrichment occurs in both the reservoirs and in downstream reaches.

In section 3.3.2.2.2, *Water Quality*, we conclude that algae blooms that occur in the project reservoirs during the spring and summer also contribute to wide fluctuations in DO levels and pH in the mainstem Klamath River downstream of Iron Gate dam. These conditions, combined with water temperatures that are generally in the stressful to severely stressful range for salmonids from June through September, contribute to a high level of stress that increases susceptibility to disease. As indicated in tables 2.2-2 through 2.2-5, water temperature and DO levels predicted by PacifiCorp's water quality model indicate that stressful conditions for juvenile fall Chinook generally occur starting in late May, which coincides with the season when increased collections of diseased and dead juvenile fall Chinook were observed during screw-trap monitoring in 2004 (figure 3-80).

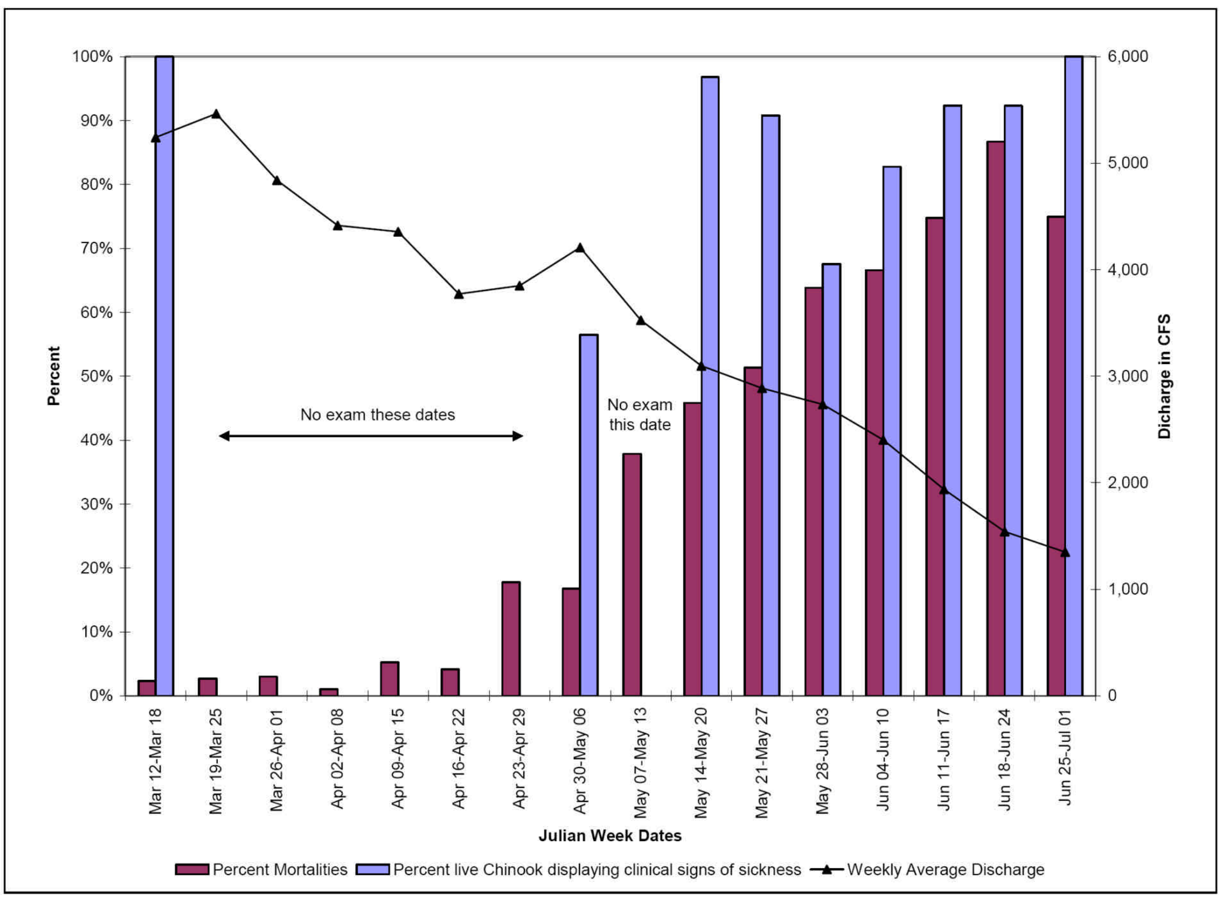

Figure 3-80. Percent of weekly frame-trap catch of Chinook salmon that were dead, percent of remaining live Chinook examined that exhibited outward clinical signs of disease, and weekly average discharge at the Kinsman trap site (RM 146) on the Klamath River near the mouth of the Scott River in 2004. (Source: KFHAT, 2005)

Development of an effective disease management plan may be essential to prevent further decline of the populations of Klamath fall Chinook salmon and the potential spread of disease to other salmonid species in the basin. Measures that could be considered for evaluation in the disease management plan include (which include some approaches developed by staff):

1. High flow releases prior to the spring juvenile fall Chinook outmigration to reduce pathogen densities by dislodging attached algae that provides habitat for the polychaete alternate host for *C. shasta* and *P. minibicornis*.

2. Increased flows during the migration season to expedite fish movement and to reduce water temperatures during the juvenile fall Chinook outmigration season. This could include water released from storage facilities on the Trinity River, which would reduce water temperatures in the lowermost 44 miles of the Klamath River.

3. Spill flows from Iron Gate dam to increase DO levels and reduce fish stress during the fall Chinook outmigration or spawning season when adverse conditions occur.

4. Physical removal or treatment of pathogens, vectors, hosts, or their habitats to minimize disease risk. Possible techniques could involve the use of high pressure water jets or direct mechanical techniques such as dragging chain mesh over the stream bed to dislodge attached algae. These types of approaches could be used in test areas to determine their effectiveness in reducing the incidence of infected polychaetes, and could be expanded to larger areas if they are found to be effective.

5. Large-scale sand and gravel augmentation efforts below Iron Gate dam to increase the amount of sediment that mobilizes during high winter and spring flows to assist with the scouring and removal of attached algae and reduce populations of the polychaete alternate host.

6. Field or laboratory investigation of chemical or other means to control disease pathogens, their intermediate host, or attached algae. Potentially successful techniques could be field tested in a smaller tributary such as Bogus Creek. Techniques to be evaluated could include the removal or treatment of carcasses to limit the quantity of pathogen spores and nutrients that are introduced into the environment.

7. Strategies for controlling blooms of nitrogen-fixing algae in Copco and Iron Gate reservoirs.

8. Cool water release from the hypolimnion of Iron Gate reservoir or from the Trinity River when severely stressful temperatures occur during the fall Chinook adult migration seasons. This measure may also be developed through development of a temperature management plan, as discussed in section 3.3.2.2.2, *Water Quality*.

9. Alternative production and release strategies at Iron Gate Hatchery to reduce crowding and disease transmission between juvenile and adult salmon in the river environment. This could include shifting production to yearling smolts, reducing overall production levels, or transportation of hatchery smolts for release closer to the estuary.

10. Maintenance of Copco and Iron Gate reservoirs at minimum operating pool seasonally or year-round to minimize adverse project effects on water quality conditions downstream of Iron Gate dam.

11. Alternatives for reducing water temperatures including riparian plantings on tributaries, purchase and acquisition of water rights to increase stream flows, and groundwater accretion in spring-fed tributaries.

12. Intensive monitoring of the distribution and prevalence of disease pathogens and their alternate hosts to evaluate relationships with environmental conditions and experimental treatments. Consideration could also be given to the potential for development of vaccines, other treatments, or disease-resistant stocks.

Developing the plan in close consultation with other stakeholders including those that are involved in disease and water quality monitoring and habitat restoration efforts would help to ensure that as many potentially viable disease control strategies as possible are identified and considered for evaluation and implementation. Development of flow-related measures in consultation with Reclamation would help coordinate the use of available storage controlled by PacifiCorp and by Reclamation in the most effective manner possible. Such a plan would benefit from review and input from recognized experts in the control of disease pathogens and their alternate hosts, and in methods for controlling attached algae including *Cladophora spp*.

Because the effects of the Klamath Hydroelectric Project on water quality are the most pronounced in the reach between Iron Gate dam and the Shasta River, it would be appropriate for PacifiCorp to take responsibility for measures that are undertaken in this section of the river (as well as measures that pertain to hatchery operations and management of project reservoirs to improve downstream water quality). As discussed in section 3.3.1, Geology and Soils, this is within the reach that has been most affected by a reduced supply of gravel and fine sediments, due to trapping of these sediments in the project reservoirs. Implementation of a substantial gravel augmentation program could provide important benefits by improving the quality and quantity of spawning gravel and reducing the abundance of *Cladophora spp.* by increasing the proportion of the streambed that is mobilized during high flows and increasing the scour of attached algae on larger substrate that is too large to be mobilized.

If a program to reintroduce anadromous fish upstream of Iron Gate dam is undertaken, developing a disease risk management plan would be essential to evaluate the risks of different reintroduction strategies and to monitor for any increases in the abundance and distribution of important pathogens. Implementing the disease monitoring efforts that PacifiCorp includes in its alternative fishway prescription would help to reduce these risks and allow restoration approaches to be modified if adverse effects on resident or anadromous fish populations are identified.

3.3.3.2.4 Dam Removal or Decommissioning

Many stakeholders recommend the removal of most or all of the project dams with the goals of restoring passage of anadromous fish to upstream habitats, improving water quality conditions in and below the project, and alleviating conditions that contribute to disease-related mortality of juvenile and adult anadromous fish in the mainstem Klamath River below the project. Although PacifiCorp does not propose to remove any of the project dams, it does propose to decommission the East Side and West Side facilities to eliminate entrainment of federally listed suckers.

The Resighini Rancheria and the Institute for Fisheries Resources/Pacific Coast Federation of Fishermen's Associations recommend full decommissioning of the project, which we interpret to mean removal of all project dams. The Quartz Valley Indian Community, Klamath Tribes, Karuk Trib), Yurok Tribe, NMFS, Conservation Groups, and PFMC all recommend removal of the J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams.

Oregon Fish & Wildlife and Cal Fish & Game recommend that, if it proves not to be feasible to provide safe, timely, and effective upstream or downstream fish passage at any project facility, PacifiCorp prepare a decommissioning proposal for the subject facility in consultation with state, federal, and tribal stakeholders.

Oregon Fish & Wildlife also recommends that PacifiCorp prepare a decommissioning plan for East Side and West Side developments that includes permanent sealing of the intakes and fish-proofing of potential areas of mortality or injury within 1 year of license issuance and implement the plan within 1 year of Commission approval. NMFS and FWS recommend that PacifiCorp develop a decommissioning plan within 1 year that identifies optimal periods of the year to avoid impacts on fish and wildlife from decommissioning activities. NMFS also recommends that decommissioning be implemented within 3 years of license issuance, with results monitored to determine future needs.

NMFS recommends that PacifiCorp establish and maintain a decommissioning fund to finance potential future decommissioning of the project, as provided for in the Commission's policy statement on decommissioning. The Hoopa Valley Tribe recommends that, in the event that PacifiCorp proposes to abandon any of the project facilities, PacifiCorp would remove or modify project facilities and restore pre-project conditions in any manner reasonably required by federal and state agencies to maintain fish and wildlife production in the project-affected area.

The Yurok Tribe recommends the Commission enlist the help of stakeholders, agencies, and outside experts to decide the future fate of Iron Gate Hatchery and other potential artificial propagation programs in the event of decommissioning, and determine how the hatchery could best contribute toward restoration efforts in the Klamath Basin

Our Analysis

We do not consider the NMFS recommendation that PacifiCorp establish a decommissioning fund to be an environmental measure. Typically, the Commission would address the need for any such funding in its license order pertaining to this proceeding. Regarding the Hoopa Valley Tribe's recommendation that, in the event that PacifiCorp proposes to abandon any of the project facilities, PacifiCorp remove or modify project facilities and restore pre-project conditions to maintain fish and wildlife production, this issue, and others like it, would be addressed in a separate license amendment or surrender proceeding, during which conditions for abandonment would be established after confirming that another party does not want the license.

Effects of Mainstem Dam Removal on Fish Disease

Removal of one or more of the mainstem dams could reduce the incidence of fish disease in the Klamath River downstream of Iron Gate dam through several mechanisms. As discussed in section 3.3.2.2.2, *Water Quality*, removal of Iron Gate and Copco No. 1 dams would have a much greater effect on water quality below the current site of Iron Gate dam than removal of Copco No. 2 or J.C. Boyle dams, since these reservoirs have longer residence times and more prevalent blooms of nitrogen-fixing blue-green algae. Removal of Keno dam would have important effects on temperatures within the current Keno impoundment, which we discuss below. While the river would continue to receive high nutrient loads from Upper Klamath Lake and the Klamath Straits drain, the effects of these inputs on fluctuations in DO, pH, and ammonia would be moderated by natural aeration from turbulent passage of water in areas of higher gradient that are currently inundated by the reservoirs. Because this genus of algae is typically most prevalent in areas that are closest to a nutrient source, the section of river where *Cladophora spp.* dominates would likely move upstream from its current location between Iron Gate dam and the Shasta River to the areas that are currently inundated, and would become less prevalent downstream of the current site of Iron Gate dam. Restoring access to these reaches for anadromous fish would allow adult fall Chinook salmon to distribute over a greater length of the river, reducing crowding and the concentration of disease pathogens that currently occur in the reach between Iron Gate dam and the Shasta River.

Removal of one or more of the project reservoirs would also eliminate the thermal lag that is produced by the existing reservoirs, and diurnal variations in temperature would increase. The reduced thermal lag would provide more suitable temperatures for adult fall Chinook salmon, which would reduce temperature-induced stress and may allow for spawning to occur earlier in the fall. This, in turn, would result in earlier emergence and growth, and encourage earlier emigration. More rapid warming of temperatures in the spring would be likely to improve the growth rates of newly emerged fall Chinook salmon fry, but average temperatures would also increase to stressful levels earlier in the summer than currently occurs (see figure 3-37). The increase in average temperatures, however, may be compensated for by lower temperatures at night, which NAS (2004) concluded may allow rearing fish to move out of temperature refugia to forage at night, allowing growth to occur even when ambient temperatures are above optimal. Restoring natural sediment transport processes would contribute to the scour of attached algae downstream of the current site of Iron Gate dam, and deposited gravel and sand would provide a less favorable substrate for attached algae because of its greater mobility during high flow events than the existing armored substrate. The reduction in attached algae would provide less habitat for the polychaete intermediate host of *C. shasta* and *P. minibicornis*, which should reduce the infection rate of juvenile salmonids downstream of Iron Gate dam.

Removal of Copco No. 2 and J.C. Boyle dams would be expected to have much less of an effect on water quality conditions due to their smaller reservoir volumes, shorter residence times, and lack of substantial algae blooms. Removal of Keno dam would cause a more substantial reduction in water temperatures due to the larger surface area of the reservoir, which contributes to substantial warming during the summer months. However, water passing from Keno dam equilibrates with ambient temperatures as it travels downstream, and any effect on downstream water temperatures from its removal is unlikely to persist downstream of the current site of Iron Gate dam. Keno dam removal would likely result in a minor reduction in some nutrients, because conditions would be less favorable for blooms of *Aphanizomenon flos-aquae*. However, nutrient levels in the vicinity of Keno would remain high because of inputs from Upper Klamath Lake and the Klamath Irrigation Project.

Effects of Dam Removal on Anadromous Fish Restoration

Removal of one or more mainstem project dams would improve the prospects for restoring anadromous fish to areas upstream of the project in the following ways:

1. Based on our previous analysis, removal of one or more of the larger project reservoirs (Iron Gate or Copco reservoirs) would likely reduce the incidence of disease in the lower Klamath River migratory corridor and would reduce the risk of further declines by providing more time for habitat restoration efforts in the upper basin to take effect and for restoration strategies to be developed, tested, and implemented.

2. Reduction of disease incidence in the lower river migratory corridor would allow additional time for critical uncertainties regarding the feasibility of anadromous fish restoration to be addressed, including the ability of juvenile and adult anadromous fish to migrate though Upper Klamath Lake and Keno reservoir, and to determine whether a smolt collection facility would be needed to transport smolts around Keno reservoir. It would also allow additional time to develop locally adapted broodstocks that could successfully migrate to and from tributaries upstream of Upper Klamath Lake. Huntington et al. (2006) suggest that hatchery supplementation may be required over multiple generations to develop stocks of fall Chinook and coho salmon that are capable of migrating through Upper Klamath Lake and Keno reservoir during time periods when water quality conditions are suitable.

3. Removal of Iron Gate dam, with or without removal of additional dams, would increase the supply of sediments to the reach between Iron Gate dam and the Scott River, which has a net sediment deficit that we conclude is attributable to the project. It would also increase spawning habitat for fall Chinook salmon and spawning and rearing habitat for lampreys. For our analysis of the effects of the project on sediment transport, refer to section 3.3.1, *Geology and Soils.*

4. Removal of Iron Gate and Copco dams would restore 12.7 miles of inundated mainstem habitat that would provide substantial spawning habitat for fall Chinook salmon. We base this

conclusion on the similar gradient of the reach to the area between Iron Gate dam and the Shasta River that is currently heavily used by spawning fall Chinook salmon and by reports of substantial spawning activity in the Copco No. 2 bypassed reach (Coots and Wales, 1952). Under this scenario, we assume that upstream and downstream passage would be provided at Copco No. 2 dam and J.C. Boyle dams. We estimate that the habitat that would be made available by the removal of Iron Gate dam could support about 4,100 spawning fall Chinook, and the additional habitat that would be made available by removing Copco No. 1 dam could support another 7,700 adult fall Chinook.[65] These reaches would also would be likely to support smaller numbers of coho salmon and steelhead.

5. Removal of one or more dams would eliminate losses of anadromous fish associated with reservoir and dam passage at the dams that are removed. Removal of Iron Gate dam provides the greatest potential to restore Pacific lamprey, a species of cultural importance to the tribes, to historic habitat upstream of Iron Gate dam. Because of poor swimming ability of the species and its tendency to become impinged on screens, effective downstream passage technology for this species has not been developed. It also appears likely that the existing hatchery fish ladders which PacifiCorp would use to collect adult fish for upstream transport under its alternative prescription would not be effective for collecting Pacific lamprey for upstream transport, as PacifiCorp reports that lamprey have never been observed in these ladders.

We do not concur with Oregon Fish & Wildlife's recommendation that a decommissioning plan should be prepared for any development where effective upstream or downstream passage cannot be provided. Due to the serious water quality problems that exist in Keno reservoir and, at times in other project reservoirs, we conclude that trapping and transporting fish around one or more of the project reservoirs is likely to be part of any near-term passage solution that is implemented. The fishway prescriptions incorporate a trapping and transporting strategy that recognizes that, at least during certain periods, volitional fish passage may not be desirable unless substantial enhancements of water quality in Keno reservoir occurs. Furthermore, we are convinced that providing volitional passage at all project dams would provide little or no benefit unless disease issues in the downstream migratory corridor are addressed.

The Yurok Tribe recommendation that the Commission enlist the help of stakeholders, agencies, and outside experts to decide the future fate of Iron Gate Hatchery and other potential artificial propagation programs in the event of decommissioning would help guide the discussion of the role of the hatchery in restoration efforts in the Klamath Basin. If the dams were decommissioned, the original purpose of the hatchery, to compensate for lost production upstream due to blocked access created by Iron Gate dam, would no longer exist. However, the Commission has authority only over a licensee of a hydroelectric project, not stakeholders who may be interested in the role that Iron Gate Hatchery should play following any decommissioning action. We consider it most appropriate for state, federal, and tribal resource agencies to be responsible for determining the future role of the Iron Gate Hatchery. If Iron Gate development, or other project developments should be decommissioned at some time in the future, the Commission would address decommissioning in a surrender proceeding, not in this relicensing proceeding. The Commission could establish a forum for appropriate parties to discuss the disposition of

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[65]We used a density of 284 spawners per mile for tributary habitat based on spawner densities reported in Jenny and Fall creeks in Coots and Wales (1952) and Coots (1957). We used a density of 428 spawners per mile for low gradient mainstem habitat (Copco No. 2 bypassed reach and reaches inundated by Iron Gate and Copco reservoirs) and 214 spawners per mile in high gradient habitat (J.C. Boyle bypassed and peaking reaches) based on spawner counts reported in Coots and Wales (1952) for the Copco No. 2 bypassed reach. For low gradient mainstem habitat, we used a density two times that reported by Coots and Wales (1952) for the Copco No. 2 bypassed reach, because they also reported that a large amount of available spawning habitat was not used at the time of their survey.

Iron Gate Hatchery, as part of a decommissioning plan, but we consider it premature to anticipate what the Commission would include in any decommissioning order that may be issued.

Adverse Effects of Dam Removal on Aquatic Resources

As we discussed in section 3.3.2.2.2, *Water Quality*, there are potential adverse effects from the release of sediments that may be contaminated with pesticides from upstream agricultural sources. In the near term, an increase in fine sediments can also be expected to reduce the quality of fall Chinook spawning habitat downstream of Iron Gate dam. We note, however, that the quantity and quality of available spawning habitat would likely increase in the long term by restoring the transport of spawning gravels from upstream. Any adverse effects that occur to spawning fall Chinook salmon would only affect only those that spawn in the mainstem Klamath, and not the majority of fall Chinook salmon that spawn in its tributaries. Removal of the mainstem dams would also eliminate existing warmwater fisheries and habitat for adult shortnose and Lost River suckers in the project reservoirs. It would, however, increase the abundance and distribution of most native species of resident and anadromous fish.

East Side and West Side Decommissioning

Decommissioning of East Side and West Side developments would prevent suckers from being entrained through turbines at these developments where they may suffer mortality during passage. However, if the NMFS/Interior fishway prescription is implemented, this would include the installation of fish screens and smolt collection facilities at East Side and West Side developments, which would reduce or eliminate the entrainment of juvenile and adult suckers through project turbines, assuming generation is occurring.

Implementing PacifiCorp's alternative prescription could also result in fish screens being installed at East Side and West Side developments, since its alternative includes the construction of a smolt collection facility at a site to be selected upstream of J.C. Boyle dam. If juvenile migration studies conducted under the adaptive management plan (included in its alternative prescription) determine that water quality conditions in Keno reservoir are not sufficient to allow for successful migration, location of the smolt collection facility at Link River dam may be the only option that would provide effective downstream passage past Keno reservoir.

Because of the possibility that fish screening facilities would be installed at East Side and West Side developments, we conclude that it could be appropriate for PacifiCorp, in the process of preparing a decommissioning plan, to consult with NMFS, FWS, and Reclamation to determine whether it would be beneficial to include any accommodations that would facilitate the potential future construction of a smolt collection facility at Link River dam.

3.3.3.2.5 Anadromous Fish Restoration

Proposals to restore anadromous fish to areas upstream of Iron Gate dam as prescribed by NMFS/Interior, as described in PacifiCorp's alternative prescription, and as recommended by other stakeholders include three distinct approaches. NMFS/Interior's prescription includes the installation of volitional passage facilities at all project dams but includes a trap-and-truck option to transport juvenile and adult fish past Keno reservoir when water quality conditions are adverse. PacifiCorp's alternative prescription involves initiating feasibility studies to be followed by trap and truck from Iron Gate dam to above J.C. Boyle reservoir if studies indicate that establishing self-sustaining runs of anadromous fish is possible. The third approach involves removal of all or most of the mainstem dams. In this section, we summarize the risks and potential benefits that are associated with these three approaches, together with recommendations that relate to coordinating restoration efforts, developing an implementation plan, and conducting studies to guide an adaptive approach to restoring anadromous fish upstream of the project.

Additional detail on the benefits of installing fish passage facilities at specific developments are discussed in section 3.3.3.2.2, *Fish Passage.*

Oregon Fish & Wildlife and the Hoopa Valley Tribe recommend that PacifiCorp establish a fish passage implementation committee. The committee would consist of PacifiCorp, and, to the extent of their interest in participating, NMFS, FWS, Forest Service, the Bureau of Indian Affairs, Bureau of Land Management, Oregon Fish & Wildlife, Cal Fish & Game, Water Board, Oregon Environmental Quality, the Klamath, Karuk, Hoopa Valley, and Yurok tribes, and two representatives of non-governmental organizations. Unless specified otherwise, PacifiCorp would allow a minimum of 60 days for the committee members to comment, work to achieve consensus, and make recommendations before filing any study, operating, or implementation plan, report, or facility design with the Commission. If any of the fisheries management agencies (NMFS, FWS, Oregon Fish & Wildlife, or Cal Fish & Game) disapprove of a study, operating or implementation plan, report, or facility design, PacifiCorp would not submit the document to the Commission until a dispute resolution process has been completed. In their recommendation, the Hoopa Valley Tribe includes their fisheries department, Hoopa Fisheries, among the fisheries management agencies.

Interior recommends that PacifiCorp establish and fund the administrative costs for a fisheries technical committee to advise the licensee on the development of plans and environmental measures related to implementation of the new license. FWS also recommends that within 2 years, PacifiCorp prepare a Pacific lamprey management plan. The plan would include provisions for telemetry studies to evaluate upstream and downstream passage of Pacific lamprey through project fishways and reservoirs. It would also include measures to monitor and evaluate the timing of juvenile lamprey outmigration through the project, downstream passage routes and proportion of juvenile lamprey which use each route, juvenile lamprey survival through the project, and the effects of reservoir fluctuations on juvenile lamprey rearing. The results of these studies and information from other Klamath Basin facilities would be used to direct operational and structural improvements to project fishways and to develop and implement plans to modify or replace existing project structures and operations to achieve upstream and downstream survival and passage levels that are commensurate with the best levels achieved elsewhere in the Klamath Basin. Any actions undertaken under this plan would be monitored to assess success of the measures.

Klamath Tribes recommend that PacifiCorp fund efforts to reintroduce and restore Chinook salmon and steelhead and their habitats in all areas downstream of, within, and upstream of the project where the project has prevented access or significantly contributed to their decline. Siskiyou County recommends that PacifiCorp develop a fish passage plan that recognizes that fish re-introduction would most likely need to take place over the long-term to be effective, cost efficient, and result in minimal risk to current fish stocks. Studies and modeling would be used to evaluate what fish passage scenarios provide the most benefit for the least cost.

As part of the adaptive management plan that it includes in its alternative fishway prescription, PacifiCorp would evaluate juvenile salmonid survival through lakes and reservoirs from March through June 15 and from September through October, including the provision of up to 250 radio tags each year. Any juvenile fish collected during the juvenile downstream passage study would be transported to holding facilities at the Iron Gate Hatchery to assess their survival during transport by truck. PacifiCorp would collect adult salmonids at Iron Gate dam, tag them, transport them to various release sites upstream of J.C. Boyle dam, including the Williamson and Wood rivers, and conduct spawning surveys to determine if released fish successfully spawn. Radio tags would be used for tracking purposes, and survival during transport would be evaluated. PacifiCorp would uniquely mark all juvenile fish transported and released in the lower Klamath River, and would enumerate tagged fish upon their return to Iron Gate dam, possibly including a search of spawning areas to retrieve tags. The results would provide a basis for estimating smolt to adult survival for a minimum of 5 brood years. PacifiCorp would also monitor early life history and migration in upper Klamath basin tributaries (e.g., Wood and Williamson rivers) using screw traps to determine survival rate, whether the dominant life-history expressed by reintroduced fish is an ocean-type (migrating to the ocean as subyearlings) pattern or spring-type (migrating to the ocean as yearling) pattern, and when juvenile migration begins and ends. Based on the results and analysis of these Phase 1 studies, fisheries managers would decide if self-sustaining runs of anadromous fish can be established. If the fisheries managers conclude that self-sustaining runs can be established, PacifiCorp would design permanent juvenile collection facilities at or above Boyle dam, modify the adult collection facility at Iron Gate dam, and implement a reintroduction program using a trap and haul approach. If fisheries managers decide self-sustaining runs of anadromous fish cannot be established, PacifiCorp would conduct a limiting factors analysis to identify obstacles for establishing such runs. PacifiCorp would not have any responsibility for addressing an identified limiting factor, but if others are successful in removing the obstacle, PacifiCorp would conduct studies to confirm that the factor is no longer limiting, and if not, implement reintroduction efforts.

Our Analysis

Our general assessment of the potential benefits and risks of the three primary alternative approaches for restoring anadromous fish reflected in agency recommendations and prescriptions, and PacifiCorp's alternative prescription is summarized in table 3-72. The NMFS/Interior prescription takes the approach of requiring volitional upstream and downstream passage facilities at each development and tailrace barriers at each of the project powerhouses with the exception of Iron Gate dam, but also includes provisions for collecting smolts at Link River dam and adult fish at Keno dam to transport past Keno reservoir when water quality conditions are adverse. Although provision of facilities that would allow fish to be trapped and trucked around Keno reservoir adds flexibility to the passage approach that can be taken, the prescription does not appear to take into account cumulative stress and mortality that may result from passage through the five project reservoirs and screening facilities associated with four mainstem powerhouse intakes. Given the potential for predation and exposure to adverse water quality conditions during passage through project reservoirs and screening facilities, we conclude there is a strong basis for questioning whether the provision of volitional passage at each project development would provide any advantage or benefit over the trap and truck approach described in PacifiCorp's alternative prescription. This concern is consistent with the results of PacifiCorp's fish passage modeling efforts, which indicate that cumulative losses of juvenile and adult salmon under volitional passage would exceed those that would occur under a trap and truck approach (table 3-73), resulting in similar predicted run sizes, despite the greater amount of habitat that would be made accessible within the project area by volitional passage (table 3-74). Regarding the potential need for tailrace barriers at the J.C. Boyle, Copco No. 1 and Copco No. 2 developments, NMFS/Interior provide no evidence to suggest that turbine draft tube injuries or migration delay would occur at these powerhouses.

PacifiCorp's alternative prescription takes a more precautionary approach to addressing critical uncertainties that may affect the feasibility of restoration before making a substantial investment in a smolt collection facility upstream of J.C. Boyle dam. Although this is a slower-paced approach towards achieving anadromous fish restoration, the more deliberate and thorough examination of the constraints that affect passage through Upper Klamath Lake and Keno reservoir may contribute to a better understanding of migration timing requirements and assist with the selection of appropriate stocks for reintroduction.

PacifiCorp's alternative prescription includes a suite of studies that would be conducted during Phase 1 of the adaptive reintroduction plan, which are listed in table 3-75. Many of the key uncertainties would be addressed in the first 5 years of study. Although PacifiCorp indicates that some aspects of the Phase 1 studies may require 9-10 years to complete, we conclude that 5 years is probably sufficient time to address the key critical uncertainties, and to identify the most promising site for constructing a smolt collection facility, if warranted.

Table 3-72. Comparison of the benefits of three alternative approaches to anadromous fish restoration.[a] (Source: Staff)

	NMFS/Interior preliminary prescription: volitional passage at all dams with transport option	**PacifiCorp alternative prescription: trap and truck from Iron Gate to above J.C. Boyle**	**Remove Copco and Iron Gate dams, fish passage at Copco No. 2, J.C. Boyle, and Keno dams**
Benefits	Provides access to 355 miles of habitat upstream of Upper Klamath Lake if migration through Upper Klamath lake is feasible. Provides access to 27.7 miles of mainstem habitat and 20.2 miles of tributary habitat within the project.	Provides access to 355 miles of habitat upstream of Upper Klamath Lake if restoration is determined to be feasible. Provides access to 14.7 miles of tributary habitat if passage to/from Spencer Creek is provided for coho. All smolts could be trucked to a release point in the lower river, bypassing most passage risks including the disease "hot spot" upstream of the Shasta River confluence.	Provides access to 355 miles of habitat upstream of Upper Klamath Lake if migration through Upper Klamath lake and Keno reservoir is feasible. Provides access to 40.4 miles of mainstem habitat (including habitat now inundated by Iron Gate and Copco reservoirs) and more than 20.2 miles of tributary habitat within the project. Risks during downstream passage through the project reach and the lower Klamath River would be substantially reduced due to improved water quality and reduced habitat for pathogens and their alternate host. Disease risk to salmon downstream of Iron Gate dam and in lower river tributaries would be reduced due to reduced crowding, increased scour of algae, reduced nutrients and improved water quality. Spawning and rearing habitat downstream of Iron Gate dam would be substantially improved due to restoration of sediment transport increasing spawning gravel and channel complexity.
Risks	Increased risk of transmission of disease (especially Infectious hematopoietic necrosis [IHN])to upper watershed, but may be reduced by initiating restoration efforts using disease-free eggs and juvenile fish. Benefits could be reduced by disease losses in the lower Klamath River unless disease management efforts in the lower river are successful.	Increased risk of disease (especially IHN) to upper watershed, but may be reduced by initiating restoration efforts using disease-free eggs and juvenile fish. Benefits could be reduced by disease losses in the lower Klamath River unless disease management efforts in the lower river are successful.	Increased risk of disease (especially IHN) to upper watershed, but may be reduced by initiating restoration efforts using disease-free eggs and juvenile fish. Potential adverse effects on trout fishery in J.C. Boyle bypassed and peaking reaches due to potential introduction of IHN and increased competition with anadromous fish.

[a] All options would include a smolt collection facility at Link River if studies indicate that fall Chinook produced in the upper basin emigrate after mid-June, when water quality conditions in Keno reservoir become unsuitable.

Table 3-73. Cumulative average survival estimates for all-volitional and collection and transport alternatives used in the KlamRAS fish passage model for fall Chinook salmon originating above Upper Klamath Lake. (Source: Oosterhout, 2005a, cited from PacifiCorp, 2006b)

Life Stage	Destination Node	Average Cumulative Survival All-Volitional	Average Cumulative Survival Collection and Transport
Juveniles	Above Upper Klamath Lake to below Link dam	0.78	0.78
	Below Link dam to below Keno dam	0.63	0.63
	Above J.C. Boyle to below J.C. Boyle	0.54	0.54
	Above Copco to below Copco	0.46	Transport
	Above Iron Gate Dam to below Iron Gate Dam	0.42	Transport
	Below Iron Gate Dam to ocean	0.34	0.42
Adults	Ocean to Iron Gate Dam	0.98	0.98
	Below Iron Gate Dam to above Iron Gate Dam	0.90	Transport
	Below Copco to above Copco	0.77	Transport
	Below J.C. Boyle to above J.C. Boyle	0.70	Transport
	Below Keno to below Link	0.65	Transport
	Below Link to above Upper Klamath Lake	0.60	0.68 (0.79)[a]

[a] For adults transported from Iron Gate dam to above Upper Klamath Lake.

Table 3-74. Estimated adult anadromous fish abundance under volitional passage and trap and transport alternatives. (Source: Oosterhout, 2005b; PacifiCorp, 2005e)

Species	All-Volitional Passage EDT	All-Volitional Passage KlamRAS	Trap and Transport EDT	Trap and Transport KlamRAS
Fall Chinook	3,169	29,754	3,619	28,539
Spring Chinook	1,354	--	2,674	--
Steelhead	358	--	363	--

Notes: EDT -- Ecosystem diagnosis and treatment model
KlamRAS -- This model incorporates both habitat data (from EDT) and fish passage survival through project structures to estimate fish production in specific reaches or areas of the basin.

Table 3-75. Phase 1 studies under PacifiCorp's alternative prescription. (Source: PacifiCorp, 2006b)

Critical Uncertainty	Study Name	Time Frame (years)	Facilities
Can juveniles migrate successfully through Upper Klamath Lake, Lake Ewauna, and J.C. Boyle reservoir?	Juvenile survival through Upper Klamath Lake, Lake Ewauna, and J.C. Boyle reservoir	5	Monitoring facilities at A-canal and J.C. Boyle, additional juvenile collectors as needed
What is the survival rate for transported juveniles?	Juvenile Transport Survival	5	Transport system at A-canal, J.C. Boyle, and any temporary facilities.
What is the overall survival rate of transported adults?	Adult Survival and Behavior During Transport and Migration	5	Upper Klamath release sites.
Can adults migrate successfully through lakes and reservoirs?			

Critical Uncertainty	Study Name	Time Frame (years)	Facilities
What is the representative range of SAR for Upper Klamath River Origin anadromous fish?	Smolt-to-Adult Survival Rate	5 brood years 9 years	No new facilities expected; dependent on mark type.
Does the release of anadromous fish to the upper basin result in increased disease related mortality on local redband and other resident fish species?	Disease (Juvenile and Adult)	10	None.
What is the behavior and early life-stage survival of juvenile fish produced from the upper basin?	Early Life Stage Survival and Juvenile Production	10	Screw-traps at mouth of key tributaries.

One limitation of using a single smolt collection facility to transport smolts past the other project dams is that some outmigrating smolts would avoid collection by passing over the spillway when flows exceed the capacity of the screening facility. These fish would then be subject to entrainment and potential turbine mortality at downstream developments. This risk, however, could be assessed via radio telemetry studies conducted during spill events, which would allow the potential benefits of shutting down or reducing generation at specific developments during peak migration periods to be evaluated.

As we discuss in section 3.3.3.2.3, *Disease Management*, neither the NMFS/Interior prescription nor PacifiCorp's alternative prescription address disease issues in the lower river migratory corridor. We reiterate our concern that, unless this issue can be addressed both promptly and effectively, implementing fish passage through the project may yield little or no benefit.

The third approach to anadromous fish restoration, removing one or more of the project dams in conjunction with provision of fish passage at the remaining dams, probably holds the greatest promise for restoring anadromous fish species, especially if Iron Gate and Copco No. 1 dams are removed. As discussed in section 3.3.3.2.4, *Dam Removal or Decommissioning*, this approach would be likely to reduce fish stress and disease losses in the lower Klamath River by improving water quality, and provide access to additional spawning habitat that is currently inundated by Iron Gate and Copco reservoirs. We consider removal of Iron Gate dam to be the only feasible method to effectively restore Pacific lamprey to a portion of their historic range, since available screening technology is not likely to provide effective downstream passage for this species. We consider it highly unlikely that the telemetry studies recommended by FWS would lead to a solution that would allow juvenile lamprey to migrate successfully through large reservoirs such as Copco and Iron Gate reservoirs or to the development of a cost-effective screening technology for this species.

Because any new license is likely to include a number of environmental measures that would have an adaptive management component, we conclude that it would be beneficial for PacifiCorp to establish and fund the administrative costs for a fisheries technical committee to advise PacifiCorp on the development of plans and environmental measures, as recommended by Interior. The committee could provide an oversight role for all fisheries measures including those related to spawning gravel augmentation, disease management, and anadromous fish reintroduction. Because these measures are interrelated and involve many of the same areas of expertise, we do not see the need for or benefit of establishing a specific committee that would be charged with the oversight of anadromous fish restoration. Inclusion of all of the fisheries management agencies and affected tribes would be appropriate, given their shared interest in anadromous fish conservation and restoration.

A fourth approach that could be implemented in conjunction with or independently from a trap-and-haul approach for restoring anadromous fish to Upper Klamath Lake tributaries would be to assess opportunities for restoring anadromous fish to one or more of the reaches that are within the Klamath Hydroelectric Project boundary. Our assessment of the number of spawning fall Chinook salmon that could be accommodated in each reach is provided in table 3-76.

Table 3-76. Estimated number of adult fall Chinook that could be accommodated by spawning habitat in the Iron Gate to Copco No. 2 dam, Copco No. 1 to J.C. Boyle, and J.C. Boyle to Keno reaches. (Source: Staff)

Location	Habitat Capacity (adult fish)	Basis
Iron Gate to Copco No. 2 dam		
Fall Creek	300	Coots (1959) estimated that Fall Creek can support 300 spawners in the accessible 1.1 miles of stream.
Jenny Creek	250	Coots and Wales (1952) estimated that 250 Chinook spawned in the 0.9 miles of accessible stream in 1952.
Copco No. 2 bypassed reach	600	Coots and Wales (1952) estimated that 300 Chinook spawned in the 1.4-mile long bypassed reach in 1952 at an observed flow of 8 cfs. They noted that "a large portion of the spawning areas appeared unused." With gravel augmentation and increased minimum flows, we estimated that the reach could support 600 spawners, which equates to 428 spawners per mile.
Reach Total	**1,150**	
Copco No. 1 to J.C. Boyle dam		
Shovel Creek	937	Huntington et al. (2006) reports that Shovel Creek has 3.3 miles of usable habitat. Using the average spawner density of 284 fish per mile observed by Coots and Wales (1952) in Jenny and Fall Creeks, we estimate that Shovel Creek could support about 937 spawners.
Long Pine Creek	213	Olsen (2006) reports that Long Pine Creek has about 0.75 miles of usable habitat. Using the average spawner density of 284 fish per mile observed by Coots and Wales (1952) in Jenny and Fall Creeks, we estimate that Long Pine Creek could support about 213 spawners.
J.C. Boyle peaking reach	3,702	To account for high gradient and limited spawning gravel, we used half of the spawner density used for the Copco No. 2 bypassed reach. Based on a stream length of 17.3 miles and 214 spawners per mile, we estimate that the peaking reach could support about 3,702 spawners.
J.C. Boyle bypassed reach	920	To account for high gradient and limited spawning gravel, we used half of the spawner density used for the Copco No. 2 bypassed reach. Based on a stream length of 4.3 miles and 214 spawners per mile, we estimate that the bypassed reach could support about 920 spawners.
Reach Total	**5,772**	
J.C. Boyle to Keno dam		
Spencer Creek	4,175	Huntington et al. (2006) reports that Spencer Creek has

Location	Habitat Capacity (adult fish)	Basis
		14.7 miles of usable habitat. Using the average spawner density of 284 fish per mile observed by Coots and Wales (1952) in Jenny and Fall Creeks, we estimate that Spencer Creek could support 4,175 spawners.
Keno reach	0	Assumed to be water quality limited
Reach Total	**4,175**	

This approach could include the introduction of adult fall Chinook into each of the three reaches and use radio telemetry methods to monitor fish movement and locations used for spawning. Production of juvenile fall Chinook could be monitored by screw-trap sampling at the lower end of each reach or at the mouths of key tributaries. Approximately 3 years of radio telemetry and juvenile production monitoring would allow year-to-year variability to be assessed. Based on the results of these monitoring studies, the production potential of each reach could be assessed in conjunction with an evaluation of options for providing downstream passage, to select a single reach for initial restoration efforts. Once the most cost-effective reach for restoration has been determined, measures to improve habitat conditions in the selected reach, such as gravel augmentation or changes in project operations, could be considered for implementation, and a downstream passage facility installed at an appropriate location.

These reach-specific restoration efforts could also facilitate restoration efforts to tributaries upstream of Upper Klamath Lake. If the J.C. Boyle to Keno reach was selected for reach-specific restoration efforts, the smolt collection facility would likely be situated in an appropriate location for collecting smolts that migrate into the project area, and it could be used to transport collected smolts for release downstream of Iron Gate dam.

3.3.3.2.6 Iron Gate Hatchery Operations

Cal Fish & Game operates Iron Gate Hatchery, and PacifiCorp funds 80 percent of the total operating costs to satisfy its annual mitigation goals for fall Chinook salmon fingerlings, coho yearlings, and steelhead yearlings. All adult steelhead processed in the hatchery are returned to the Klamath River, and all juvenile salmon and steelhead that are produced are released directly into the Klamath River from the hatchery. Maintaining genetic diversity by distributing the egg allotment throughout the spawning run takes precedence over meeting numeric production goals.

The hatchery production supports recreational and commercial fisheries in the Klamath River Basin and the Pacific Ocean, and current hatchery production goals are presented in table 3-52. Beginning in 1979, portions of the fall Chinook salmon fingerling production have been reared to the yearling stage for release in November in order to reduce potential interactions with wild fish in the lower river in June. The Chinook salmon yearling program is funded entirely by Cal Fish & Game; although since 2004 funding for this program has not been available. Furthermore, no yearlings were released in 1997 or 1998. When there is no yearling production, the number of smolts released is increased.

Current production at Iron Gate Hatchery maximizes use of the facilities, with six of eight raceways dedicated to Chinook salmon production, and one each for coho salmon and steelhead. In years when Cal Fish & Game funds Chinook salmon yearling production, the Fall Creek facility is used for rearing approximately 200,000 fall Chinook salmon to the yearling stage, with survival to release typically 180,000 fish at 8 fish/lb. Water used to support current production at Iron Gate comes from high and low-level intakes at Iron Gate reservoir, and from late spring through early fall, water for the raceways and upper ladder is supplied from the 70-foot deep intake at Iron Gate. This supply of cool water from below the thermocline is limited, and in some years is depleted by late summer, to the extent that warm water temperatures have caused substantial mortalities of adult Chinook salmon in the pre-spawning holding ponds (PacifiCorp, 2005k). At the Fall Creek facility, Cal Fish & Game diverts and uses 6 to 9 cfs from the Fall Creek bypassed reach. Flows are returned back to Fall creek.

PacifiCorp proposes to maintain their current obligation to fund 80 percent of the annual O&M costs for production and operation of Iron Gate Hatchery. It also proposes to fund minor upgrades at Iron Gate Hatchery, although no details of the upgrades were provided.

Currently, about 5 percent of Chinook salmon produced at Iron Gate Hatchery are tagged with coded wire tags and marked with an adipose fin clip. Cal Fish & Game funds the marking (fin or maxillary clip) of all coho (75,000 released annually since 1996) and all steelhead (200,000 released annually since 1998). PacifiCorp proposes to purchase and construct a mass-marking facility at Iron Gate Hatchery to enable tagging 25 percent of released fall Chinook salmon. This measure would fund annual tagging operations including labor, equipment, and tagging materials.

The Klamath Tribes recommend PacifiCorp continue funding for O&M of Iron Gate Hatchery and bring hatchery management up to standards appropriate for a conservation hatchery, as determined by a hatchery technical advisory group. NMFS and Cal Fish & Game recommend that PacifiCorp fund 100 percent of hatchery annual operating costs,[66] facility improvements, new construction, fish marking, monitoring and recovery costs, and any permits and plans required by state or federal agencies. NMFS further recommends the hatchery facilitate implementation of fish passage measures to restore wild runs of anadromous and resident fish above and below the project. The Klamath Tribes recommend PacifiCorp fund a group of state, federal and tribal technical experts to provide recommendations and guidance to fisheries' managers to maximize the use of Iron Gate Hatchery for anadromous salmonid restoration and management efforts on portions of the Klamath River Basin affected by the project.

NMFS, FWS, Cal Fish & Game and the Forest Service recommend that PacifiCorp consult with the agencies to develop a hatchery and genetics management plan for Iron Gate Hatchery operations that includes: (1) an accurate adult census of natural salmonids; (2) determination of the rate and contribution of hatchery strays to natural spawning stocks; (3) determination of the rate of competition between hatchery and natural salmonids; (4) determination of genetic characteristics of natural and hatchery coho and steelhead stocks; (5) determination of outmigration timing of hatchery and natural stocks; (6) maintenance of tribal trust and resource trustee obligations to mitigate for lost habitat; (7) development of conservation hatchery techniques; and (8) minimization of any negative effects from fish husbandry or juvenile releases on native, naturally occurring populations of listed salmonids.

The Forest Service recommends PacifiCorp be responsible for marking 25 percent of all Chinook salmon releases. Cal Fish & Game recommends PacifiCorp fully fund marking 25 percent of Chinook salmon released, allowing for adjustment to the marking rate as new technologies are developed or deemed appropriate in consultation with agencies and affected tribes. FWS recommends PacifiCorp be responsible for marking 25 percent of Chinook salmon releases and 100 percent of coho releases. NMFS recommends PacifiCorp be responsible for tagging 100 percent of hatchery-released Chinook salmon.

Siskiyou County recommends the Commission consider the scientific questions around "wild fish" production versus "hatchery fish" production. They state they understand the goal of favoring wild fish populations over hatchery fish to be federal and state fisheries agency policy; however, they request resolution of the question of "…when hatchery fish are or are not the "same" as wild fish."

Our Analysis

Production from Iron Gate Hatchery contributes to commercial, tribal, and recreational fisheries in the Klamath River Basin and the Pacific Ocean. In the mixed-stock coastal fisheries of the Pacific

[66]Cal Fish & Game states that Fall Creek rearing facility operations are integral to Iron Gate Hatchery, and incorporates Fall Creek in all its recommendations for Iron Gate Hatchery.

Ocean, the presence of hatchery fish allows for higher harvest levels than if there were no hatchery stocks in the fishery. PacifiCorp's proposal and the agency's recommendations to continue to produce fish from the Iron Gate Hatchery would provide fish to support these fisheries. However, because wild fish are harvested along with hatchery fish in coastal commercial and recreational fisheries, an increase in allowable harvest may also affect the escapement of wild stocks when these fish are harvested along with hatchery fish.

Hatchery production can benefit natural stocks of salmonids by increasing their population and conserving genetic strains of populations that are at risk of extinction. Hatchery production may also have an adverse effect on natural populations through behavioral differences that result in diminished fitness and survival of hatchery fish relative to naturally spawned fish, genetic effects resulting from poor broodstock and rearing practices, and increased competition with and predation on naturally spawned populations (NMFS, 2006). At Iron Gate Hatchery, wild spawners are commonly integrated into the hatchery egg take to minimize genetic digression between hatchery and wild stocks.

PacifiCorp (2005k) evaluated several alternatives for increasing production of Chinook salmon yearlings at Iron Gate Hatchery. The rationale for producing fewer Chinook salmon smolts and replacing the production with more yearling Chinook salmon is to lessen competition for space and food resources in the lower river during the spring when most wild Chinook salmon smolts are migrating. Available space for outmigrating smolts during late spring is often limited to thermal refugia. As the water temperature warms, smolts of wild and hatchery origin crowd into such habitat creating stressful conditions. Stress from crowding can result in mortality from a variety of causes, including increased susceptibility to disease, as discussed in section 3.3.1.4, *Diseases Affecting Salmon and Steelhead*. In addition to funding the yearling fall Chinook program in past years, Cal Fish & Game implemented an early release strategy starting in 2001 to reduce crowding of smolts in thermal refugia late in the migration season. Instead of releasing subyearling Chinook smolts between June 1 and June 15 as was previously done, smolts are now released in four groups beginning in May (Hampton, 2005).

Production scenarios evaluated by PacifiCorp include continuing existing production levels (Alternative 1), replacing a portion of the current Chinook salmon subyearling smolt production with the equivalent weight of yearling production (Alternative 2), producing all Chinook salmon at the hatchery to yearling stage (Alternative 3), modifying Alternative 2 to include producing spring Chinook salmon (Alternative 4), and converting all hatchery production to yearling Chinook salmon and eliminating all coho and steelhead production (Alternative 5).

The scenarios evaluated by PacifiCorp assume the total pounds of fish produced at Iron Gate Hatchery remain approximately the same as current production due to limitations of the existing water supply. As previously discussed, water used to support current production at Iron Gate comes from high and low-level intakes at Iron Gate reservoir, and from late spring through early fall, water for the raceways and upper ladder is supplied from the 70-foot deep intake at Iron Gate. This supply of cool water from below the thermocline is limited, and in some years is so depleted by late summer that warm water temperatures have caused substantial mortalities of adult Chinook salmon in the pre-spawning holding ponds (PacifiCorp, 2005k). For this reason PacifiCorp did not evaluate expansion of capacity at Iron Gate Hatchery when evaluating Alternatives 2 through 5.

For the Fall Creek facilities, PacifiCorp assumes a 12 cfs minimum flow would be maintained in Fall Creek.[67] Existing stream flow in Fall Creek is typically about 40 cfs, and the city of Yreka maintains a water right for 15 cfs. Therefore, 40 cfs less the 15 cfs water right less the 12 cfs minimum flow would leave 13 cfs available for hatchery uses. The existing facility uses 6 to 8 cfs when operational (PacifiCorp indicated this could possibly be reduced to 4 cfs), therefore 5 to 7 cfs of flow would potentially be

[67] In its alternatives analysis, PacifiCorp assumes a minimum instream flow of 12 cfs. In its license application, it proposes a 15 cfs minimum flow release for Fall Creek.

available for new facilities, assuming no additional water supplies could be identified. If water used by the existing hatchery could be reused at a new downstream facility, then up to 13 cfs could be available.

The production totals evaluated in Alternatives 2 through 5 are limited by the estimated water supply available from Fall Creek. PacifiCorp assumes increasing yearling production under Alternatives 2 and 3 would require an additional facility be constructed at Fall Creek[68] to accommodate rearing an additional 300,000 yearling fish, and would use approximately 6.2 cfs and 8.4 cfs, respectively from Fall Creek. PacifiCorp estimates Alternative 4 would require new facilities that use 5.4 cfs of flow, and Alternative 5 would require an estimated 6.2 cfs of flow from Fall Creek.

Currently, production at Iron Gate Hatchery is at full capacity based on available water supplies. Therefore, without increasing capacity, a shift to produce more yearlings would substantially reduce the number of subyearling smolts that could be produced. Based on its analysis of alternatives 1 through 3, PacifiCorp concluded that shifting towards yearling production would decrease total returns of adult fall Chinook salmon to the hatchery.[69] PacifiCorp assumed in its analysis that subyearling smolts would have an adult return rate of 1 percent and yearling smolts would have an adult return rate of 3 percent.

Recent returns of Chinook salmon to Iron Gate Hatchery indicate that adult return rates are highly variable, especially for fish that were released as subyearling smolts. In a comparison of subyearling and yearling return rates for fall Chinook releases for 1990-1996 and 1999-2000, Hampton (2005) found that return rates of subyearlings were 0.05 percent or less in four out of 9 years evaluated (table 3-77). Furthermore, preliminary data from the 2001 brood year indicated that only 181 out of 3,149 adults that returned as age 3+ fish in 2004 were from subyearling releases. Hampton (2005) concluded that low flow conditions that occurred during the spring of 2002 when the 2001 brood year emigrated from the river, and the lack of substantial scouring flows in the preceding 2 years, may have contributed to high losses from disease during the spring outmigration. He also noted subyearling smolts from the 1992 brood year may have benefited from high flows that occurred during the spring outmigration period, and that this is the only brood year where the return rate of subyearling smolts exceeded the adult return rate for fish that were released as yearlings (table 3-77).

Table 3-77. Ratio of coded-wire tagged Chinook salmon subyearling and yearling smolt release return rates (percent) to Iron Gate Hatchery and water-year types. (Source: Hampton, 2005; Reclamation, 2003; adapted by staff)

Brood Year[a]	Return rate of tagged subyearlings (%)	Return rate of tagged yearlings (%)	Ratio yearling/ sub-yearling returns	Average monthly flow (cfs) in year of outmigration (brood year plus 1)	
				May	June
1990	0.38	0.77	2.04	874	677
1991	0.05	0.18	3.66	513	506
1992	0.55	0.36	0.66	2,677	2,408
1993	0.03	0.20	9.42	727	704
1994	0.05	0.52	10.84	3,251	1,073
1995	0.04	1.06	23.87	3,279	1,532
1996	0.08	0.61	7.39	2,104	1,243
1999	0.38	0.56	1.5	2,282	1,334
2000	0.14	0.67	4.65	1,726	1,897
AVG	**0.19**	**0.55**	**7.11**	**1,937**	**1,263**

[a] There were no yearling releases in 1997-1998 due to funding limitations.

[68] PacifiCorp assumes the existing Fall Creek rearing facility is used to capacity to rear 180,000 fall Chinook yearlings.

[69] PacifiCorp estimates Alternative 1 through 3 fall Chinook adult returns at 81,400; 61,400; and 44,640 fish, respectively (PacifiCorp, 2005k).

The highly variable return rates observed for subyearling smolt releases indicates that pursuing a more balanced strategy of releasing both subyearling smolts and yearling fall Chinook salmon may provide more consistent adult returns, and help to prevent a severe decline if several years of poor spring migration conditions were to occur in a row. As discussed in section 3.3.3.2.3, *Disease Management*, there appears to be a trend towards increased losses of subyearling juvenile fall Chinook from disease, with mortality rates exceeding 70 percent in the last half of the outmigration in both 2004 and 2005. Releasing a substantial portion of hatchery-produced fall Chinook salmon as yearlings, which are released in November when water quality conditions are more favorable, would reduce the potential for hatchery fish to be exposed to disease, consequently reducing the potential for severe decline in adult returns.

The recommendations by the Klamath Tribes, NMFS, FWS, and Cal Fish & Game to develop a hatchery genetics management plan in consultation with an advisory committee would provide a structure for ongoing analysis of hatchery programs and recommendations for future management of hatchery production. Hatchery and genetic management plans are described in NMFS's final salmon and steelhead 4(d) rule (July 10, 2000, 65 FR 42422) as a mechanism for addressing the take of certain listed species that may occur as a result of artificial propagation activities. However, we view development of the hatchery and genetics management plan to be the responsibility of Cal Fish & Game, because it can manage and operate the hatchery and manage fisheries on the stocks that are produced at the hatchery. Cal Fish & Game is also in a better position to evaluate the incidence and distribution of hatchery fish spawning in the Klamath River and its tributaries because it conducts or coordinates spawning ground surveys and escapement estimates throughout all parts of the basin that are accessible to anadromous fish.

PacifiCorp proposes, and FWS and Cal Fish & Game recommend marking 25 percent of hatchery-released Chinook salmon. Such marking can help reduce harvest mortality on wild Chinook salmon through implementation of harvest restrictions on unmarked fish. Marking hatchery fish, including coho and steelhead, would aid recovery and harvest management programs by enabling an assessment of the relative contribution of hatchery and natural production of these fish in the ocean and inland harvests, in-river spawning escapements, straying rates, and hatchery returns. Marking hatchery fish can also aid in distinguishing the origin of fish that may be re-introduced to spawn in habitats upstream of Iron Gate dam.

Marking only a portion of the fish released would make it impossible for fishermen to distinguish non-clipped hatchery fish from wild fish. Furthermore, if selective harvest restrictions were in place to protect natural spawners, this could reduce the amount of catch that may otherwise be available for harvest. Marking 100 percent of hatchery fish released would avoid that occurrence. The ability of fishermen to distinguish coho salmon of hatchery origin, which are not protected under the provisions of the ESA, from those of wild origin, which are protected under the ESA, would avoid inadvertent takings of federally listed salmon. The ability of recreational fishermen to distinguish Klamath fall Chinook salmon of hatchery origin from those of wild origin, whose harvest is regulated under the terms of the Pacific Salmon Management Plan, would allow for targeted fisheries on hatchery stocks in years when all harvest of Klamath Chinook may be prohibited, as they are in 2006.

Siskiyou County requests that the Commission require resolution of the question of "…when hatchery fish are or are not the "same" as wild fish." In a review of 18 studies estimating relative fitness of hatchery and natural anadromous salmonids, Berejikian and Ford (2004) find that the literature on genetic introgression of hatchery and natural populations is inconclusive. They find that variables such as intensity and duration of stocking efforts, genetic similarity of hatchery and natural stocks, habitat quality, selective fisheries, and other factors make it difficult to ascertain relative fitness between stocks. Although relative fitness is only one aspect of whether hatchery fish are the same as wild fish, these results illustrate that resolving this question requires much more study. Conducting such research falls outside the purview of the Commission, and more appropriately rests with the fisheries scientists and management agencies.

3.3.3.2.7 Habitat Enhancement

PacifiCorp proposes to modify irrigation diversions associated with its Copco Ranch (a non-hydro related property) to reduce entrainment of trout fry and to increase instream flows. It proposes to replace unscreened gravity-fed diversions in the J.C. Boyle peaking reach with screened pump systems and to eliminate existing diversions on Shovel Creek and its tributary, Negro Creek.

Siskiyou County recommends that PacifiCorp fund about $26 million of programs over the next 5 to 10 years. These programs, as identified by the Shasta Valley and Siskiyou Resource Conservation districts, focus on (1) maintaining connectivity to ensure juveniles can emigrate from the tributaries to the mainstem and from the mainstem or lower portion of the tributaries upstream to suitable habitat; (2) habitat improvement programs that focus on minimizing the effects on riparian areas, ensuring adequate flows, and addressing temperature-related issues; (3) water quality programs that focus on implementing riparian planting projects to increase shade needed to cool water temperatures; (4) water supply improvement programs that enhance stream flows; and (5) monitoring and assessment programs.

NMFS and FWS recommend that PacifiCorp develop habitat protection, mitigation, and enhancement plans to mitigate for effects on upstream and downstream migrating anadromous fish (FWS also includes effects on migrating federally listed suckers). The plans would include (1) assessing the effectiveness of all upstream and downstream fish passage facilities; (2) evaluating the survival of upstream and downstream migrating fish; (3) identifying fish protection, mitigation, and enhancement measures such as modifications of project facilities and operations to maximize the efficiency of fishway operations, including reservoir elevations and flows, and predator and predation control; and (4) implementing the measures and monitoring to ensure their effectiveness.

Oregon Fish & Wildlife recommends that PacifiCorp develop and implement a fish and wildlife habitat restoration resource management plan. The plan would entail an annual compilation of information summarizing progress towards restoring fish and wildlife habitat below, within, and above the project. The plan would be updated every 5 years in consultation with stakeholders. Annual reports would include a work plan for the upcoming year, a report on actions that were implemented in the previous year, and a monitoring and compliance report. Oregon Fish & Wildlife recommends that stakeholders be provided a minimum of 60 days to review and comment on all plans and actions, and that consultation be documented in each plan or report that is submitted to the Commission.

NMFS, FWS, Cal Fish & Game, Oregon Fish & Wildlife, and the Hoopa Valley Tribe recommend that PacifiCorp develop plans to restore habitat above and below the project to mitigate for continued, ongoing, and cumulative project effects. The plans would be developed to compensate for project effects on (1) 5 miles of bypassed channel at the J.C. Boyle and Copco No. 2 developments; (2) 14.2 miles of riverine channel inundated by project reservoirs; and (3) any other continued effects on anadromous fish that are not avoided in future operations, including fish passage facilities that are not 100 percent effective. Oregon Fish & Wildlife and the Hoopa Valley Tribe recommend that the plans include projects that enhance and improve wetlands, riparian and riverine habitat, and riparian, aquatic, and terrestrial species connectivity, including measures such as habitat restoration projects, instream flow and water quality restoration, and land acquisition. FWS and NMFS recommend that the plan include measures on Forest Service and Bureau of Land Management lands on Jenny, Fall, Spencer, and Shovel creeks, including measures identified in the Spencer Creek Pilot Watershed Analysis. Measures identified by FWS and NMFS include cooperative funding with water users to improve fish passage at irrigation diversions or other constructed barriers in the upper basin and purchase of instream water rights. Cal Fish & Game recommends that PacifiCorp identify and fund aquatic and riparian habitat monitoring and enhancement measures in mainstem reaches and tributaries to mitigate for flow-related effects.

Our Analysis

PacifiCorp's proposal to modify irrigation diversions associated with its Copco Ranch would reduce the entrainment of trout fry from the mainstem diversions in the peaking reach and from Shovel and Negro creeks, which provide an important spawning area for trout in the California section of the peaking reach. Eliminating diversions on Shovel and Negro creeks would increase minimum flows in Shovel Creek by about 15 cfs, further increasing the production potential from these tributaries. These tributaries and the bypassed reach provide the only substantial spawning areas that are available to trout residing in the 17.3-mile-long peaking reach and 4.5-mile-long bypassed reach. Access to spawning habitat for trout residing in the J.C. Boyle peaking reach has been reduced by the interruption of sediment transport, inundation of spawning habitat by J.C. Boyle reservoir, and the lack of effective passage at J.C. Boyle dam.

We do not have enough information to evaluate the potential benefits of the enhancement plans recommended by NMFS, FWS, Cal Fish & Game, Oregon Fish & Wildlife, and the Hoopa Valley Tribe. Although these parties provide some idea of measures that might be considered, they provide no specific details on how such measures would be implemented, where they would occur, how closely associated they would be with project-related effects, or what benefits they would provide. It is most appropriate to address identified project-specific effects with specific protection and enhancement measures that address those effects, rather than considering general types of protection or enhancement measures that may not clearly connect to project purposes. It is not appropriate to require PacifiCorp to collect and compile information on restoring fish and wildlife habitat upstream of the project, as several entities recommend, without specific measures and a nexus to the project.

Siskiyou County's recommendation that PacifiCorp fund programs to enhance flows and reduce water temperatures in Klamath River tributaries has the potential to benefit anadromous fish that spawn and rear in the tributaries, and also to improve water quality conditions in the mainstem Klamath River and may contribute to alleviating disease-related losses. In section 3.3.3.2.3, *Disease Management*, we include these types of measures in our listing of measures that could be included in a disease monitoring and management plan. The potential benefits of all disease management approaches can be most effectively considered in a single coordinated plan that would allow the most effective combination of approaches to be selected for implementation.

In section 3.3.3.2.5, *Anadromous Fish Restoration*, we evaluate the development of a reach-specific anadromous fish restoration plan, which would focus on initially restoring anadromous fish passage and habitat conditions in a single reach upstream of Iron Gate, Copco No. 1, or J.C. Boyle dam (with the potential for including additional project reaches in the restoration effort at a later time). The reach would be selected based on the results of radio telemetry monitoring of adult fall Chinook salmon and of juvenile production conducted over a 3-year evaluation period. The restoration plan would evaluate potential methods for providing fish passage, and the need for habitat enhancement measures such as spawning gravel augmentation or operational changes that are needed to support restoration efforts. The plan would be developed in consultation with the management agencies and tribes, and filed with the Commission for approval. We anticipate that the plan would be developed in the fourth year after license issuance, and implemented over a 5-year period.

In section 3.3.1.2.3, *Project Effects on Sediment Transport*, we describe in detail and evaluate measures proposed by PacifiCorp and recommended or prescribed by agencies to augment the supply of spawning gravel in project-affected reaches. PacifiCorp proposes an initial placement of 100 to 200 cubic yards of gravel in the J.C. Boyle bypassed reach and an initial placement of 1,755 to 3,510 cubic yards of gravel between Iron Gate dam and the Shasta River, with the volumes and frequencies of recurring gravel augmentation to be determined based on the results of monitoring. Agency recommendations include assessing and addressing gravel needs in all project-affected reaches, and the Bureau of Land

Management specifies the annual placement of between 1,226 and 6,134 tons (826 to 4,131 cubic yards) of gravel each year in the J.C. Boyle bypassed and peaking reaches.

PacifiCorp reports that the availability of suitably sized spawning gravel is very limited in the J.C. Boyle bypassed and peaking reaches, and we conclude that the abundance of gravel in these reaches has likely been reduced due to gravel being trapped in J.C. Boyle reservoir. The addition of gravel to the J.C. Boyle bypassed reach would increase the availability of spawning habitat and likely lead to increased recruitment of trout to the bypassed and peaking reaches. In addition, gravel that is transported from the bypassed reach during high flow events would provide some improvement in potential spawning habitat in the peaking reach. To assess the potential benefit to trout populations, we estimate that, if 2,000 cubic yards of gravel was introduced (10 years of augmentation at a rate of 200 cubic yards per year), this would be sufficient to cover 18,000 square feet of stream bed at an average depth of 1 foot. Assuming an average of space requirement of 8 square feet of spawning area per redd,[70] this area of gravel could accommodate approximately 6,200 trout redds. Because much of the gravel may be transported downstream or deposited in areas that do not have appropriate depths or velocities to support spawning, we estimate that the actual number of redds that could be accommodated would probably be on the order of 1,000 to 2,000. Because of its high gradient and the greater magnitude of flow fluctuations that occur in the downstream peaking reach, gravel placed in the peaking reach would be likely to be transported downstream more rapidly and would provide less benefit to trout spawning than gravel that is placed in the bypassed reach.

The reach below Iron Gate dam is heavily used by spawning fall Chinook salmon, and the availability of spawning-sized gravel in this reach has probably been affected by the interruption of gravel transport by Iron Gate and the other project dams. Augmenting gravel in this reach would increase the quantity of available spawning habitat, and as we discuss in section 3.3.3.2.3, *Disease Management*, increasing the supply of gravel would increase substrate mobility and help to reduce the accumulation of attached algae that provides habitat for the polychaete intermediate host for two important disease pathogens. We estimate that if 35,000 cubic yards of gravel was introduced (10 years of augmentation at a rate of 3,500 cubic yards per year), that this would be sufficient to cover 945,000 square feet of stream bed at an average depth of one foot. Assuming an average requirement of 220 square feet of spawning area per redd,[71] this area of gravel could accommodate approximately 4,300 fall Chinook salmon redds. Because fall Chinook salmon spawn over at least 100 miles of the lower Klamath River, this gravel would remain accessible to spawning salmon for a considerable number of years before it was transported from the reach. However, because some gravel would be transported to and deposited in areas that do not have appropriate depths or velocities to support spawning, we estimate that the actual number of redds that could be accommodated would probably be on the order of 1,000 to 3,000.

3.3.3.2.8 Monitoring and Adaptive Management

Monitoring

Monitoring the effects of environmental measures that are included in a new license helps to ensure that the measures are effective, and it affords the opportunity for measures to be modified, if needed, to meet resource management goals. Numerous stakeholders provided recommendations related

[70] This is based on an average redd area of 0.8 square foot given in Bjornn and Reiser (1991), and an assumed total space requirement of five times that area based on the area per spawning pair recommended for salmonid species by Bjornn and Reiser (1991).

[71] This is based on an average redd area of 20.4 square feet given in Bjornn and Reiser (1991), and an assumed total space requirement of five times that area based on the area per spawning pair recommended for salmonid species by Bjornn and Reiser (1991).

to monitoring fisheries and aquatic habitat, reporting monitoring results to stakeholders, and implementing adaptive management. We describe and evaluate these recommended measures in the following section.

PacifiCorp does not propose any specific monitoring or adaptive management measures for aquatic resources.

FWS recommends that PacifiCorp develop and implement an aquatic habitat monitoring plan to monitor the effectiveness of implementation of license conditions that improve quality and quantity of aquatic habitat for resident, migratory, and anadromous fish within project reaches, and to apply adaptive management, as needed. Annual reports, which would be provided to a Fisheries Technical Subcommittee, would include monitoring data and PacifiCorp's conclusions on the state of aquatic habitat including the adequacy of flows for supporting aquatic and riparian resources and providing opportunities for recreation. Components would include monitoring habitat condition and habitat productivity at 5-year intervals and spawning habitat and habitat connectivity at 3-year intervals. The plan would include details of methods, implementation strategies, procedures for adjusting monitoring strategies, reporting, and how adaptive management principles would be applied.

FWS recommends that PacifiCorp develop and implement a plan to monitor resident fish populations every 3 years to include (1) monitoring the distribution, population structure, and abundance of resident fish populations, including federally listed suckers (using protocols of Markle et al. [2000] and Simon et al. [1995], for larvae, juvenile, and adult suckers) in all project reservoirs and reaches below Keno dam; and (2) monitoring the number, size, and sex of spawning redband trout in important project reach tributaries including Scotch, Camp, Jenny, Fall, Shovel, Long Prairie, and Spencer creeks.

Oregon Fish & Wildlife recommends that PacifiCorp develop and implement an aquatic monitoring plan for the J.C. Boyle bypassed and peaking reaches, including provisions to monitor fish populations and habitat to assess the effectiveness of implementation of measures that pertain to flow, ramp rates, and gravel augmentation. The plan would include an adaptive management strategy that addresses changes and proposed actions for meeting resource goals for restoration of fish and aquatic life in the J.C. Boyle bypassed and peaking reaches. Every 5 years, PacifiCorp would consult with stakeholders to review and revise monitoring strategies based on new information.

Oregon Fish & Wildlife recommends that PacifiCorp develop and implement an aquatics monitoring resource management plan. The plan would include provisions for implementing monitoring activities associated with restoring aquatic fish population productivity including fish health and condition, fish habitat condition, reach productivity (bioenergetics), population structure (age distribution, sex rations, species assemblages), spawning populations, and fish migration and movement. The plan would be updated every 5 years in consultation with stakeholders. Annual reports would include a work plan for the upcoming year, a report on actions that were implemented in the previous year, and a monitoring and compliance report. The plan also would include provision for preparing a tri-annual aquatics monitoring report that describes monitoring efforts over the previous 3 years; information on compliance with license conditions relating to instream flow, ramp rate, and gravel augmentation; and reporting any unusual events or conditions that may have affected fish and aquatic resources during the previous 3 years. Oregon Fish & Wildlife recommends that stakeholders be provided a minimum of 60 days to review and comment on all plans and actions, and that consultation be documented in each plan or report that is submitted to the Commission.

Oregon Fish & Wildlife's J.C. Boyle aquatic monitoring plan is similar to its proposed fish monitoring resource management plan, but the recommendation provides different monitoring frequencies for some elements and greater detail on the elements that would be included. The results of fish health monitoring would be reported annually, monitoring of fish habitat condition and reach productivity would occur every 5 years, and population structure, spawning populations, and fish migration and movement monitoring would occur every 3 years. Monitoring of fish health would include monitoring for fish disease and of fish condition for salmonids in the bypassed and peaking reaches. Fish habitat condition monitoring would include surveys to identify new spawning areas; substrate composition, particle size, and degree of embeddedness; and changes in aerial extent of riparian vegetation and riparian species cover. Reach productivity would include monitoring of bioenergetics using methods described in Addley (2003). Population monitoring would include monitoring changes in the distribution, annual growth, population structure (age distribution, sex ratios, species assemblages), and abundance of resident and anadromous fish populations, using specific sampling protocols for monitoring of larvae, juvenile, and adult suckers. Monitoring of spawning populations would include the number, size, and sex of spawning rainbow/redband trout and anadromous salmonids spawning in the Klamath River Project reaches, identification of potential spawning areas identified by habitat surveys, and testing of the proportion of resident and anadromous forms of rainbow trout in tributary streams at 3, 7, and 15 years after reintroduction of anadromous fish. Monitoring of fish migration and movement would include monitoring of native fish populations for effects of flow alteration on feeding behavior, possible delayed migration between the peaking and bypassed reaches, and survival.

The Forest Service recommends that PacifiCorp model and monitor integrated project effects, including hatchery operations, on the anadromous fish populations downstream of Iron Gate dam. Results would be used to reduce effects on fish, especially wild stocks, through adaptive management.

NMFS and FWS recommend that PacifiCorp develop and implement an anadromous fish monitoring plan that describes protocols for (1) estimating the number, size, sex, timing, survival, and origin of anadromous fish returning to Iron Gate dam by using a combination of PIT tags and fish marked in other ways; (2) estimating the spawning populations of each species of anadromous fish in key tributaries within the project area; (3) estimating the numbers of juvenile outmigrant Chinook originating from the same key tributaries within the project area; and (4) implementing measures recommended by the agencies to meet project passage goals. Both agencies recommend estimating juvenile outmigrants every third year. NMFS recommends estimating spawning populations every 3 years, while FWS recommends annual estimates.

Our Analysis

Development of a habitat and fish population monitoring plan would help to ensure that measures included in a new license are effective and would help to identify any modifications that are needed to meet resource management goals. Because all available information indicates that the trout fisheries in the Keno and J.C. Boyle peaking and bypassed reaches are in good condition, and because we see no reason to expect that any of the proposed changes in operation would adversely affect these fisheries, we conclude that monitoring riverine fish populations every 3 years as recommended by FWS is not justified. Monitoring riverine fish populations in project-affected reaches at 5-year intervals should be sufficient to assess population responses to changes in instream flow or passage-related measures, and this frequency could be reduced to every 10 years after fish populations have stabilized. For reaches where gravel augmentation would occur, annual monitoring for the first 10 years would help to determine whether the quantity and location of gravel placement requires any adjustment to assure that a sufficient amount of habitat is available to support salmonid spawning. Telemetry studies conducted at 5-year intervals over the first 15 years would assist with determining the spawning locations used by trout residing in the J.C. Boyle peaking reach. The frequency of spawning gravel monitoring could be reduced to every 5 years after the first 10 years, and the frequency of telemetry studies could be reduced to every 10 years once a good understanding of fish spawning movements has been developed.

We see little benefit in monitoring the number, size, and sex of spawning redband trout in Scotch, Camp, Shovel, Long Prairie, and Spencer creeks, as FWS recommends, because spawning habitat in these creeks is not affected by project operations. However, periodic population sampling in Jenny and Fall creeks would enable the effects of project operations on trout in these tributaries to be monitored. In addition, telemetry studies of trout spawning migrations in the J.C. Boyle peaking reach would provide information on fish movement into Shovel Creek and spawning activity within the creek.

Some of the monitoring elements that Oregon Fish & Wildlife recommends appear to go beyond what is needed to monitor the effectiveness of resource measures that would be implemented under a new license. For example, the condition factor of trout collected during population assessments in the J.C. Boyle peaking reach would provide a good indication of fish growth without the need for conducting additional bioenergetics modeling, and there is no reason to believe that the project or any proposed measures would have any effect on the sex ratios of fish populations.

We conclude that the intent of the Forest Service recommendation to model and monitor integrated project effects would be encompassed by the implementation of several other measures. We describe these measures under sections 3.3.1, *Geology and Soils*, 3.3.2.2.2, *Water Quality*, and 3.3.3.2.6, *Iron Gate Hatchery Operations*; the effects of all of these measures would be integrated in a disease monitoring and management plan that we evaluate in section 3.3.3.2.3, *Disease Management*.

We agree with NMFS and FWS that it would be beneficial for PacifiCorp to develop and implement an anadromous fish monitoring plan that would include recording and reporting the number, species, mark information, and the migration timing of any fish that are collected at fish ladders located at Iron Gate dam and at Iron Gate Hatchery, and of any fish that are collected for transport at these and any other fish collection facilities that are installed in the future. Information on water quality conditions and survival rates during transport and water quality conditions at the collection and release point also would assist with modifying procedures to maximize the survival rates of any transported fish. It also would be beneficial for PacifiCorp to mark any outmigrating juvenile anadromous fish that are transported and released downstream of Iron Gate dam, most likely using coded wire or PIT tags, so that the origin of adult fish that return to Iron Gate dam can be determined. If passage of anadromous fish is restored to any mainstem reaches within the project, it would be beneficial to monitor the timing and location of anadromous fish spawning activity to evaluate the potential effects of project operations and to determine the need for any measures to improve spawning habitat in areas that are used for spawning. We do not concur that it is the responsibility of PacifiCorp to monitor spawning populations or juvenile production in tributary streams. If passage of anadromous fish to any tributary stream is restored, this addresses the principal project effect on fish populations in that tributary. Therefore, it is not PacifiCorp’s responsibility to monitor the condition or productivity of these tributary habitats.

In section 3.3.3.2.5, *Anadromous Fish Restoration*, we evaluate the development of a reach-specific anadromous fish restoration plan, which would focus on restoring anadromous fish passage and habitat conditions in a single reach upstream of Iron Gate, Copco No. 1, or J.C. Boyle dam (with provisions to increase the number of reaches restored in the future). The reach would be selected based on the results of radio telemetry monitoring of adult fall Chinook salmon and of juvenile production conducted over a 3-year evaluation period. Developing specific methodologies to be used for monitoring fish movement, spawning, and juvenile production in consultation with the resource agencies, as part of an overall anadromous fish restoration plan, would enable PacifiCorp to incorporate appropriate input into the anadromous fish monitoring aspects of the plan.

Responses to Monitoring

Oregon Fish & Wildlife also recommends that if, at any time, unanticipated circumstances or emergency situations arise in which non-ESA-listed fish or wildlife are being killed, harmed, or endangered by any of the project facilities or project operation, PacifiCorp should immediately take appropriate action to prevent further loss in a manner that does not pose a risk to human life and property. Within 48 hours of an event, PacifiCorp would notify Oregon Fish & Wildlife, NMFS, FWS, the Bureau of Land Management, Cal Fish & Game, the California State Water Resources Control Board, Oregon Environmental Quality, and the Oregon Water Resources Department, as appropriate, and comply with any restorative measures required by the resource agencies to the extent such measures do not conflict with the conditions of the license. PacifiCorp would be required to notify the Commission as soon as possible, but no later than 10 days after each event, and inform the Commission as to the nature of the event and of the restorative measures taken.

The Bureau of Land Management specifies that PacifiCorp develop an adaptive management plan in consultation with the Bureau that is designed to monitor how implementation of the "river corridor management condition" is effective in improving fish habitat quantity and quality for resident, migratory, and anadromous fish. Monitoring results and an evaluation of the results would be reported annually to the Bureau of Land Management, including PacifiCorp's conclusions about spawning, holding, feeding, juvenile rearing, riparian, and migratory habitat; and the adequacy of flows for providing migration, rearing, and spawning habitat for native aquatic species; moving spawning gravel; achieving riparian habitat objectives; supporting power generation; and providing recreational opportunities.

Our Analysis

It is reasonable to expect that in response to any type of environmental monitoring, if the need for corrective actions or opportunities for environmental enhancements becomes apparent, recommendations based on the monitoring results would be specified in any monitoring report submitted to the Commission for approval. We consider it most appropriate to include measures that would protect fish and wildlife from identifiable sources of harm as specific conditions of a new license. However, in some instances, unanticipated project-related effects may result in unexpected mortality or injury to fish and wildlife. We conclude that establishing notification procedures to alert the management agencies of project-related fish or wildlife problems and to develop appropriate measures to minimize adverse effects, as Oregon Fish & Wildlife recommends, is both reasonable and appropriate.

As previously discussed, some habitat-related measures that the Bureau of Land Management specifies would constitute a substantial change from current operations, and would warrant monitoring to determine their effects and evaluating whether additional alteration of project operations may be warranted. However, because we do not support adopting several of the measures specified by the Bureau, we do not see a benefit in requiring PacifiCorp to monitor implementation of the Bureau's specified river corridor management condition. We conclude that alternative monitoring approaches would be equally effective in providing a basis for reaching adaptive management decisions.

3.3.3.3 Cumulative Effects

In this section we address cumulative effects on Chinook salmon, steelhead, redband trout, and Pacific lamprey. We address cumulative effects on coho salmon, shortnose suckers, and Lost River suckers in section 3.3.5.3.

3.3.3.3.1 Chinook Salmon

The settlement and development of the Klamath River Basin has caused substantial adverse cumulative effects on the habitat and population size of spring and fall Chinook salmon. Dams for impounding water for mining and farming operations were first built in the 1850s, and water uses associated with mining activities caused substantial increases in turbidity, siltation, and altering stream morphology. Starting around 1912, construction and operation of facilities associated with Reclamation's Klamath Irrigation Project resulted in extensive draining of wetlands, increased agricultural diversions, increased nutrient loading, and reduced dissolved oxygen levels. In the 1920s, the water resources in the Shasta and Scott rivers were developed to support irrigated agriculture, and the construction of Dwinnell dam blocked access for Chinook salmon to the southern headwaters. Agricultural diversions in these tributaries and in the tributaries to Upper Klamath Lake have reduced flows, increased water temperatures, and increased nutrient inputs.

Poor water quality in Keno reservoir related to nutrient inputs can largely be attributed to creating conditions that would block upstream or downstream passage of Chinook salmon during late spring and much of the summer. This seasonal water quality migration barrier is the primary reason that NMFS and Interior included collection facilities for adult salmon at Keno dam and smolts at Link River dam. It would be unlikely that migrating salmon would be able to successfully pass through Keno reservoir under current late spring and summer water quality conditions. As such, the irrigation project has contributed to the blockage of suitable Chinook salmon habitat by creating a water quality migration barrier that is likely exacerbated by the presence of Keno dam. Diversion of up to 80 percent of the flow from the Trinity basin to support agriculture in the Sacramento River Basin started in 1964 with the completion of Trinity and Lewiston dams. Timber harvest practices and grazing have also contributed to erosion, damage to riparian habitat, and increased water temperatures. Overfishing and competition with Chinook salmon produced at Iron Gate Hatchery also has adversely affected wild runs of Chinook salmon in the basin.

Construction of Copco No. 1 dam in 1918 blocked Chinook salmon from accessing more than 350 miles of habitat upstream of Upper Klamath Lake and 55.7 miles of mainstem habitat between Copco No. 1 dam and Upper Klamath Lake. Construction of Iron Gate dam in 1964 blocked access to another 8.2 miles of mainstem habitat and tributaries including Fall and Jenny creeks.

The Klamath Hydroelectric Project contributes to adverse cumulative effects on Chinook salmon by blocking access to habitats upstream from Iron Gate dam. The project contributes to the cumulative effects associated with nutrient inputs from upstream, non-project sources by providing seasonal increases in nutrients, and diurnal fluctuations in DO levels and pH downstream of Iron Gate dam associated with plankton blooms in the project reservoirs. Several project effects act in a cumulative manner to contribute to disease losses downstream of Iron Gate dam, including an increase in the density of salmon spawning below the dam, increased habitat for disease pathogens and their alternate hosts due to seasonally increased nutrient inputs and armoring of the stream bed, which provides a stable substrate for the growth of attached algae, and increased disease susceptibility caused by stressful water quality conditions.

Implementing fish passage either through installation of volitional passage facilities, implementation of a trap and truck fish passage program, or by dam removal would help to reduce adverse effects associated with blocked access to historic habitats, which would alleviate the crowded spawning conditions downstream of Iron Gate dam. Implementing measures to reduce nutrient inputs, decrease water temperatures or increase DO levels also would help to reduce cumulative effects on Chinook salmon. Cumulative effects associated with disease losses could be reduced by implementing an effective disease management program. Removal of one or more dams, especially Iron Gate and Copco No. 1 dams, would be expected to alleviate conditions that are conducive to the spread of fish disease by reducing the crowding of spawners downstream of Iron Gate dam, reducing the abundance of the alternative host of two key fish pathogens by reducing the abundance of attached algae, and alleviating water quality conditions that cause fish stress and increase susceptibility to disease. It is clear, however, that the blockage of Chinook salmon from historical upstream habitat is currently not solely the result of the construction of project dams. Therefore, a cooperative approach that involves PacifiCorp and Reclamation (at a minimum) would be most effective in restoring anadromous fish to currently available habitat within the project area, upstream of Upper Klamath Lake, and downstream of Iron Gate dam.

3.3.3.3.2 Steelhead

Steelhead are influenced by many of the same cumulative effects as Chinook salmon that are attributable to historic mining practices, agricultural development, forest practices, grazing, and hydroelectric development. The pathways in which the Klamath Hydroelectric Project contributes to these cumulative adverse effects are also similar to those that we describe for Chinook salmon. Although disease losses of steelhead in the migratory corridor have not been monitored extensively, steep declines in the returns of steelhead to Iron Gate Hatchery since 1992 suggest that adverse conditions may exist in the migratory corridor for this species as well.

Implementing fish passage either through installation of volitional passage facilities, implementation of a trap and truck fish passage program, or by dam removal would help to reduce adverse effects associated with lost access to upstream spawning habitats. Implementing measures to reduce nutrient inputs, reduce water temperatures, or increase DO levels also could reduce cumulative effects on steelhead. Implementing an effective disease management program may reduce the potential losses of steelhead from fish diseases. The Klamath Hydroelectric Project plays a role in the cumulative adverse affects on steelhead, along with other entities. Restoration of steelhead to historical habitat and restoration of currently accessible habitat downstream of Iron Gate should be a cooperative effort to maximize the opportunities for success.

3.3.3.3.3 Redband Trout

Resident redband trout have been affected by many of the same cumulative effects as steelhead associated with historic mining practices, agricultural development, forest practices, grazing, and hydroelectric development. Construction of numerous tributary dams and agricultural development of the basin has reduced habitat connectivity, reduced recruitment of spawning gravel to historic redband trout habitats, altered river flows, and adversely affected water quality by increasing water temperatures and nutrient loads, reducing DO, and introducing pesticides.

Implementing fish passage either through installation of volitional passage facilities, implementation of a trap and truck fish passage program, or by dam removal would help to improve connectivity among redband trout populations in the project area. Gravel augmentation in the J.C. Boyle bypassed reach, as PacifiCorp proposes, would help to alleviate the reduced recruitment of spawning gravel. Eliminating agricultural diversions on Negro and Shovel creeks, also proposed by PacifiCorp, would also help to improve trout recruitment from that tributary, compensating for lost access and diminished quality of mainstem spawning habitats due to trapping of gravel in project reservoirs.

3.3.3.3.4 Pacific Lamprey

The overall distribution and abundance of Pacific lamprey on the Pacific Coast has been severely reduced due to effects associated with hydropower development. The construction of numerous mainstem and tributary dams has reduced the amount of habitat that is accessible for freshwater spawning and rearing of this species over most of its range. Although a substantial amount of habitat suitable for lampreys remains accessible in the Klamath River Basin, accounts given by tribal elders indicate that the number of lampreys in the river has declined precipitously from historic levels (Larson and Belchik, 1998). Because the species is not known to exhibit a high degree of fidelity to its native stream, we believe that the decline in the number of Pacific lamprey returning to the Klamath River may be an outcome of the overall coast-wide decline of the species.

The Klamath Hydroelectric Project contributes to adverse cumulative effects on Pacific lamprey by blocking access to historic habitat upstream of Iron Gate dam. Implementation of the NMFS/Interior fishway prescription or a trap and haul fish passage program may provide little benefit to the species. Effective technology for providing downstream passage for outmigrating Pacific lamprey at hydroelectric projects has not been developed, and it is likely that there would be substantial losses to predation during migration through project reservoirs. In addition, adult lamprey do not appear to be effectively attracted to the existing fish ladders associated with Iron Gate Hatchery.

3.3.3.4 Unavoidable Adverse Effects

If the project is relicensed without removal of Iron Gate or Copco No. 1 dams, the project would likely continue to adversely affect water quality conditions downstream of Iron Gate dam, which adversely affects Chinook salmon during their outmigration through the lower Klamath River. A project-specific water quality management plan would identify measures that could be implemented to minimize project-related water quality degradation of salmon and steelhead habitat. Although some entrainment mortality of redband trout would continue, the level of entrainment that has occurred in the past has not caused substantial adverse effects on the trout fishery in the Keno or J.C. Boyle bypassed and peaking reaches, which are among the best trout fisheries in the region.

3.3.4 Terrestrial Resources

3.3.4.1 Affected Environment

3.3.4.1.1 Botanical Resources

The Klamath Hydroelectric Project is located near the confluence of the Siskiyou, Klamath, and Cascade mountain ranges and within several different eco-regions or physiographic provinces, resulting in a diverse mix of flora and fauna. In Oregon, the Oregon Diversity Plan refers to these eco-regions as the East Slope Cascades and the West Slope Cascades. In California, the project is within the Southern Cascades and the Modoc Plateau physiographic provinces and is also within the Cascade-North Sierra floristic region of the California floristic province. The Upper Klamath River forms a corridor between the Great Basin and California floristic provinces, creating a transition zone. Within Oregon, the area is generally within the interior valley, ponderosa pine, and mixed conifer vegetation zones. The Klamath River Canyon (from the J.C. Boyle development to the California-Oregon state line) has the greatest botanical diversity of any section of the river.

The area east of J.C. Boyle dam generally includes vegetation typical of the East Slope Cascades physiographic province. In the Klamath River Basin, non-forested areas in the valley are generally sagebrush steppe vegetation, wetlands, or are cultivated. From J.C. Boyle dam to the eastern end of Copco reservoir, the Klamath River cuts through several vegetation zones as it bisects the Cascade Range, forming a steep canyon. Montane vegetation typical of the Cascades is mixed with high desert and interior valley plant communities. The area downstream of the canyon is composed of vegetation similar to that found in the interior valley of Oregon, with oak and grasslands dominating.

PacifiCorp characterizes the Klamath River Canyon as a mosaic of pine, oak, juniper, and mixed conifer forest communities, with ponderosa pine and Oregon white oak (*Quercus garrayana*) being the dominant tree species. Limited areas of oak savannahs also occur. Narrow riparian habitats dominated by oak, birch (*Betulua occidentalis*), and white alder (*Alnus rhombifolia*) occur along the river and tributaries. Overall oak production in the Klamath River Canyon was reported to be less than 20 percent of the potential productivity, although the trees within the canyon tend to produce more acorns while the poor-production trees are located outside of the canyon.

Cover Types and Unique Habitats

As shown in table 3-78, PacifiCorp identified and mapped 12 upland cover types, 8 riparian and wetland habitats, 4 aquatic habitats, 2 barren habitats, and 5 kinds of agricultural or developed lands in the project vicinity.[72] Upland tree-dominated cover types are most abundant in all locations except at the Keno reservoir and along the Klamath River from the Iron Gate development to the Shasta River. From Iron Gate development to the Shasta River, riparian cover types occupy approximately 25 percent of the area. Developed and agricultural lands dominate the area near Keno reservoir (48 percent). Upland shrub cover types occupy a low of 7 percent of the area at Iron Gate reservoir to a high of 21 percent near the Copco No. 2 bypassed reach. Upland herbaceous cover types are common along the Klamath River

[72] The project vicinity includes the Klamath River from Link River dam to the Shasta River, the area within 0.25 mile of all project facilities, reservoirs, and river reaches; the land in the Klamath River Canyon; and all PacifiCorp land in the area, but outside of the 0.25-mile buffer.

between the Iron Gate development and the Shasta River and at the Iron Gate and Copco reservoirs, occupying between 16 and 26 percent of these areas. Agricultural habitat (excluding general grazing allotment areas) occupies more than 20 percent of the area along Link River, at Keno reservoir, and along the Klamath River from Iron Gate development to the Shasta River, but represents less than 2 percent in the rest of the project vicinity.

Table 3-78. Cover types and habitats mapped in the vicinity of the Klamath Hydroelectric Project. (Source: PacifiCorp, 2004a)

Cover Type/Habitat	Acres	Description, Dominant Species, and Location
All upland tree habitats	28,317	More than 10 percent total cover by tree species; common from Keno reach to Iron Gate reservoir.
Montane hardwood oak	5,071	Moderately open tree canopy, moderately dense shrub layer, moderately dense herbaceous layer. Yellow starthistle and medusahead occur in about 25 percent of stands in the project vicinity. Most abundant around Iron Gate reservoir, Copco reservoir, and along J.C. Boyle peaking reach.
Montane hardwood oak-conifer	8,638	Dense tree cover, sparse shrub layer, moderately open herbaceous layer. Most abundant along the J.C. Boyle peaking and bypassed reaches, at Copco reservoir, at Fall Creek, and along Copco No. 2 bypassed reach.
Montane hardwood oak-juniper	8,968	Open tree layer, sparse shrub layer, dense herbaceous layer. Yellow starthistle and medusahead occur in 45 percent of stands, primarily around Iron Gate and Copco reservoirs and along Copco No. 2 bypassed reach. Most abundant cover type in the project vicinity.
Ponderosa pine	3,473	Moderate canopy cover, relatively sparse shrub cover, moderately open herbaceous layer. Most abundant along Keno reach and at J.C. Boyle reservoir.
Juniper	1,268	Open canopy, shrub layer varies from sparse to dense, herbaceous layer ranges from sparse to dense. Most abundant along Link River and along J.C. Boyle peaking reach.
Mixed conifer	834	Dense tree cover is often two-layered, open shrub layer, moderately sparse herbaceous layer. Approximately 70 percent of stands are along J.C. Boyle bypassed reach.
Lodgepole pine	64	Lodgepole pine stands occur along J.C. Boyle bypassed reach and at J.C. Boyle reservoir as a result of replanting following timber harvest. Sparse tree layer, sparse shrub layer, dense herbaceous layer.
All upland shrub habitats	5,042	More than 10 percent total cover by shrub species and less than 10 percent total cover by tree species
Mixed chaparral	4,396	Requires occurrence of two or more shrub species, each covering 5 percent or more of the area. Very few trees, moderate shrub layer, herbaceous layer varies from sparse to dense. Approximately 60 percent occurs along J.C. Boyle bypassed reach and around Copco reservoir.
Sagebrush	108	Moderately dense shrub layer, sparse herbaceous layer. This limited habitat type occurs near Keno and J.C. Boyle reservoirs.
Rabbitbrush	538	Gray rabbitbrush is the dominant shrub species in most areas and Sierra plum is the only other shrub species present within

Cover Type/Habitat	Acres	Description, Dominant Species, and Location
		this cover type. Moderately dense herbaceous layer. Applegate's milk-vetch, a federally endangered plant species, grows in a seasonally moist site with rabbitbrush and saltgrass along Keno reservoir. Occurs at Keno reservoir and along Keno reach.
All upland herbaceous habitats	4,841	More than 2 percent total cover by herbaceous species and less than 10 percent total cover of tree and/or shrub species.
Annual grassland	4,474	Total shrub cover is less than 1 percent. Nine of the 11 most frequent herbaceous species are introduced species; two of them are the exotic/invasive species medusahead and yellow starthistle. Cheatgrass is relatively more abundant in annual grasslands along Keno reservoir and along J.C. Boyle bypassed reach. Medusahead, hairy brome, and yellow starthistle dominate grasslands downriver of J.C. Boyle peaking reach. More than 88 percent of the annual grasslands occur along J.C. Boyle peaking reach and around Copco and Iron Gate reservoirs.
Perennial grassland	366	Sparse shrub cover includes a wide variety of species. A total of 31 graminoid species occurs; 5 introduced annuals, 11 introduced perennials, 2 native annuals, 10 native perennials, 1 native rush, and 2 native sedges. More than 87 percent occurs around J.C. Boyle reservoir and in the J.C. Boyle peaking and bypassed reaches.
All wetlands and riparian plant communities	2,836	
Palustrine emergent wetland	1,796	Dense herbaceous layer, often with a weedy zone immediately upslope of the bulrush zone. Short-podded thelypody, a special status species, occurs in this habitat type at Keno reservoir. More than 88 percent occurs adjacent to Keno reservoir, where wetlands associated with the Klamath Wildlife Area and the undiked wetlands southwest of the Klamath Wildlife Area are located. The largest single emergent wetland associated with the project covers more than 63 acres and is near Sportsman's Park at J.C. Boyle reservoir.
Palustrine scrub-shrub wetland	31	Open canopy with moderate shrub layer. Coyote willow (also known as narrowleaf willow) and arroyo willow are the primary hydrophilic shrubs. Arroyo willow is more abundant upriver and upslope. The only shrub layer species in the Link River wetland is arroyo willow; this species was most frequent at Keno reservoir, J.C. Boyle reservoir, and Fall Creek. Species dominating the Spencer Creek wetland include arroyo willow and coyote willow. Arroyo willow also occurred in the Fall Creek reach. Coyote willow is the dominant shrub layer species in 75 percent of the wetlands from J.C. Boyle reservoir to Iron Gate reservoir. More than 80 percent occurs adjacent to J.C. Boyle, Copco, and Iron Gate reservoirs.
Palustrine forested wetland	119	Dense tree cover includes the primarily hydrophilic tree species coyote willow and shining willow; weeping willow is the dominant tree layer species in one of the Keno reservoir wetlands. The two Keno reservoir wetlands have no shrub

Cover Type/Habitat	Acres	Description, Dominant Species, and Location
		layer. Brown dogwood and arroyo willow are the only species in the open shrub layer of the two wetlands along Copco No. 2 bypassed reach. Wetlands at Copco and Iron Gate reservoirs had an open shrub layer with coyote willow. More than 80 percent occurs adjacent to Copco and Iron Gate reservoirs.
Palustrine aquatic bed	293	Occurs in all project reservoirs and slow moving sections of the Klamath River. Dominant species include pondweeds and coontail.
Riparian grassland	60	Dense herbaceous cover. Reed canarygrass is relatively common along Link River, along Keno reach, and along J.C. Boyle peaking reach.
Riparian shrub	121	Coyote willow, arroyo willow, and Oregon ash saplings are the primary hydrophilic shrubs. Dense herbaceous cover is dominated by reed canarygrass along Link River, Keno reach, J.C. Boyle bypassed reach, and J.C. Boyle peaking reach. J.C. Boyle peaking reach and Klamath River from Iron Gate development to Shasta River are the locations with the most riparian shrub habitat.
Riparian deciduous	365	Moderate canopy cover includes coyote willow. Moderate shrub and herb layers. Occurs primarily along J.C. Boyle peaking reach and along the Klamath River from Iron Gate development to Shasta River.
Riparian mixed deciduous-coniferous	52	A total of 8 tree, 12 shrub, and 49 herbaceous plant species were documented in this habitat. Dense tree layer, moderate shrub layer, open herbaceous layer. A taller herb layer with reed canarygrass and devil's beggarstick is often present along the river. There are 37.8 acres mapped at Fall Creek, 12.0 acres along J.C. Boyle peaking reach, and 1.9 acres around Copco reservoir.
Riverine and lacustrine habitats	5,077	The reservoirs represent 4,333 acres of lacustrine habitat in the project vicinity. Riverine unconsolidated bottom, which includes the semipermanently flooded flowing water of the Klamath River, totaled 726 acres. Riverine and lacustrine unconsolidated shoreline or gravel bar habitats cover a total of 17.2 acres. Several of the reservoirs and river reaches have pockets of submerged aquatic vegetation.
All barren habitats	926	Less than 2 percent total cover by herbaceous, desert, or non-wildland species and less than 10 percent cover by tree or shrub species.
Rock talus	559	Most rock talus habitats are barren with small patches of vegetation where the talus is thin or at the margins of the talus patch. A total of 2 tree, 7 shrub, and 23 herbaceous plant species provided sparse cover in rock talus habitats. Particularly abundant along J.C. Boyle peaking and bypassed reaches.
Exposed rock	367	A wide variety of species occurs in the sparse shrub and moderate herb layers. Most abundant along J.C. Boyle peaking and bypassed reaches and Copco No. 2 bypassed reach; does not occur at Link River or Keno reservoir.

Cover Type/Habitat	Acres	Description, Dominant Species, and Location
Developed and disturbed habitats	5,830	More than 2 percent total vegetation cover is non-wildland vegetation. Includes three developed vegetation types: residential, recreational development, and industrial, where vegetation includes plants grown for landscaping. Also includes agricultural types such as pasture and irrigated hayfields, where vegetation includes plants grown for food and/or fiber. Pastures and irrigated hayfields are distributed over 3,682 acres. More than 85 percent of the pasture/irrigated hayfields occur around Keno reservoir. J.C. Boyle peaking reach and the area along the Klamath River from Iron Gate development to Shasta River also have a substantial amount of pasture/irrigated hayfields.

The relative and absolute cover of wetlands is greatest along Keno reservoir with nearly 20 percent or 1,866 acres of wetland habitat that was mapped by PacifiCorp during the terrestrial resources studies. The relative cover of wetland cover types in the rest of the project vicinity ranges from 0.2 percent or 5.1 acres in the Keno reach to 5.5 percent or 105 acres at J.C. Boyle reservoir.

PacifiCorp identified three primary vegetative habitats of special concern that occur in the project vicinity based on its review and understanding of the Clean Water Act (33 U.S.C. §1341), the Northwest Forest Plan (Forest Service and Bureau of Land Management, 1994), and the Klamath Falls Resource Area Resource Management Plan (Bureau of Land Management, 1995). These habitats are riparian and wetland habitats, late-successional conifer forest, and snag and coarse wood rich habitats.

Riparian and Wetland Habitats

Wetlands provide habitat for numerous plant and wildlife species, collect and hold water, buffer the effects of floods, and conserve moisture for drier seasons of the year. Riparian areas provide critical diversity and stability in forested ecosystems, including (1) multiple vegetation layers that provide a variety of nesting sites, cover areas, and food sources for wildlife; (2) vegetation that absorbs nutrients and sediment; (3) vegetation roots that stabilize streambanks, lake shores, and adjacent slopes; and (4) vegetation that shades streams and maintains low water temperatures. Riparian areas have been shown to support more wildlife species than adjacent uplands, particularly in arid environments, and are particularly important for breeding birds.

Under current conditions, between 19 and 30 percent of the shorelines along J.C. Boyle, Copco, and Iron Gate reservoirs are bordered by riparian and/or wetland habitat. Currently, wetland and riparian vegetation along reservoirs is limited mostly to small patches in protected locations and near inlets/tributaries. There are, however, several large wetland and riparian habitats associated with J.C. Boyle reservoir and tributaries and seeps near the other project reservoirs.

Link River. The riparian vegetation at Link River is influenced by river hydrology and by seepage from the West Side and East Side canals and penstocks. Seepage, especially from the West Side canal, has created many perched wetland habitats well away from the hydrological influence of normal river flows in the reach. The riparian vegetation at Link River is unique compared to other project reaches because of the presence and abundance of introduced woody species. Apple, plum, and elm are commonly the dominant species in the tree layer. Reed canarygrass is abundant in close proximity to the active channel and in seepage areas. Five vegetation types are found in the riparian/wetland community along the Link River.

Keno Reservoir. The wetland vegetation at Keno reservoir is more diverse than at any other project reservoir, probably because of the wide variety of land uses that have modified habitats around the reservoir. The most abundant wetland vegetation types are dominated by hardstem bulrush and broad-fruited bur-reed. Ten vegetation types are found in the riparian/wetland community at the Keno reservoir; hardstem bulrush/stinging nettle/cattail is the most abundant. Hardstem bulrush/broad fruited bur-reed/duckweed/knotweed is one of the most abundant vegetation types at the edge of the reservoir pool. The coyote willow vegetation type, which is dominated by coyote willow in the shrub layer, is not common at the Keno reservoir, but occurs in dense, small stands in low-lying pastures protected by levees. Two coyote willow stands are located at the downstream end of the Keno reservoir. One of these stands was recently disturbed, most likely by grazing, and has young coyote willow that appear to be increasing in abundance. The other stand has not been disturbed for many years and has much older coyote willow and arroyo willow at the upper end of a long, low-gradient slope.

Keno Reach. The most frequently occurring of the nine vegetation types PacifiCorp documented in the riparian plant species growing in the Keno reach are reed canarygrass, hardstem bulrush, and river bulrush; these species are well-suited to coarse substrates that are frequently inundated by fast-moving water. The reed canarygrass vegetation type was found on mid-channel islands and at the water's edge among large boulders; this is the most abundant riparian vegetation type in the Keno reach. The hardstem bulrush/devil's beggarstick and hardstem bulrush vegetation types also occur on mid-channel islands and at the water's edge, but in more open water than the reed canarygrass vegetation type. Other riparian plant species were scarce by comparison and were restricted primarily to narrow benches or terraces. PacifiCorp observed some large shining willow trees on a narrow, low-gradient terrace among dense stands of reed canarygrass. All of the willow trees are in a state of decay and have large horizontal branches broken because of rot or chewing by beavers. Willow reproduction does not currently occur in this reach.

J.C. Boyle Reservoir. Approximately 30 percent of the J.C. Boyle reservoir shoreline currently is bordered by riparian and wetland vegetation. Vegetation in the J.C. Boyle reservoir riparian/wetland zone is generally restricted to herbaceous types, but some woody riparian vegetation occurs in palustrine scrub-shrub wetlands in Spencer Creek, a major tributary to the reservoir. Pre-project aerial photography indicates that only a narrow band of riparian/wetland vegetation with few trees or shrubs bordered the Klamath River in this area and occurred in approximately the same proportion of the river shoreline as currently exists along the reservoir shoreline. The limited historical occurrence of willow in the area may explain why there are generally few willows along the J.C. Boyle reservoir today.

The current wetland/riparian zone at the J.C. Boyle reservoir is often perched on a low bench or low gradient slope above the current full pool level and averages between 68 and 204 feet wide. The riparian/wetland community at this reservoir is composed of six vegetation types. The most abundant vegetation type at the J.C. Boyle reservoir is the sedge/Baltic rush/bentgrass/Kentucky bluegrass vegetation type. Reed canarygrass is relatively uncommon at the J.C. Boyle reservoir and only occurs at elevations that are inundated 14 to 93 percent of the growing season.

J.C. Boyle Bypassed and Peaking Reaches. The riparian/wetland community in the J.C. Boyle bypassed and peaking reaches is composed of 11 vegetation types. Oregon oak/western serviceberry/snowberry occurs at the upper end of the elevation gradient supporting riparian vegetation and is one of the most abundant vegetation types abutting the river. Oregon ash/colonial bentgrass/woolly sedge includes arroyo willow in the shrub layer; Oregon ash/Himalayan blackberry occurs on the right bank downstream of Beswick Ranch and includes coyote willow in the tree layer; coyote willow/reed canarygrass/colonial bentgrass, is most abundant on low-gradient terraces, although small clumps of coyote willow were observed on banks with a steeper gradient.

Reed canarygrass is the most abundant species in the J.C. Boyle peaking reach varial zone, which is that portion of the channel's margin associated with project peaking flow fluctuations between 350 and 3,000 cfs (PacifiCorp, 2005d). Reed canarygrass may have a distinct competitive advantage in the varial zone because of its ability to better use abundant nutrients and withstand frequently fluctuating peaking flows. It has been shown to be highly adaptable under a wide range of growing conditions and appears to respond favorably to various inundation patterns and to nutrient supply (PacifiCorp, 2005d). Reed canarygrass seeds germinate best immediately following maturation; however, some seed remains viable throughout the winter and following summer giving this species a competitive advantage.

Between 65 and 100 percent of the remaining peaking reach riparian/wetland vegetation types occur above the varial zone. Very little dense reed canarygrass occurs above the varial zone. The most evenly distributed vegetation types across the upper boundary of the varial zone include coyote willow/reed canarygrass/colonial bentgrass, perennial ryegrass, and Oregon ash/colonial bentgrass/woolly sedge. The three vegetation types occurring in high numbers within or below the varial zone include coyote willow/reed canarygrass/bentgrass, reed canarygrass, and hardstem bulrush/reed canarygrass.

In the J.C. Boyle peaking reach, young willows grow at several locations on the higher elevation portions of mid-channel islands; Douglas' spiraea was observed growing on larger terraces. There was no strong association between coyote willow abundance and position along the inundation/elevation gradient within the varial zone of the peaking reach (willow generally occurs at elevations above the varial zone). Coyote willow seeds disperse in May and June and are viable only for about 1 week after dispersal and require bare, alluvial surfaces in close proximity to the water table for germination. Willow seeds are also capable of photosynthesis and require light to successfully germinate. Coyote willow is intolerant of shade in all stages of growth. Reed canarygrass may prohibit willow germination by shading, and daily peaking may inhibit willow germination by flooding seed and seedlings before they can develop. However, coyote willow is a colonizing species and may not colonize new areas from seed, but instead may invade new areas by vegetative suckering and possibly by root fragments. Coyote willow colonies along the peaking reach often had large, decaying stems surrounded by suckers of various ages growing up through reed canarygrass. Coyote willow sprouts were observed in the coyote willow/reed canarygrass/colonial bentgrass, reed canarygrass, and hardstem bulrush/reed canarygrass vegetation types.

The width of the riparian vegetation zone in many parts of the J.C. Boyle peaking reach is dictated by geomorphological constraints, especially in the steeper portions of the reach. The J.C. Boyle peaking reach tends to have narrow, often discontinuous bands of riparian vegetation along the river's margin. PacifiCorp's review of historic aerial photography indicates a general lack of disturbance of the general character and size of the riparian zone in the J.C. Boyle peaking reach over time. PacifiCorp attributes a variety of factors that probably contribute to the relative lack of disturbance, including coarse substrates that resist scouring during large flow events, the lack of finer particle sizes in the river required for sedimentation, streambanks stabilized by dense vegetation that also resist scouring, and possibly an attenuation of potentially scouring flood flows during major flood events as a result of upper basin diversions (PacifiCorp, 2005d).

Copco Reservoir. About 19 percent of Copco reservoir shoreline is bordered by four types of wetland and riparian habitat: starthistle/medusahead/hairy brome, coyote willow, hardstem bulrush/broad-fruited bur-reed/duckweed/knotweed, and hardstem bulrush/stinging nettle/cattail. This lack of substantial riparian and wetland habitat is largely the result of the generally steep slopes along the shoreline. The bank slope averages about 19 percent, compared to 3 percent at the J.C. Boyle reservoir. Only along low-gradient shorelines, especially near inlets, is the topography suitable for riparian and wetland vegetation development. Residential development at the upper portion of the reservoir reduces shoreline available for native vegetation. Currently, most of the wetland and riparian habitat is herbaceous, although in some areas coyote willow is abundant. Shining willow and arroyo willow are not common and the absence of bare substrates at elevations suitable for willow seed germination may be the most important factor limiting the distribution of willow. Coyote willow establishment occurs on bare substrates with good light. Copco reservoir, like the other reservoirs, has a high incidence of weedy species around the reservoir but reed canarygrass is uncommon and only occurs in locations with 25 to 67 percent inundation.

Copco No. 2 Bypassed Reach. The riparian vegetation in the Copco No. 2 bypassed reach is influenced by river flows that are low compared to pre-project flows. The lower water level has made more potential substrate available for establishment of riparian and wetland plants on previously inundated portions of the channel bed. An abundance of riparian vegetation has encroached, particularly in closer proximity to and at lower elevations in the active channel of the Copco No. 2 bypassed reach. Copco dam predates the first available aerial photographs for this reach (1955) by approximately 30 years, but encroachment was evident to PacifiCorp when comparing 1955 and 1994 aerial photos. Four vegetation types occur in the riparian/wetland community of the Copco No. 2 bypassed reach. A distinct separation of the vegetation types by elevation occurs along the Copco No. 2 bypassed reach despite the fact that seepage from the adjacent penstock intercepts the left bank in many places and creates many wetland habitats in the former active river channel. The riparian vegetation along the Copco No. 2 bypassed reach is unique because many large white alder dominate the tree canopy. The dense white alder canopy may contribute to the scarcity of the shade-intolerant coyote willow and reed canarygrass relative to other project reaches.

Fall Creek. The riparian vegetation at Fall Creek is influenced by a combination of Fall Creek flows and by seepage from the Fall Creek canal. Seepage from the canal has created wetland habitats between the canal and the left bank of Fall Creek that occur only because of canal seepage. In downstream portions of Fall Creek where the flow is not influenced by canal seepage, the gradient steepens and the riparian vegetation zone becomes narrow. The riparian vegetation at Fall Creek is unique compared to other project reaches due to the presence and abundance of conifers in the riparian zone and the absence of coyote willow. Four riparian/wetland vegetation types occur along Fall Creek: Oregon ash/western birch, Oregon ash/Douglas' spiraea, white alder, and ponderosa pine/Douglas fir/western serviceberry, which occurs in drier and more upland areas. The relatively long history of upstream diversion since 1903 (Spring Creek and Fall Creek canal) and seepage from the Fall Creek canal have created a riparian zone with both wetland and upland species growing in close proximity to one another.

Iron Gate Reservoir. Currently, about 22 percent of the Iron Gate reservoir shoreline is bordered by riparian and wetland vegetation. The bank slope averages 23 percent, and the steep shorelines that border much of the reservoir are not conducive for extensive riparian and wetland development. Trampling and grazing by cattle along some sections of the reservoir shorelines likely contribute to the degraded nature of the riparian/wetland communities. Historically, the river in this area was bordered by narrow bands of riparian shrub and deciduous vegetation (approximately 68 percent of shoreline) with oak and grassland types interspersed. PacifiCorp classified five vegetation types in the riparian/wetland community at Iron Gate reservoir. There are many narrow patches of coyote willow along the sections of low-gradient shoreline, particularly in protected inlets, and along steeper shorelines where surrounding uplands have slumped or eroded into the water creating a shelf that provides the appropriate substrate and inundation pattern. Some of the youngest willow stands are located along the peninsula that is roughly due south of the Camp Creek campground. Reed canarygrass is not common, and only occurs in locations with inundation durations of 9 and 28 percent.

Klamath River from Iron Gate Dam to Shasta River. The riparian/wetland community in this reach includes 12 vegetation types; coyote willow occurs in almost all of the vegetation types in this reach, in the tree, shrub, and herbaceous layers. Coyote willow/Himalayan blackberry is the most abundant vegetation type in this reach. Coyote willow/poison hemlock occurs in slightly more hydric habitats and has many more young coyote willow sprouts in the herbaceous layer compared to other willow-dominated stands in this reach, as well as tree and shrub layers dominated by coyote willow.

The vegetation types in the Klamath River from the Iron Gate dam to the Shasta River fall into three groups that occupy three generally different elevation zones. Group 1 consists of vegetation types that typically grow in or just upgradient of the water surface: coyote willow/knotweed, rice cutgrass/hardstem bulrush, hardstem bulrush/duckweed, and curly pondweed. Group 2 consists of vegetation types that occupy bars and islands in the river channel and the lower floodplain elevations: coyote willow/Himalayan blackberry, coyote willow/poison hemlock, and Oregon ash/bentgrass/woolly sedge. Group 3 consists of vegetation types that occupy steep banks and higher floodplain elevations: Oregon oak/bentgrass/Kentucky bluegrass, medusahead/cheatgrass, Oregon oak/blue wildrye, and chicory/tall fescue.

Woody riparian vegetation is more abundant in the reach from the Iron Gate dam to the Shasta River than in any other project reach. However, the tree-dominated stands are typically much smaller in area than some of the Oregon ash-dominated stands along the J.C. Boyle peaking reach, white alder stands along the Copco No. 2 bypassed reach, and non-native, tree-dominated stands along Link River. Coyote willow is most abundant in this reach, especially downstream of Cottonwood Creek and immediately downstream of Iron Gate dam. Reed canarygrass is not common along the river downstream of Iron Gate dam for unknown reasons.

Late-Successional Conifer Forest

According to the Northwest Forest Plan (Forest Service and Bureau of Land Management, 1994), late-successional forests are those in which the biggest, oldest, and most dominant trees create a maturing canopy with shade-tolerant trees occupying and flourishing on the forest floor. Typically, late-successional forests include trees at least 80 years old. Late-successional forests provide important wildlife habitat for a large number of wildlife species. Forests on both the east and west sides of the Cascades tend to have more species associated with large trees that are typically associated with late-successional conifer forest and especially with multi-canopy stands. PacifiCorp determined that only 13 acres of forest in the Klamath Hydroelectric Project vicinity near the J.C. Boyle peaking reach included late-successional conifer forest with large-diameter (greater than 24 inches in diameter 4.5 feet above the forest floor) trees. However, there are also 8,435 acres of younger forest with small to moderately large diameter (11 to 24 inches) trees.

Snag and Coarse Wood Rich Habitat

Researchers have documented that snags (dead trees that are still standing or part of a dead tree from which the leaves and smaller branches have fallen) and down wood are important to wildlife. In Douglas-fir forests of southern Oregon, species richness of terrestrial vertebrates (i.e., small mammals, insectivores, and amphibians) increases with increasing volumes of coarse woody debris. The Klamath Falls Resource Area Resource Management Plan (Bureau of Land Management, 1995) calls for maintaining the number of snags needed to support at least 60 percent of the maximum biological potential of cavity-nesting species over time. Recent research indicates that greater numbers of snags are needed to provide for wildlife habitat needs and ecosystem function than was previously thought.

PacifiCorp grouped snag data collected during its cover type mapping into the size categories and decay classes used by the six primary cavity-nesting species known to occur in the project vicinity in order to determine if the study area met the guidelines in the Klamath Falls Resource Area Resource Management Plan (Bureau of Land Management, 1995). PacifiCorp determined that the Klamath Hydroelectric Project vicinity provides sufficient snags to meet at least 60 percent of the maximum population needs for all six cavity-nesting species that occur there—downy woodpecker, hairy woodpecker, pileated woodpecker, acorn woodpecker, Lewis' woodpecker, and redbreasted sapsucker. Riparian deciduous, riparian mixed, and riparian shrub vegetation types all greatly exceed the density of snags needed to provide for 100 percent of the maximum biological potential for all species except acorn, pileated, and Lewis' woodpeckers, which require snags more than 17 or 25 inches in diameter 4.5 feet above the forest floor. However, the forested wetlands meet the 60 percent level for all species except the hairy woodpecker. Scrub-shrub wetlands provide adequate snags for all species except pileated woodpecker. Snags suitable for downy woodpeckers (more than 11 inches in diameter) occur primarily in riparian mixed deciduous-coniferous forest, and the density greatly exceeds the number needed to maintain downy woodpecker populations. The density of snags more than 25 inches in diameter is low in all cover types except mixed conifer, riparian mixed, and lodgepole pine forest.

The Northwest Forest Plan (Forest Service and Bureau of Land Management, 1994) calls for at least 120 linear feet of logs greater than 16 inches diameter and 16 feet in length per acre in the project vicinity. In the project vicinity, only the mixed conifer cover type provides sufficient down wood to meet that standard. Most of the other cover types have low numbers of large downed wood with few areas having logs more than 16 inches diameter.

Riparian communities are important for providing wood to riverine areas for fish and wildlife habitat. In the Klamath River project vicinity, the abundance of coarse woody debris varies substantially among riparian habitats along reservoirs and river reaches. At one extreme, the riparian habitat along the Link River provides no coarse woody debris, and at the other extreme, the riparian habitat along Fall Creek provides 561 feet/acre. The riparian areas along other river reaches were intermediate in log abundance. The Keno reach and the J.C. Boyle bypassed reach had 87 and 119 feet/ acre, respectively, but the reach from Iron Gate dam to the Shasta River reach had only 20 feet/ acre. Much of the J.C. Boyle peaking reach is bordered by forested habitat (either upland or riparian) that can supply the system with logs, but most of the immediate river shoreline is lacking in coarse woody debris. Apparently, logs that reach the river are quickly transported downstream.

In the riparian areas adjacent to reservoir shorelines, log abundance was extremely low. No logs were found at Keno reservoir, and the J.C. Boyle, Copco, and Iron Gate reservoirs each had 12, 8, and 58 feet/acre, respectively. The lack of forested habitat upslope of most of the reservoirs limits the availability of logs along the shoreline. Recreationists also likely reduce the availability of coarse woody debris near recreation sites along reservoirs and river segments.

In and along the margins of the Klamath River, coarse woody debris (large pieces of dead, down wood such as fallen logs, wind blown trees, and large branches) was surveyed at 15 geomorphic study sites within the project boundary and downstream of it. Averaged data for each site shows that coarse woody debris length ranges from 3.3 feet to 32.8 feet; the average diameter ranges from less then an inch to 24 inches; and the average spacing ranges from 16 to 328 feet.

Two study sites downstream of Iron Gate dam had very little coarse woody debris present. The largest (average) coarse woody debris was found at survey sites in the J.C. Boyle peaking reach, where larger oaks and occasional conifers are within one stem-length[73] of the water's edge. PacifiCorp noted that in general, the coarse woody debris at the survey site is not accessible to the channel until periods of higher flows. Along the J.C. Boyle bypassed reach, coarse woody debris is typically colluvial wood from the banks that generally is not accessible by the channel.

Although substantial deposits of coarse woody debris observed in most project reaches may provide temporary aquatic and riparian habitat, PacifiCorp concluded that surveyed coarse woody debris did not appear to strongly influence underlying geomorphic processes.

Noxious and Invasive Weeds

The Oregon Department of Agriculture (ODA) lists 104 plant species as noxious weeds in Oregon (ODA, 2005) and the California Department of Food and Agriculture (CDFA) lists 133 plant species as noxious weeds in California (CDFA, 2004). Based on literature review and information obtained from ODA, CDFA, the Forest Service, and Bureau of Land Management, PacifiCorp developed a target list of 43 weed species that could occur in the project area. PacifiCorp conducted surveys for noxious weeds in the project vicinity in 2002, 2003, and 2004 in conjunction with its surveys for rare

[73]Trees that are located within one stem length (the height of the tree) from the edge of the river are capable of entering the channel when they fall, therefore becoming coarse woody debris.

plants, its vegetation cover type verification, and its riparian/wetland vegetation characterization studies. PacifiCorp determined that 21 of the target species occurred in the project vicinity and covered more than 582 acres. PacifiCorp identified and mapped 62 infestations of 15 noxious weed species based on its field surveys and mapped an additional 92 infestations of 18 noxious weed species based on information obtained from the Bureau of Land Management's noxious weed database. Three noxious weed species (cheatgrass, medusahead, and bull thistle) were not mapped because they were found to be so widespread in the project vicinity. Yellow starthistle is the most abundant of the mapped noxious weed species.

PacifiCorp documented several noxious weed species near project facilities where maintenance activities create suitable habitat for invasive species by removing native vegetation or disturbing the ground. Maintenance around facilities is conducted annually and includes both mechanical vegetation removal and spraying. Trees posing a hazard near facilities are cleared as needed. Fire breaks about 10 to 12 feet wide are created annually around campgrounds by using a bulldozer to scrape the ground cover down to mineral soil. Other than standard facility vegetation maintenance, no other fire/fuels management activities are conducted. Substation grounds are kept clear of vegetation. PacifiCorp follows guidelines in its vegetation management plan for managing vegetation in road rights of way.

Special Status Plant Species

PacifiCorp's review of information from the Forest Service, FWS, Bureau of Land Management, ODA, Cal Fish & Game, and the California Native Plant Society (CNPS) indicated that 65 vascular plants, 3 bryophytes, and 10 lichens with special status could potentially occur in the project vicinity. PacifiCorp conducted field surveys for rare plants during May, June, and July 2002, and revisited some sites in October and November of that year and in September 2003 to confirm the identity of plant species potentially with special status. Sixty-seven occurrences of 12 plant species with special status were documented in the project vicinity either during the 2002 surveys or previously by the Bureau of Land Management, ONHP, or the California Natural Diversity database (table 3-79). One of these special status plant species, Applegate's milk-vetch, is federally listed as endangered, and is discussed in section 3.3.5, *Threatened and Endangered Species*.

Table 3-79. Special status plant species that are known to occur in the vicinity of the Klamath Hydroelectric Project. (Source: Cal Fish & Game, 2006a; Oregon Natural Heritage Information Center, 2004; PacifiCorp, 2004a, 2005)

Species	Status[a]	Habitat and Location Where Found
Applegate's milk-vetch (*Astragalus applegate*)	FE, OE, ONHP List 1	Occurs in flat-lying, seasonally moist, strongly alkaline soils. Documented during PacifiCorp's field surveys at Keno reservoir.
Greene's mariposa lily (*Calochortus greenei*)	FSC, BS, OC, ONHP List 1, CNPS List 2	Occurs primarily in annual grassland, wedgeleaf ceanothus chaparral, and oak and oak-juniper woodlands. Documented during PacifiCorp's field surveys at Iron Gate reservoir. Yellow starthistle, medusahead, and annual bromes form the dominant herb layer cover at nearly all of the sites where Greene's mariposa lily was observed. Also known to occur at Copco reservoir and along J.C. Boyle peaking reach.
Mountain lady's slipper (*Cypripedium montanum*)	TS, S/M, ONHP List 4, CNPS List 4	Occurs in dry, open conifer forests, but more often in moist riparian habitats. Documented during PacifiCorp's field surveys on a shaded and mesic, forested slope above

Species	Status[a]	Habitat and Location Where Found
		Frain Creek, a small tributary to the Klamath River at Frain Ranch along J.C. Boyle peaking reach.
Bolander's sunflower (*Helianthus bolanderi*)	TS, ONHP List 3	Occurs in yellow pine forest, foothill oak woodland, chaparral, and occasionally in serpentine substrates or wet habitats. Documented during PacifiCorp's field surveys in highly disturbed and degraded sites filled with annual bromes and starthistle along the lower reach of Hayden Creek, a tributary to the Klamath River along J.C. Boyle peaking reach, and south of Iron Gate reservoir.
Salt heliotrope (*Heliotropium curvasassavicum*)	AS, ONHP List 2	Occurs in seasonally flooded, low-lying, non-porous areas on the east side of the Cascades. Documented during PacifiCorp's field surveys at the upper end of Keno reservoir.
Bellinger's meadow foam (*Limnanthes floccosa* ssp. b*ellingeriana*)	FSC, BS, OC, ONHP List 1, CNPS List 1B	Occurs in rocky, seasonally wet meadows, or along the margins of damp rocky meadows often partially shaded by adjacent trees and shrubs. Not documented during PacifiCorp's field surveys. Known to occur along J.C. Boyle peaking reach.
Egg Lake monkeyflower (*Mimulus pygmaeus*)	FSC, CNPS List 1B	Occurs in damp areas or vernally moist conditions in meadows and open woods. Documented during PacifiCorp's field surveys on the southwest end of J.C. Boyle reservoir in damp mudflats adjacent to shallow and narrow tributaries to the reservoir and under the transmission line just southwest of J.C. Boyle dam.
Red root yampah (*Perideridia erythrorhiza*)	FSC, BS, OC, ONHP List 1	Occurs in moist prairies, pastureland, seasonally wet meadows, and oak or pine woodlands, often in dark wetland soils and clay depressions. Not documented during PacifiCorp's field surveys. Known to occur along Keno reach, at J.C. Boyle reservoir, and along J.C. Boyle peaking reach.
Columbia yellow cress (*Rorippa columbiae*)	FSC, BS, OC, ONHP List 1, CNPS List 1B	Occurs in cobbly, gravelly silt associated with seasonal creek drainages in ponderosa pine/ juniper woodland, on the shores of alkaline lakes, along roadside ditches, in meadows, and seeps. Documented during PacifiCorp's field surveys at Keno reservoir.
Fleshy sage (*Salvia dorrii* var. *incana*)	CNPS List 3	Occurs in silty to rocky soils in great basin scrub, pinyon, and juniper woodland. Documented during PacifiCorp's field surveys on weathered bedrock outcrops overlain with thin, loose, and rocky substrate at Iron Gate reservoir and along Klamath River from Iron Gate dam to Shasta River.

Species	Status[a]	Habitat and Location Where Found
Pendulus bulrush (*Scirpus pendulus*)	AS, ONHP List 2, CNPS List 2	Occurs along streambanks and in wet meadows. Documented during PacifiCorp's field surveys along Fall Creek and J.C. Boyle peaking reach.
Short-podded thelypody (*Thelypodium brachycarpum*)	FSC, AS, ONHP List 2, CNPS List 4	Occurs in meadows and open flats. Documented during PacifiCorp's field surveys in low-lying saltgrass grassland at Keno reservoir.

[a] **FE =** Listed as endangered by the FWS.
FSC = Federal species of concern – candidate species the FWS is considering listing under the ESA.
S/M = Survey and Manage Species, Category A and C plant species as defined in the Northwest Forest Plan.
BS = Bureau of Land Management sensitive plant species – species that could easily become endangered or extinct.
AS = Bureau of Land Management assessment plant species – species not presently eligible for federal or state status that may need protection or mitigation.
TS = Bureau of Land Management tracking plant species – more information needed to determine status.
OE = Listed as endangered by ODA.
OC = Candidate for listing by ODA.
ONHP List 1= threatened with extinction or presumed to be extinct throughout their entire range.
ONHP List 2 = threatened with extirpation or presumed to be extirpated from the state of Oregon.
ONHP List 3 = more information is needed before status can be determined, but may be threatened or endangered in Oregon or throughout their range.
ONHP List 4=of conservation concern but not currently threatened or endangered.
CNPS List 1B =rare, threatened, or endangered in California and elsewhere.
CNPS List 2 = rare, threatened, or endangered in California, but more common elsewhere.
CNPS List 3 = on the review list - more information needed
CNPS List 4 = on the watch list - limited distribution

At the time of its field surveys, PacifiCorp documented (by literature review and field surveys) the occurrence of two species in the project vicinity with special status at that time: Howell's yampah (*Perideridia howellii*)[74] and Lemmon's silene (*Lepidium latifolium*).[75] PacifiCorp documented Howell's yampah, which occurs in wet meadows and along stream banks, during its field surveys along the J.C. Boyle peaking reach, along Shovel Creek, and in a small seep at Copco reservoir. The Bureau of Land Management had previously documented Lemmon's silene, which occurs in open pine woodlands, in relatively undisturbed oak and conifer dominated forest along the J.C. Boyle peaking reach, but PacifiCorp did not locate this species in its field surveys.

PacifiCorp conducted surveys for Peck's milk-vetch (*Astragalus peckii*),[76] pumice grapefern (*Botrychium pumicola*),[77] and Ashland thistle (*Cirsium ciliolatum*)[78] but did not locate any occurrences of these species. PacifiCorp determined that potential habitat for Peck's milk-vetch, sandy soils in dry shrublands and sometimes in juniper or pine woodlands, occurs at J.C. Boyle reservoir. Pumice

[74]Previously considered a Bureau of Land Management tracking species and included on the Oregon Natural Heritage Information Center's List 4, but not included on their most current lists.

[75]Previously included on the Oregon Natural Heritage Information Center's List 3, but not on the current list.

[76]Listed as threatened by the Oregon Department of Agriculture and included on the Oregon Natural Heritage Information Center's List 1.

[77]Listed as threatened by the Oregon Department of Agriculture and included on the Oregon Natural Heritage Information Center's List 1.

[78]Considered a sensitive plant species by the Bureau of Land Management and included on the Oregon Natural Heritage Information Center's List 1.

grapefern, which occurs in seasonally moist to dry, alpine, fine to coarse pumice gravels in open pumice fields on treeless ridges and gently rolling slopes, is known to occur along the J.C. Boyle peaking reach and at the Copco and Iron Gate reservoirs. Ashland thistle occurs in dry, rocky grasslands and in open woodlands on south-facing aspects; PacifiCorp determined that potential habitat for this species is located along the Klamath River from the J.C. Boyle peaking reach to the Shasta River.

In its scoping comments, Interior suggested that this EIS should address impacts of roads on pygmy monkey flower (*Mimulus rubellus*). PacifiCorp did not identify pygmy monkey flower as a species that could potentially occur in the project area and therefore, did not conduct surveys for this plant. Pygmy monkey flowers occur in sandy places in washes at elevations of 3,000 to 8,000 feet and have been documented in desert habitats in southeastern and east-central parts of California. It is unlikely that pygmy monkey flower occurs in the Klamath Hydroelectric Project vicinity.

Ethnobotanical Resources

Native American groups in the Klamath River region share a tradition of using botanical resources in the area for food and basketry. Many of the plant species traditionally used by native Americans for food are still founding the vicinity of the Klamath River Project. Klamath and Modoc women dug ipos (*Carum oregonum*) roots and scraped the cambium layers of young ponderosa pines for food. Desert parsley (*Lomatium canbyi*), camas bulbs, and wocas (the nutritious seeds of the yellow pond lily), were also processed into food, as were cattail roots, which were dried and ground into meal. Chokecherries, serviceberries, Klamath plums, pine nuts, blackberries, gooseberries, and huckleberries were also gathered for food.

The Shasta Tribe also used a wide variety of plant products for food, including roots, bulbs, seeds, and berries. In addition to acorns and pine nuts, important roots and bulbs included ipos, redbells, brodiaea, and tiger lily bulbs. Women also collected wild celery, wild parsley, and wild rhubarb for fresh eating, drying, or both. Other vegetal foods included blackberries, elderberries, wild grapes, chokecherries, manzanita and madrone fruits, plums, and grass seeds. Nuts used by the Shasta included acorns from black, white, and canyon live oaks, along with tan oaks that were traded from the Karuk and Yurok tribes. Other nuts included those from gray, ponderosa, and sugar pine, as well as hazelnuts.

Acorns harvested from upland oak groves were also important food sources for the Karuk, Yurok and Hoopa. Traditional foods used by the Karuk Tribe include Indian rhubarb, watercress, and wild turnips from riparian areas, and upland species including red huckleberry, evergreen huckleberry, tan oak, dwarf tan oak, hazel, white oak, canyon oak, and black oak (Norgaard, 2005). Yurok gathered wild sunflower, various bulbs, grass seed and clover, as well as many kinds of fruits and berries, including salmon berry, huckleberry, gooseberry, sallal, currants, and grapes. Plants with cultural and spiritual significance to the Hoopa include willow, cottonwood, wild grape, bulrush, hazel, tules, spearmint and blackberries (King, 2004).

All of the tribes in the Klamath basin continue to collect materials from along the Klamath River for making baskets that are used in various ceremonies. Willow brush is a common basket-making material and fresh willow growth on gravel bars produces the best basket material. Other plant materials used in basket making include pine, redwood and spruce roots, grapevine, and fern.

3.3.4.1.2 Wildlife Resources

The Klamath River valley from Link River to Iron Gate dam is a natural wildlife migration corridor through the Cascade Mountains. The diverse terrain and plant communities support a large number of wildlife species.

Amphibians

PacifiCorp's review of published range maps and habitat associations indicated that 16 amphibian species could occur in the project area. PacifiCorp reviewed existing databases and literature; conducted field surveys in 2002 and 2003 of potential pond-breeding, stream, and terrestrial habitats; and determined that six species of amphibians occur in the project vicinity, including two with special status. Table 3-80 describes the four non-special-status amphibian species. We discuss the two special-status amphibians—the western toad and the foothill yellow-legged frog—later in this section.

Table 3-80. Non-special status amphibian species that are known occur in the vicinity of the Klamath Project. (Source: PacifiCorp, 2004a, 2005a)

Species	Habitat and Location Where Found
Pacific treefrog (*Hyla regilla*)	Inhabits marshes, mountain meadows, woodlands, brush, and disturbed areas, breeding in water less than 1.6 feet deep in permanent or seasonal pools; tadpoles live in shallow water while froglets occur in vegetation along the perimeter of ponds. Documented by the Bureau of Land Management in its surveys in 2000 and 2001 along the Klamath River in pine and mixed-conifer woodlands, as well as in non-forested habitats. The Bureau of Land Management also documented breeding Pacific treefrogs at a number of widely scattered locations in Oregon portion of J.C. Boyle peaking reach. In its surveys, PacifiCorp documented breeding sites in wetlands directly connected to J.C. Boyle peaking reach and Iron Gate reservoir.
Bullfrog (*Rana catesbiana*)	Not native to Oregon or California but occurs throughout much of the project vicinity, inhabiting very warm and sunny permanent ponds, marshes, and slow river backwaters. Lays eggs in ponds during the summer, and tadpoles occupy shallow water with dense aquatic vegetation; froglets, and adults require permanent water with dense submerged, emergent, and shoreline vegetation. Reported by Oregon Fish & Wildlife along Link River. Documented by PacifiCorp in its surveys along Keno reservoir, at J.C. Boyle reservoir, in J.C. Boyle bypassed reach, in the uppermost portion of J.C. Boyle peaking reach, at Copco reservoir, at Iron Gate reservoir, along Jenny Creek (0.25 mile upstream of Iron Gate reservoir), and at two locations downstream of Iron Gate dam. This species likely breeds in all project reservoirs, in slow-moving sections of river reaches, and at other sites and creates substantial predatory pressure on native amphibians and small fish.
Pacific giant salamander (*Dicamptoden tenebrosus*)	Inhabits cool, moist forests adjacent to streams and lakes and are also found in moist talus. Neonates prefer Order III-V streams; larva are typically found in Order II-V streams, but will use Order I. May be found in low to moderate gradient tributaries with pool morphology and rocky bottoms. In its surveys, PacifiCorp found larval forms of Pacific giant salamanders above and below Fall Creek diversion dam as well as in J.C. Boyle bypassed reach.
Long-toed salamander (*Ambystoma macrodactylum*)	Inhabits a wide variety of habitats including forests, grasslands, and disturbed areas. Eggs are laid in water less than 1.6 feet deep in seasonal pools, along shallow lake edges, and in slow streams through wet meadows; hatchlings and larvae live in sediments in shallow water. Adults stay underground, but can be found under logs and rocks during the rainy season. Documented by PacifiCorp in its surveys in the stock pond southwest of Topsy campground, on the south side of J.C. Boyle reservoir and in the Long Prairie stock pond north of Copco reservoir along Long Prairie Creek.

Reptiles

PacifiCorp's review of published range maps and habitat associations indicated that 22 reptile species could occur in the project area. PacifiCorp reviewed existing databases and literature; conducted field surveys in 2002 and 2003 of potential pond-breeding, stream, and terrestrial habitats; and determined that 16 species of reptiles occur in the project vicinity, including four with special status. We address the 12 non-special-status species in table 3-81 and the special-status species later on in this section.

Table 3-81. Non-special status reptile species that are known to occur in the vicinity of the Klamath Project. (Source: PacifiCorp, 2004a, 2005)

Species	Habitat and Location Where Found
Northern alligator lizard (*Elgaria coerulea*)	Inhabits the edges of meadows in coniferous forests and in riparian zones. PacifiCorp documented it during its surveys in proximity to J.C. Boyle powerhouse intake canal.
Southern alligator lizard (*Elgaria multicarinata*)	Occurs in thickets, logs, or rock piles in grasslands, chaparral, oak woodlands, edges of conifer forests, riparian areas, and moist canyon bottoms. The Bureau of Land Management documented it in its 2000 and 2001 surveys in hardwood woodlands and in non-forested habitats along the Klamath River throughout J.C. Boyle peaking reach, particularly downstream of Frain Ranch on southern aspects. Documented by PacifiCorp in its surveys in montane hardwood oak-conifer forests along J.C. Boyle peaking reach and in riparian and wetland habitats along Keno and J.C. Boyle peaking reaches, and Copco reservoir.
Western skink (*Eumeces skiltonianus*)	Inhabits moist sites under rocks and logs in grassland, chaparral, juniper woodlands, conifer forests, and riparian areas. The Bureau of Land Management documented it in its 2000 and 2001 surveys at seven locations along Klamath River in conifer, hardwood, and Douglas-fir woodlands, including two sites immediately north of the river just upstream of the California-Oregon border and at other widely scattered sites 0.2 to 0.8 mile from the river. PacifiCorp documented it in its surveys in riparian grass habitat along J.C. Boyle bypassed reach.
Western fence lizard (*Sceloporus occidentalis*)	Inhabits a wide range of habitats, but requires vertical structure. The Bureau of Land Management documented it in its field surveys in 2000 and 2001 along Klamath River in pine, hardwood, Douglas fir, and mixed conifer woodlands as well as in non-forested habitats. It was the most abundant reptile species encountered by PacifiCorp in its field surveys. PacifiCorp documented it in a wide variety of habitats including riparian and wetland, mixed chaparral, juniper, montane hardwood oak woodlands, ponderosa pine forest, mixed conifer forest, and lodgepole pine stands throughout the project vicinity except at Link River. Also found by PacifiCorp in proximity to J.C. Boyle powerhouse intake canal.
Rubber boa (*Charina bottae*)	Commonly found in forest openings with stumps and logs, but also in forested areas and grasslands. The Bureau of Land Management documented this species in its 2000 and 2001 surveys along Klamath River in mixed-conifer woodlands. Not documented by PacifiCorp in its surveys.
Yellow-bellied racer (*Coluber constrictor*)	Occurs in sagebrush flats, juniper woodlands, chaparral, and meadows; avoids dense forests. The Bureau of Land Management documented it in its 2000 and 2001 field surveys along Klamath River in pine, Douglas-fir, non-forested, hardwood, and mixed conifer woodlands. PacifiCorp documented it in its surveys along J.C. Boyle peaking reach, in pasture and in riparian habitat. Also found by PacifiCorp in proximity to J.C. Boyle powerhouse intake canal.

Species	Habitat and Location Where Found
Western rattlesnake (*Crotalis viridus*)	Found in areas with low or sparse vegetation and rocky areas; known to occur throughout the project vicinity, with a patchy distribution. Reported along various sections of J.C. Boyle peaking reach. Documented by the Bureau of Land Management in its surveys in hardwood woodlands and in non-forested habitats along the Klamath River between the J.C. Boyle dam and the Oregon-California border. PacifiCorp documented it in its surveys in riparian and wetland habitat along J.C. Boyle bypassed reach and at Iron Gate reservoir. Also observed by PacifiCorp on roads either basking or already killed by vehicles and in proximity to J.C. Boyle powerhouse intake canal.
Ring-necked snake (*Diadophis punctatus*)	Inhabits moist conditions under wood, rocks, talus, or woody debris and are known to occur in riparian habitats with a deciduous overstory. Surface activity is limited, with most activity occurring from March to mid-May. Documented by the Bureau of Land Management in its 2001 surveys at one location approximately 0.1 mile west of Klamath River and northwest of Frain Ranch in hardwood woodlands. PacifiCorp documented it in its surveys near J.C. Boyle powerhouse intake canal.
Striped whipsnake (*Masticophis taeniatus*)	Occurs in grasslands, sagebrush, rocky stream courses, and canyon bottoms, as well as juniper and pine-oak woodlands. The Bureau of Land Management documented it in its 2000 and 2001 field surveys along Klamath River in pine and non-forest habitats, near Keno dam, and 0.5 mile north of the Klamath River not far from the California-Oregon border. In its surveys, PacifiCorp found one striped whipsnake dead on the county road near Copco village in montane hardwood oak habitat. PacifiCorp also provided anecdotal reports of observations along the Copco Road just northeast of Fall Creek powerhouse.
Gopher snake (*Pituophis melanoleucus*)	Inhabits a wide variety of habitats. The Bureau of Land Management documented it in its field surveys in 2000 and 2001 along Klamath River from the J.C. Boyle dam to the Oregon-California border in pine, hardwood, and mixed-conifer woodlands. PacifiCorp documented it in its surveys of riparian habitat at Keno reservoir, along Keno reach, along J.C. Boyle peaking reach, and along Klamath River from Iron Gate dam to Shasta River. Also observed by PacifiCorp on roads either basking or already killed by vehicles.
Western terrestrial garter snake (*Thamnophis elegans*)	Inhabits a wide variety of habitats. The Bureau of Land Management documented it in its 2000 and 2001 field surveys along Klamath River from the J.C. Boyle dam to the Oregon-California border in ponderosa pine, hardwood, and mixed-conifer woodlands, as well as non-forested habitats. PacifiCorp documented it in surveys of riparian habitat along J.C. Boyle peaking reach and at Fall Creek diversion dam.
Common garter snake (*Thamnophis sirtalis*)	Inhabits a wide variety of habitats. The Bureau of Land Management documented it in its field surveys in 2000 and 2001 along Klamath River from the J.C. Boyle dam to the Oregon-California border in ponderosa pine and mixed-conifer woodland, and non-forested habitats. Documented by PacifiCorp in its surveys in riparian habitats along Link River, and Keno, J.C. Boyle bypassed, and J.C. Boyle peaking reaches. PacifiCorp also documented one winter hibernaculum with numerous common garter snakes just downstream of Keno dam among concrete rubble about 20 feet from the Klamath River.

Birds

PacifiCorp conducted avian plot surveys, facility surveys, and reservoir surveys, and also reviewed Klamath Bird Observatory data from avian censuses and mist-netting conducted in the project vicinity. PacifiCorp found birds in all habitats surveyed in the project vicinity. Habitats with the lowest avian relative abundance were rock talus and mixed riparian habitats; habitats with the highest relative abundance were sagebrush, wetlands, and pastures.

PacifiCorp documented 93 passerine species, and seven were found at all of the project reservoirs and in all of the project reaches: western wood pewee, song sparrow, yellow warbler, brown-headed cowbird, black-headed grosbeak, Brewer's blackbird, and mourning dove. All seven of these species are associated with riparian and/or wetland habitat. PacifiCorp found four of the 93 passerine species in or near the disturbed habitats around the project facilities: cliff swallow, Brewer's blackbird, red-winged blackbird, and brown-headed cowbird. PacifiCorp found that species relatively abundant in riparian and wetland habitats throughout the project vicinity included red-winged blackbird, song sparrow, and yellow warbler.

Project reservoirs are important for many waterfowl and water-related birds. Approximately 67 percent of all birds documented by PacifiCorp during its field surveys were waterfowl and other water-related birds. PacifiCorp observed 47 species of water birds including 20 species of waterfowl and 19 species of open-water, marsh, and wading birds other than waterfowl. Five of the waterfowl species are permanent or summer residents and have been documented breeding near the project: Canada goose, wood duck, mallard, blue-winged teal, and common merganser. PacifiCorp observed wood duck and common merganser broods during waterfowl surveys of the reservoirs and during other surveys of river reaches.

During its field surveys PacifiCorp also documented:

- Nineteen species of birds of prey, including six species of hawk, two eagle species, three falcon species, seven owl species, and one species of vulture.
- Eight species of woodpeckers, including acorn woodpecker, white-headed woodpecker, Lewis' woodpecker, red-shafted flicker, red-breasted sapsucker, downy woodpecker, hairy woodpecker, and pileated woodpecker.
- Five gamebird species, including wild turkey, blue grouse, California quail, mountain quail, and mourning dove.

Mammals

PacifiCorp conducted track surveys, photographic bait station surveys, and wildlife surveys near project facilities as well as live trapping for small mammals on each side of the West Side, J.C. Boyle, and Fall Creek canals. PacifiCorp also documented incidental observations of mammals throughout the project vicinity. PacifiCorp observed a total of 30 mammals in the project vicinity; black-tailed jackrabbit, deer, and California ground squirrels occurred throughout the project vicinity.

<u>Big Game</u>: Big game mammals in the project vicinity include mule deer, black-tailed deer, elk, black bear, and cougar. Oregon Fish & Wildlife manages these species in Oregon, and Cal Fish & Game manages them in California primarily for sport-hunting purposes.

Mule deer typically occur to the east of the Cascade crest, and black-tailed deer occur to the west. However, within the project vicinity, hybrid deer may be the most common. Oregon Fish & Wildlife does not distinguish between the two species when managing populations on the Keno Wildlife Management Unit, north of the Klamath River in Oregon. Oregon Fish & Wildlife's winter deer population goal at this management unit is 3,200 individuals (Oregon Fish & Wildlife, 2003b); Oregon Fish & Wildlife estimates that approximately 1,200 deer currently winter in the Keno Wildlife Management Unit, and most of them are also residents during the summer. In California, the Cascade-North Sierra Nevada Deer Assessment Unit extends from the Oregon border south to Lake Almanor and the Feather River drainage. In this area, the deer population has declined due to loss of high quality early-successional habitat and a hard freeze several years ago that killed desirable browse in the summer range.

The Bureau of Land Management, Oregon Fish & Wildlife, and Cal Fish & Game consider the canyon and mid-elevation hillsides and plateaus between the J.C. Boyle powerhouse and Iron Gate dam as critical deer winter range. This area represents one of the largest contiguous areas of winter range in the southern Oregon and northern California region. In the project vicinity, south-facing lower canyon walls and hillsides are some of the most critical habitat for wintering migratory black-tailed deer herd as well as for resident deer.

Several acres of habitat with wedgeleaf ceanothus and mountain mahogany, major deer browse species, occur within the project vicinity. These two shrub species are estimated to be a major component in 14 vegetation cover types occurring in the project vicinity. There is a substantial amount of desirable browse along the J.C. Boyle peaking reach, along the Copco No. 2 bypassed reach, and along Fall Creek.

Oregon Fish & Wildlife's winter management objective for elk at the Keno Wildlife Management Unit is 700 elk; currently, about 400 elk winter there. Most elk have an affinity for certain ranges and generally will use the same summer and wintering grounds throughout their life (Oregon Fish & Wildlife, 2003a). The severity of winter often will influence how far and to what elevation elk will move to avoid adverse weather conditions. Studies in the central Oregon Cascades have shown that elk often winter on the west slope of the Cascades and cross to central Oregon in the summer. Elk are known to have summer ranges west of Upper Klamath Lake in Oregon and in the upper portions of the Long Prairie Creek and Jenny Creek watersheds, as well as several areas at higher elevations north of the river. No data exist on elk wintering near the project reservoirs. Based on previous studies, a small number of elk may cross into the project vicinity during migration periods, but elk do not appear to remain close to project reservoirs for long periods of time during any season. During its field surveys, PacifiCorp observed two elk along the J.C. Boyle peaking reach.

The black bear is a resident of most forested ecosystems in southern Oregon and northern California. PacifiCorp documented black bear during its field surveys along the Link River and along the J.C. Boyle bypassed reach. Oregon Fish & Wildlife considers bear density in the project vicinity as medium on the eastern end of the project and high on the western end. Cal Fish & Game expects bear populations to be highest in montane hardwood, montane chaparral, and mixed conifer forests.

The mountain lion commonly occurs in most habitats in the project vicinity. During its field surveys PacifiCorp documented mountain lions along the J.C. Boyle bypassed reach, the J.C. Boyle peaking reach, and along the Copco No. 2 bypassed reach. The state of Oregon classifies the mountain lion as a game mammal and gives Oregon Fish & Wildlife management responsibility (Oregon Fish & Wildlife, 2006). The 2006 mountain lion harvest quota for the southwest Cascades region of Oregon is 173 individuals (the highest of any region in Oregon). In California, the mountain lion is a specially protected mammal, and no take is allowed except under depredation/nuisance circumstances.

<u>Other Mammals</u>: During its field surveys, PacifiCorp documented five aquatic fur-bearing mammal species in the project vicinity including raccoon, beaver, muskrat, mink, and river otter. Mink and raccoons are common throughout the project vicinity along the Klamath River and its tributaries. Muskrats are particularly common along the Keno reservoir and the adjacent Klamath Wildlife Area, where large patches of emergent wetland provide ample habitat. PacifiCorp documented river otters or their sign downstream of the J.C. Boyle and Iron Gate dams, and in the beaver pond wetlands near Copco village. Beaver sign is common along all river reaches and in the portions of project reservoirs where there are well-developed riparian and wetland habitats, such as along Spencer Creek on the J.C. Boyle reservoir and near Jenny and Camp creeks on the Iron Gate reservoir.

Medium-sized mammals that PacifiCorp documented in the project vicinity include bobcat, gray fox, yellow-bellied marmot, and coyote. Yellow-bellied marmots were only found at the Link River and at the Keno reservoir. The other species were found throughout the project vicinity.

During its field surveys PacifiCorp also documented several small mammal species, particularly the deer mouse, bushy-tailed woodrat, dusky-footed woodrat, montane vole, canyon mouse, and least chipmunk.

PacifiCorp reported that a wild horse herd roams throughout the area from near Fall Creek to near J.C. Boyle dam. This herd is known as the Pokegama Wild Horse Herd and occurs primarily on a formally established wild horse herd management area controlled by the Bureau of Land Management. The Bureau of Land Management's goal is to keep the herd near 30 animals, but no accurate population estimate is currently available.

PacifiCorp also reported that local ranchers have seen wild pigs near the Klamath River during the last several decades. PacifiCorp did not find any evidence of wild pigs during its field surveys.

Special Status Wildlife Species

PacifiCorp conducted a search of federal and state databases of wildlife with special status and consulted with agency (Forest Service, FWS, Bureau of Land Management, Oregon Fish & Wildlife, and Cal Fish & Game) biologists familiar with special status species locations and determined that 107 vertebrate species and 22 invertebrate species with special status could potentially occur in the project vicinity. PacifiCorp conducted field surveys for rare vertebrate and invertebrate wildlife species in the project vicinity during 2002 and 2003 and documented 45 of the 107 vertebrate species with special status, including one amphibian, four reptiles, 38 birds, and two mammals. Two of these special status vertebrate species, northern spotted owl and bald eagle, are federally listed as threatened, and are discussed in section 3.3.5, *Threatened and Endangered Species*. The amphibians, reptiles, birds, and mammals shown in table 3-82 include federal species of concern and state-listed threatened, endangered, or species of concern that have been documented in the project vicinity either by PacifiCorp, the Bureau of Land Management, Oregon Fish & Wildlife, or Cal Fish & Game. The current status of each species was identified after reviewing Oregon Fish & Wildlife's and Cal Fish & Game's current lists of special-status animals. Table 3-83 provides the status information for each special status species and summarizes information about the typical habitat for each of these species and their occurrence in the project vicinity.

Table 3-82. Special status species that are known or documented to occur in the Klamath Project vicinity. (Source: Bureau of Land Management, 2006; Cal Fish & Game, 2005, 2006b; Oregon Fish & Wildlife, 2005a, 2005b; Oregon Natural Heritage Information Center, 2004; PacifiCorp, 2004a, 2005)

Species	Status[a]	Habitat and Location Where Found
Amphibians		
Western toad *Bufo boreas*	Bureau of Land Management-T, Oregon Fish & Wildlife SV, ONHP List 4	Breeds from February to early May in ponds, the edges of shallow lakes, and in slow-moving streams where the water depths are less than 1.6 feet deep and the water temperature is at least6°C; hatchlings and tadpoles live in the warmest water available, up to30°C; adults are common near marshes and small lakes but may also be found in dry forests, shrubby areas, and meadows. Documented during PacifiCorp's surveys along J.C. Boyle peaking reach, along the north shore of Iron Gate reservoir, and along Klamath River near RM 185 (between the confluence of Bogus and Cottonwood creeks).

Species	Status[a]	Habitat and Location Where Found
Foothill yellow-legged frog *Rana boylii*	FSC, Bureau of Land Management-A, Oregon Fish & Wildlife SV, ONHP List 2, Cal Fish & Game SSC	Inhabits permanent slow-moving streams with rocky bottoms in a variety of habitats, including large cobble bars or in-channel islands, coupled with slower backwater areas for larval rearing. Not documented during PacifiCorp's surveys. Known to occur along J.C. Boyle bypassed reach near J.C. Boyle dam.
Reptiles		
Northwestern pond turtle *Clemmys marmorata marmorata*	FSC, Bureau of Land Management, Oregon Fish & Wildlife SC, ONHP List 2, Cal Fish & Game SSC	Prefers quiet water in small lakes, marshes, and sluggish streams and rivers; requires basking sites, such as logs, rocks, mud banks, or cattail mats; nests in open canopy sites with loose soil; home range of 0.6 to 2.4 acres. Documented during PacifiCorp's surveys at Keno, J.C. Boyle, Copco, and Iron Gate reservoirs, along J.C. Boyle bypassed reach, along J.C. Boyle peaking reach in California, and along Klamath River from Iron Gate dam to Shasta River.
Northern sagebrush lizard *Sceloporus graciosus graciosus*	FSC, Bureau of Land Management-T, Oregon Fish & Wildlife SV, ONHP List 4	Inhabits sagebrush, chaparral, juniper woodlands, and dry conifer forests. Documented during PacifiCorp's surveys in the rocky riparian shrub habitat of Keno reach, along J.C. Boyle peaking reach, near J.C. Boyle powerhouse intake canal, and near the edge of a forested wetland along Iron Gate reservoir.
Sharptail snake *Contia tenuis*	Bureau of Land Management-T	Inhabits moist sites in chaparral, conifer forests, and deciduous forests, but primarily occurs in oaks and other deciduous tree woodlands, particularly in the forest edges. Active from March to mid-May. Known to occur along upper J.C. Boyle peaking reach west of Frain Ranch in Douglas-fir habitat but not detected by PacifiCorp during its surveys.
Common kingsnake *Lampropeltis getula*	FSC, Bureau of Land Management-T, Oregon Fish & Wildlife SV, ONHP List 4	Inhabits thick vegetation along watercourses, farmland, chaparral, deciduous, and mixed-coniferous forests; specifically associated with moist river valleys and dense riparian vegetation. Relatively wide-ranging in California, but have been reported to occur in Oregon only within the inland valleys of Douglas, Jackson, and Josephine counties. Documented during PacifiCorp's surveys along J.C. Boyle peaking reach in oak/woodland and mixed-conifer woodland and along Copco Road.
California mountain kingsnake *Lampropeltis zonata*	FSC, Bureau of Land Management-T, Oregon Fish & Wildlife SV, ONHP List 4	Occurs in pine forests, oak woodlands, and chaparral in, under, or near rotting logs and usually near streams; associated with well-illuminated rocky riparian habitat with mixed deciduous and coniferous trees, especially canyon live oak and black oak. Documented during PacifiCorp's surveys along Copco Road and in close proximity to J.C. Boyle powerhouse intake canal. Also known to occur in mixed-conifer woodlands along J.C. Boyle peaking reach.

Species	Status[a]	Habitat and Location Where Found
Birds		
Common loon *Gavia immer*	FSC, Cal Fish & Game SSC-HP	May over-winter on project reservoirs or occur in aquatic habitat associated with large bodies of water like the project reservoirs while migrating from sub-arctic freshwater breeding grounds to coastal and near-shore pelagic marine habitat along the Pacific coast. Documented during PacifiCorp's surveys at Iron Gate reservoir.
American white pelican *Pelecanus erythrorhynchos*	Bureau of Land Management-A, Oregon Fish & Wildlife SV, ONHP List 2, Cal Fish & Game SSC-HP	Nests at lakes and marshes and uses almost any lake outside of the breeding season; have a restricted range in southern Oregon and along the California border, where they are found to be associated with only a few large bodies of inland water. Documented during PacifiCorp's surveys on all project reservoirs, with the highest number occurring on Keno reservoir, and along Link River, Keno reach, J.C. Boyle bypassed reach, and on Klamath River between Iron Gate dam and Shasta River.
Black-crowned night heron *Nycticorax nycticorax*	FSC	Found in riparian habitats and in wetland sites. Communal roost used by night herons and other heron species located in a group of willow trees near the East Side powerhouse adjacent to Link River. Documented during PacifiCorp's surveys primarily along Keno reach, but also along Link River, at Keno reservoir, and along Klamath River from Iron Gate dam to Shasta River.
Snowy egret *Egretta thula*	Bureau of Land Management-A, Oregon Fish & Wildlife SV, ONHP List 2	Inhabits emergent wetlands associated with freshwater marshes and along the periphery of large water bodies. The northern limit of the snowy egret's range includes the area along the border between California and Oregon and southern Oregon. Documented during PacifiCorp's surveys near Link River dam, at Keno dam, and along Keno reach.
White-faced ibis *Plegadis chihi*	FSC, Bureau of Land Management-T, ONHP List 4, Cal Fish & Game SSC-HP	Breeds in freshwater marshes and lakes, and estuaries, and nests near the water on mats of vegetation and twigs; usually occurs in isolated con-specific flocks. Does not typically overwinter in Oregon but is a fairly common visitor in the Klamath Wildlife Area during the spring and summer. Documented during PacifiCorp's surveys along Link River and at Keno and J.C. Boyle reservoirs.
Barrow's goldeneye *Bucephala islandica*	Oregon Fish & Wildlife SU, ONHP List 4, Cal Fish & Game SSC-TP	Tends to breed along high-elevation mountain lakes and winter in coastal areas. Potential nesting habitat includes forests with sparse to moderate tree canopy closure next to rivers and reservoirs. Documented during PacifiCorp's surveys along Keno reservoir, in an inundated drainage ditch off of Copco reservoir, and on Iron Gate reservoir.
Bufflehead *Bucephala albeola*	Bureau of Land Management-A, Oregon Fish & Wildlife SU, ONHP List 4	Typically breeds around isolated mountain lakes; nesting habitat includes mixed conifer forest and ponderosa pine forests with sparse to moderate tree canopy closure close to lakes and ponds. Nests in cavities, including artificial nest boxes. May be found in open water and riverine habitat throughout southern Oregon after the breeding season. Documented during PacifiCorp's surveys primarily from January until April along the Link River, at Keno, Copco, and Iron Gate reservoirs.

Species	Status[a]	Habitat and Location Where Found
Osprey *Pandion haliaetus*	Cal Fish & Game SSC-SP	Nests in all forested vegetation types with large trees near water, as well as on platforms erected in less optimal habitat. A minimum of 16 active osprey nests, both artificial nesting platforms and natural sites, are located along the shores of the project reservoirs and river reaches. Documented during PacifiCorp's surveys along the Keno reach, along the J.C. Boyle bypassed reach, along the J.C. Boyle peaking reach, at J.C. Boyle, Copco, and Iron Gate reservoirs, along Fall Creek, and along Klamath River from Iron Gate dam to Shasta River.
Northern harrier *Circus cyaneus*	Cal Fish & Game SSC-SP	Nests and forages in grasslands and emergent wetlands. Permanent residents in the project vicinity and common at the Klamath Wildlife Area. Documented during PacifiCorp's surveys in the low-lying marshland and agricultural fields east of Keno reservoir and along Klamath River from Iron Gate dam to Shasta River.
Golden eagle *Aquila chrysaetos*	Cal Fish & Game SSC-TP	Breeds in open mountain and hill habitats, nests on cliff ledges, and forages in grasslands and open conifer forests and woodlands with sparse to open tree canopy closure. Eagles use two to three nests during a lifetime. Historical records exist of several golden eagle nests located on cliffs from J.C. Boyle bypassed reach to Iron Gate reservoir. Documented during PacifiCorp's surveys at J.C. Boyle powerhouse, along the lower section of J.C. Boyle peaking reach, along Copco and Iron Gate reservoirs, and Copco bypassed reach.
Bald eagle *Haliaeetus leucocephalus*	FT, Oregon Fish & Wildlife LT, ONHP List 4, CFGC LE	Nests in large conifers within several miles of water; forages in rivers and lakes for fish and waterfowl; requires large snags for perching and conifers for night roosts. Documented during PacifiCorp's surveys at all project reservoirs and in all project reaches throughout the project vicinity.
Sharp-shinned hawk *Accipiter striatus*	Cal Fish & Game SSC-TP	Inhabits riparian deciduous forest, montane hardwood oak woodland, montane hardwood oak juniper, montane hardwood oak-conifer, juniper woodland, mixed conifer forest, ponderosa pine forest, and lodgepole pine with any level of tree canopy closure and tree diameters ranging from 6 to 24 inches. Documented during PacifiCorp's surveys in oak habitat along J.C. Boyle bypassed and peaking reaches, and along Klamath River from Iron Gate dam to Shasta River.
Cooper's hawk *Accipiter cooperii*	Cal Fish & Game SSC-TP	Inhabits riparian deciduous forest, montane hardwood oak woodland, montane hardwood oak-juniper, montane hardwood oak-conifer, juniper woodland, mixed conifer forest, ponderosa pine forest, and lodgepole pine with any level of tree canopy closure. Documented during PacifiCorp's surveys along J.C. Boyle bypassed and peaking reaches, and along Klamath River from the Iron Gate dam to Shasta River.

Species	Status[a]	Habitat and Location Where Found
Northern goshawk *Accipiter gentilis*	FSC, Bureau of Land Management, CC, Oregon Fish & Wildlife SC, ONHP List 4, Cal Fish & Game SSC-TP	Inhabits forested communities with at least 60 percent canopy cover and trees greater than 6 inches in diameter, except oak woodland, oak-conifer woodland, and oak-juniper woodland; forages over large home ranges. Documented during PacifiCorp's surveys flying over J.C. Boyle peaking reach.
Swainson's hawk *Buteo swainsoni*	FSC, Bureau of Land Management-T, Oregon Fish & Wildlife SV, ONHP List 4, Cal Fish & Game SSC-HP, CFGC LT	Dwells in open country and typically inhabits sagebrush, annual grassland, juniper woodland, montane hardwood oak-juniper, and riparian deciduous forest with sparse to open tree canopy closure. The species' range generally lies east of the project vicinity and includes the plains of the Great Basin in southeast Oregon and eastern northern California. Documented during PacifiCorp's surveys flying over agricultural fields southeast of Keno reservoir.
Merlin *Falco columbarius*	Bureau of Land Management-A, ONHP List 2, Cal Fish & Game SSC-HP	Uses a variety of forested and open habitats. Ranges throughout North America and travels great distances during migration from breeding grounds in northern Canada and Alaska to wintering habitat through the contiguous United States south to Central America. Documented during PacifiCorp's surveys at J.C. Boyle reservoir and along J.C. Boyle peaking reach.
Prairie falcon *Falco mexicanus*	Cal Fish & Game SSC-TP	Uses cliffs for nesting and plateau grasslands for foraging. Documented during PacifiCorp's surveys near Keno reservoir campground and boat ramp, above J.C. Boyle bypassed reach, near Copco reservoir, and flying over Klamath Wildlife Refuge.
American peregrine falcon *Falco peregrinus anatum*	Bureau of Land Management-S, CC, OFWC LE, ONHP List 2, CFGC LE	Breeds at suitable nest sites on cliffs and rocky outcroppings. Uses a variety of habitats, including open grassland areas, forest stands, and reservoirs throughout the project vicinity. The project vicinity is located in a management area designated for peregrine falcon recovery. Known to occur along Keno reservoir and the J.C. Boyle bypassed reach but not documented during PacifiCorp's surveys.
Mountain quail *Oreortyx pictus*	FSC, Bureau of Land Management-T, Oregon Fish & Wildlife SU, ONHP List 4	Inhabits open forests, chaparral, and juniper woodlands with dense undergrowth offering suitable refuge; breeds in higher elevation areas; migrates on foot up to 40 miles to lower elevation winter grounds. Documented during PacifiCorp's surveys at J.C. Boyle reservoir, along the J.C. Boyle bypassed reach and peaking reaches, along Fall Creek, and along Klamath River from the Iron Gate dam to Shasta River.
Greater sandhill crane *Grus canadensis tabida*	FSC, Bureau of Land Management-T, Oregon Fish & Wildlife SV, ONHP List 4, CFGC LT, Cal Fish & Game SSC-TP	Nests in marshes and wet meadows, and occasionally in pastures and irrigated hayfields. A primary requirement for suitable nesting habitat is the presence of surrounding water or undisturbed habitat. Documented during PacifiCorp's surveys east of Keno reservoir and along J.C. Boyle reservoir. PacifiCorp located an active nest with two eggs in it in the emergent wetland bordering J.C. Boyle reservoir.

Species	Status[a]	Habitat and Location Where Found
Caspian tern *Sterna caspia*	CC	Nests in tightly packed colonies on undisturbed islands, levees, and shores along inland water bodies during the summer breeding season and migrates south to winter from southern California through Central America. Forages over water. Documented during PacifiCorp's surveys on all project reservoirs as well as along Link River, Keno and J.C. Boyle bypassed reaches, and along the Klamath River from Iron Gate dam to Shasta River.
Forster's tern *Sterna forsteri*	Bureau of Land Management-T, ONHP List 4	Breeds at lakes and marshes and on mud or sand flats near water; forages over water. Documented during PacifiCorp's surveys along Link River, along Keno and J.C. Boyle bypassed and peaking reaches, and at all project reservoirs.
Black tern *Chlidonias niger*	FSC, Bureau of Land Management-T, ONHP List 4, Cal Fish & Game SSC	Nests in emergent vegetation along the shoreline periphery of freshwater lakes, wetlands, and marshes along rivers and ponds; forages in wet meadows, pastures, agricultural fields, and water. Documented during PacifiCorp's surveys at Keno and J.C. Boyle reservoirs.
Great gray owl *Strix nebulosa*	Bureau of Land Management-T, S/M-C, Oregon Fish & Wildlife SV, ONHP List 4, CFGC LE	Inhabits mixed conifer, ponderosa pine, and riparian mixed forest stands with trees greater than 11 inches in diameter providing at least 60 percent canopy cover within at least 984 feet of a natural or manmade opening greater than 10 acres. Breeds in tree cavities, typically located near suitable open grassland foraging habitat. Documented during PacifiCorp's surveys east of Fall Creek near Jenny Creek.
Northern spotted owl *Strix occidentalis caurina*	FT, OFWC LT, ONHP List 1	Inhabits ponderosa pine forest and mixed conifer forest with trees greater than 11 inches in diameter. Prefers old-growth forests with multi-layered tree canopies. Documented during PacifiCorp's surveys near J.C. Boyle reservoir and along J.C. Boyle peaking reach.
Flammulated owl *Otus flammeolus*	Bureau of Land Management, CC, Oregon Fish & Wildlife SC, ONHP List 4	Nests in abandoned woodpecker nest cavities in open forests with a ponderosa pine component. Documented during PacifiCorp's surveys along J.C. Boyle bypassed and peaking reaches.
Vaux's swift *Chaetura vauxi*	Cal Fish & Game SSC	Found in mixed conifer, ponderosa pine, lodgepole pine, riparian deciduous, montane hardwood oak woodland, montane hardwood oak-conifer, and montane hardwood oak-juniper forests with trees greater than 11 inches in diameter. Documented during PacifiCorp's surveys at J.C. Boyle, Copco, and Iron Gate reservoirs, along the J.C. Boyle bypassed and peaking reaches, along Fall Creek, and along Klamath River from Iron Gate dam to Shasta River.
Acorn woodpecker *Melanerpes formicivorous*	FSC, Bureau of Land Management-T, ONHP List 4	Nests in cavities located in snags of deciduous tree species, particularly oak snags at least 17 inches in diameter. PacifiCorp documented several nesting colonies in oak, oak-juniper, and oak-conifer habitats, primarily at Copco reservoir. Also documented during PacifiCorp's surveys at J.C. Boyle and Iron Gate reservoirs, along J.C. Boyle peaking reach, along Copco bypassed reach, along Fall Creek, and along Klamath River from Iron Gate dam to Shasta River.

Species	Status[a]	Habitat and Location Where Found
White-headed woodpecker *Picoides albolarvatus*	FSC, Bureau of Land Management, CC, Oregon Fish & Wildlife SC, ONHP List 2	Nests in cavities typically located in ponderosa pine at least 18 inches in diameter. Occurs in lodgepole pine, ponderosa pine, and Klamath mixed conifer forests with trees greater than 11 inches in diameter. Documented during PacifiCorp's surveys along J.C. Boyle bypassed reach.
Lewis' woodpecker *Melanerpes lewis*	FSC, Bureau of Land Management-A, CC, Oregon Fish & Wildlife SC, ONHP List 2	Associated with oak woodlands and mixed oak conifer habitat, but also can be found in a variety of open forest stands including ponderosa pine and cottonwood-dominated riparian areas. Documented during PacifiCorp's surveys in upland habitats along J.C. Boyle peaking reach, in riparian habitats at Iron Gate reservoir, and along Klamath River from Iron Gate dam to Shasta River.
Williamson's sapsucker *Sphyrapicus thyroideus*	Bureau of Land Management-T, Oregon Fish & Wildlife SU	Associated with higher-elevation coniferous forest types including ponderosa pine, lodgepole pine, and Douglas-fir. Known to occur in the general project vicinity but not documented during PacifiCorp's surveys.
Pileated woodpecker *Dryocopus pileatus*	Bureau of Land Management-T, Oregon Fish & Wildlife SV	Occurs in all forest and woodland cover types with moderate to dense tree canopy closure. Requires large snags 25 inches or more in diameter for excavating suitable nest cavities. Documented during PacifiCorp's surveys along Keno reach, at J.C. Boyle reservoir, along J.C. Boyle bypassed and peaking reaches, and along Fall Creek.
Olive-sided flycatcher *Contopus cooperi*	FSC, Bureau of Land Management-T, CC, Oregon Fish & Wildlife SV, ONHP List 4	Typically found in coniferous forests with tall trees providing suitable perch sites. Documented during PacifiCorp's surveys along Link River, at Keno, J.C. Boyle and Iron Gate reservoirs, and along Keno and J.C. Boyle peaking reaches.
Willow flycatcher *Empidonax traillii adastus*	FSC, Bureau of Land Management-T, Oregon Fish & Wildlife SU, ONHP List 4, Cal Fish & Game SSC-HP, CFGC LE	Associated with dense riparian willow thickets. Documented during PacifiCorp's surveys in some of the more dense willow patches along Link River, at J.C. Boyle, Copco, and Iron Gate reservoirs, along the J.C. Boyle peaking reach, and along Klamath River from Iron Gate dam to Shasta River.
Purple martin *Progne subis*	FSC, Bureau of Land Management, Oregon Fish & Wildlife SC, ONHP List 2, Cal Fish & Game SSC-SP	Occurs in riparian and wetland forests, as well as mixed conifer forest, ponderosa pine forest, montane hardwood oak woodland, montane hardwood oak-conifer, and montane hardwood oak-juniper with sparse to moderate tree canopy closure. Nests in cavities and requires suitable nest sites located adjacent to open areas for foraging. Documented during PacifiCorp's surveys above the upper falls at Fall Creek.
Black-capped chickadee *Parus atricapillus*	Cal Fish & Game SSC-TP	Nests in a variety of woodland habitats wherever suitable, small nest cavities can be found. Documented during PacifiCorp's surveys along Link River and at Copco and Iron Gate reservoirs.

Species	Status[a]	Habitat and Location Where Found
Pygmy nuthatch *Sitta pygmaea*	Bureau of Land Management-T, Oregon Fish & Wildlife SV	Typically found in ponderosa pine forests with less than 70 percent canopy closure. Documented during PacifiCorp's surveys at Keno and J.C. Boyle reservoirs.
Western bluebird *Sialia mexicana*	Bureau of Land Management-T Oregon Fish & Wildlife SV, ONHP List 4	Found in a variety of open habitats; may be limited by the availability of suitable nesting cavities. Nests in open clearings adjacent to woodlands or in human-made structures providing suitable nest sites. Documented during PacifiCorp's surveys along Copco bypassed reach, along Fall Creek, and at Iron Gate reservoir.
Yellow warbler *Dendroica petechia*	Cal Fish & Game SSC-SP	Found in riparian deciduous forest, riparian shrub, scrub-shrub wetland, and forested wetland. Breeds in riparian habitat throughout North America and winters south from Mexico through South America. Documented during PacifiCorp's surveys throughout the project vicinity at all project reservoirs and in all project reaches. PacifiCorp assessed habitat suitability for the yellow warbler based on an existing HSI model and determined that the extremely dense tree and shrub habitat along Link River is most suitable while habitat along J.C. Boyle reservoir was least suitable. However, yellow warbler abundance was relatively high at both of these locations, even though the riparian zone at J.C. Boyle reservoir is generally lacking in hydrophytic shrubs.
Yellow-breasted chat *Icteria virens*	FSC, Bureau of Land Management-T, ONHP List 4, Cal Fish & Game SSC-SP	Found in the brushy understory of deciduous and mixed woodlands; breeds in brushy vegetation, typically willow thickets, along rivers and streams. Documented during PacifiCorp's surveys primarily in wetland and riparian habitats along J.C. Boyle peaking reach, at Copco reservoir, along Fall Creek, and along Klamath River from Iron Gate dam to Shasta River.
Mammals		
Yuma myotis *Myotis yumanensis*	FSC, Bureau of Land Management-T, ONHP List 4	Generally found in open forests and a variety of habitats; the availability of suitable roost sites (rock crevices, cliff ledges, and human-made structures) limits distribution and occurrence. Documented during PacifiCorp's surveys roosting in J.C. Boyle forebay spillway house, in transformer bays at Copco No. 1 powerhouse, and in rafters at Iron Gate south gatehouse. Also known from J.C. Boyle peaking reach.
Townsend's big-eared bat *Corynorhinus townsendii townsendii*	FSC, Bureau of Land Management, Oregon Fish & Wildlife SC, ONHP List 2, Cal Fish & Game SSC-SP	Generally found in open forests and a variety of habitats; the availability of suitable roost sites (rock crevices, cliff ledges, and human-made structures) limits distribution and occurrence. Known from J.C. Boyle peaking reach but not documented during PacifiCorp's surveys.

Species	Status[a]	Habitat and Location Where Found
Western gray squirrel *Sciurus griseus*	Bureau of Land Management-T, Oregon Fish & Wildlife SU, ONHP List 4	Found in a variety of forested habitat types including mixed conifer forest, ponderosa pine forest, lodgepole pine, montane hardwood oak woodland, montane hardwood oak-conifer, and montane hardwood oak juniper with trees greater than 6 inches in diameter. Documented during PacifiCorp's surveys at J.C. Boyle and Copco reservoirs, along J.C. Boyle peaking reach, and along Copco bypassed reach.

[a] **FT =** Listed as threatened by the Fish and Wildlife Service.
FSC = Federal species of concern – candidate species the FWS is considering listing under the ESA.
CC = Birds of Conservation Concern (FWS Division of Migratory Bird Management)
S/M-C = Survey and Manage Species, as designated in the Northwest Forest Plan; category C – Uncommon, pre-disturbance surveys practical.
Bureau of Land Management = Bureau of Land Management sensitive species - species that could easily become endangered or extinct.
Bureau of Land Management-A = Bureau of Land Management assessment species - species not presently eligible for federal or state status that may need protection or mitigation.
Bureau of Land Management-T = Bureau of Land Management tracking species - more information needed to determine status.
OFWC LE = Listed as endangered by the Oregon Fish and Wildlife Commission under the OESA.
OFWC LT = Listed as threatened by the Oregon Fish and Wildlife Commission under the OESA.
Oregon Fish & Wildlife SC = Sensitive Critical - listing as threatened or endangered is pending, or listing as threatened or endangered may be appropriate if immediate conservation actions are not taken.
Oregon Fish & Wildlife SV = Sensitive Vulnerable - listing as threatened or endangered is not imminent and can be avoided through continued or expanded use of adequate protective measures and monitoring. In some cases the populations are sustainable and protective measures are being implemented; in others, populations may be declining and improved protection measures are needed to maintain sustainable populations over time.
Oregon Fish & Wildlife SU = Sensitive Undetermined Status - species for which status is unclear.
ONHP List 1= threatened with extinction or presumed to be extinct throughout their entire range.
ONHP List 2 = threatened with extirpation or presumed to be extirpated from the state of Oregon.
ONHP List 4=of conservation concern but not currently threatened or endangered.
Cal Fish & Game SSC = Species of Special Concern - not listed under the federal or CA ESA but are believed to: 1) be declining at a rate that could result in listing, or 2) historically occurring in low numbers and having current known threats to their persistence.
Cal Fish & Game SSC-HP = Species of Special Concern - High Priority - species that appear to have a high probability of extinction from their entire range in California.
Cal Fish & Game SSC-SP = Species of Special Concern – Second Priority - species that are definitely jeopardized and declining, but extinction or extirpation appears less imminent than species listed with a higher priority.
Cal Fish & Game SSC-TP = Species of special concern – Third Priority - species that do not appear to be facing extinction in the near future, but are declining seriously or are otherwise highly vulnerable because of human developments.
CFGC LE = Listed as endangered by the California Fish and Game Commission under the CESA.
CFGC LT = Listed as threatened by the California Fish and Game Commission under the CESA.

Wildlife Management in the Klamath Basin

The Klamath basin is an important wintering and staging area for waterfowl in the Pacific flyway (Oregon Fish & Wildlife, 1993). This area provides extensive feeding and resting areas for waterfowl during spring and fall migrations and is also an important nesting area. In the late 1800s, agriculture developers began diverting water from the basin for irrigation purposes and by the early 1900s, the federal government had developed an irrigation project in the basin. The federal government and the state of Oregon also began setting aside land in the basin in the early 1900s for the sole purpose of maintaining the values of the basin for waterfowl.

Lower Klamath National Wildlife Refuge. The Lower Klamath National Wildlife Refuge was established by President Theodore Roosevelt in 1908 as a waterfowl refuge and is now one of five national wildlife refuges in the Klamath basin (FWS, undated). The 49,600 acre refuge is located just east of U.S. Highway 97 along the Oregon-California border on both sides of Highway 161. The Lower

Klamath Refuge was established as the nation's first waterfowl refuge and is managed by the FWS to provide feeding, resting, nesting, and brood rearing habitat for waterfowl and other water birds. In addition to providing and enhancing habitat for fall and spring migrant waterfowl, the FWS objectives for this refuge include maintaining habitat for endangered, threatened, and sensitive species; protecting native habitats and wildlife that represent the natural biological diversity of the Klamath basin; integrating the maintenance of productive wetland habitats and sustainable agriculture; ensuring that the refuge agricultural practices conform to the principles of integrated pest management; and providing high quality wildlife-dependent visitor services.

Klamath Wildlife Area. The state of Oregon obtained the lands of the Klamath Wildlife Area in the early to mid 1900s to protect and enhance wildlife habitat for all endemic species, with an emphasis on ducks, geese, and other waterbirds (Oregon Fish & Wildlife, 1993). The Klamath Wildlife Area is comprised of four units: Shoalwater Bay and Squaw Point, located north of the Klamath Project vicinity along Upper Klamath Lake, and Miller Island and Gorr Island, located on the east side of the Keno reservoir. Oregon Fish & Wildlife management objectives for the Klamath Wildlife Area include providing waterfowl forage and loafing areas for over 4 million use days a year; providing habitat for feeding, resting, breeding, and rearing for the endemic birds, mammals, amphibians, and reptiles that use the Klamath Wildlife Area; protecting and maintaining threatened and endangered species that inhabit the area consistent with federal and state laws; providing opportunities for recreational harvest of waterfowl, upland game, and furbearers; and providing opportunities for wildlife viewing, public awareness, and other non-consumptive wildlife-oriented recreation.

3.3.4.2 Environmental Effects

3.3.4.2.1 Vegetation Management/Noxious and Invasive Species Control

Project operations have the potential to affect vegetation within and along the perimeter of project facilities, on project transmission line rights-of-way, and along project roads. Vegetation maintenance, including pesticide and herbicide use, and vegetation removal could directly affect plants in the project boundary, whereas project recreation could have indirect effects. Additionally, reservoir water-level fluctuations, water releases, and altered hydrology in project reaches could cause conditions that are favorable for the proliferation of noxious species.

PacifiCorp proposes to develop and implement a vegetation resources management plan in consultation with the resource agencies to guide land management practices on PacifiCorp-owned non-aquatic land within the project boundary. Specifically, this plan would address (1) project facility vegetation management; (2) noxious weed control; (3) vegetative restoration of sites that have been disturbed by project activities; (4) threatened, endangered, and sensitive plant protection; and (5) long-term monitoring. Additionally, PacifiCorp proposes, as part of its recreation resources management plan, to add native vegetation for use as screening at selected recreation sites. In addition to its proposed vegetation resources management plan, PacifiCorp proposes to coordinate with its transmission and delivery group to provide avoidance training, procedures, and scheduling to avoid or protect threatened, endangered, and sensitive plants in or near transmission line rights-of-way. PacifiCorp also proposes to enhance upland habitat for winter use by deer by managing approximately 1,031 acres of PacifiCorp-owned land within the project boundary to increase forage and cover habitat for deer. The upland habitat that PacifiCorp proposes to enhance occurs mostly around Iron Gate reservoir but also in smaller amounts near J.C. Boyle reservoir, along Fall Creek, and near Copco No. 2 reservoir. PacifiCorp proposes to work with resource agencies to investigate and implement habitat enhancements within the project boundary aimed at improving shrub forage in oak woodlands and chaparral habitats, and to reduce or eliminate livestock grazing effects.

Interior recommends that PacifiCorp develop, in consultation with the Bureau of Land Management, and submit to the Commission for approval, a plan for managing upland vegetation to improve forest health (by reducing risk of insect infestation) and reduce potential fire hazard (by reducing wildfire risk) adjacent to project facilities. Interior recommends that the plan include provisions for (1) fuel reduction treatments; (2) thinning to reduce overstocking; (3) using a variety of fuel treatments including manual and mechanical treatment and prescribed fire; (4) thinning understory trees and ground vegetation to relieve stress on larger, older trees; (5) removing excess fuels through salvaging; (6) reestablishing conifer forest and woodland stands following stand-replacing events; and (7) implementing an underburn program following initial treatment. Interior also recommends that, within 1 year of license issuance, PacifiCorp consult with affected tribes to develop and implement a vegetation management plan to reestablish native vegetation and plants that are suitable to tribal members for food, medicine, basket material, cradles, art, and other cultural products.

Oregon Fish & Wildlife recommends that, within 1 year of license issuance, PacifiCorp consult with it and other state, federal, and tribal agencies to develop a vegetation and noxious weed resource management plan and submit it to the Commission for approval. Oregon Fish & Wildlife recommends that the plan be updated every 5 years in consultation with the agencies to reflect new information, new management needs, and updated implementation strategies. In addition, Oregon Fish & Wildlife recommends that PacifiCorp prepare its vegetation and noxious weed resource management plan in consultation with Oregon Fish & Wildlife and other state, federal, and tribal stakeholders, and allow a minimum of 60 days for these entities to comment and make recommendations prior to PacifiCorp filing the plan with the Commission for approval. Oregon Fish & Wildlife recommends that PacifiCorp submit an annual report of activities completed the previous year as part of the vegetation and noxious weed resource management plan, along with an annual work plan to the Commission, Oregon Fish & Wildlife, and other state and federal agencies and tribes. Oregon Fish & Wildlife recommends that PacifiCorp include a monitoring and compliance report in its annual report including a narrative and compilation of information, data, and graphs summarizing progress toward implementation of strategies for managing native vegetation to optimize habitat for wildlife species and control invasive weeds.

Oregon Fish & Wildlife recommends that PacifiCorp develop, within 2 years of license issuance, a vegetation management plan in consultation with resource agencies including it, Cal Fish & Game, Bureau of Land Management, and FWS, which would include strategies for managing native vegetation to optimize habitat for wildlife species and control invasive weed species. Oregon Fish & Wildlife recommends that the plan guide land management practices on PacifiCorp-owned land, such as the management of forest, shrub, and grassland communities to contain, control, and suppress exotic and invasive weeds so they do not act as a source of infestations downstream or on adjacent property. Oregon Fish & Wildlife recommends that PacifiCorp improve winter range habitat for deer and elk on existing PacifiCorp lands and on Bureau of Land Management-administered lands in the Klamath River Canyon and acquire additional winter range habitat. Oregon Fish & Wildlife suggests vegetation treatments such as juniper removal, conifer and oak thinning, prescribed fire, mechanical shrub rejuvenation, improved livestock grazing management, and noxious weed control in mixed conifer, oak woodland, and shrub communities to improve the mosaic of forage and cover components. Oregon Fish & Wildlife also recommends that PacifiCorp prepare a plan for actively managing habitat for optimum big game benefits.

The Hoopa Valley Tribe recommendations pertaining to vegetation management are essentially identical to the two recommendations by Oregon Fish & Wildlife described above. However, the Hoopa Valley Tribe recommends that PacifiCorp include the Tribe in its consultations during preparation of these plans.

In its May 12, 2006, response to Oregon Fish & Wildlife's recommendation, PacifiCorp proposes allocating 2 years to develop the vegetation and noxious weed resource management plan to allow time for coordination among plans and among agencies. In its response to the Hoopa Valley Tribe, PacifiCorp states that it would consult with the appropriate agencies on specific environmental measures once a final license is issued by the Commission and accepted by PacifiCorp.

The Bureau of Land Management specifies that PacifiCorp develop, in consultation with the Bureau, and file for Commission approval, within 1 year of license issuance, a vegetation resources management plan that includes provisions for managing noxious and invasive plants and threatened, endangered, and sensitive plants on Bureau-administered lands that are affected by the Klamath Hydroelectric Project. The Bureau specifies that the section of the plan that addresses noxious and invasive plants include (1) a protocol for conducting weed surveys, including a review of federal, state, and local noxious weed lists, and the list of Exotic Pest Plants of Greatest Ecological Concern in California from the California Invasive Plant Council; (2) a timeline for a systematic survey of land affected by the project, including Bureau-administered lands within the project area; (3) a protocol for producing a geospatial map (e.g., GIS map) and digital database to store information on species occurrence, distribution, status according to the Oregon Department of Agriculture system of ranking species for control, and timing of last survey (PacifiCorp would make the database available to the Bureau); and (4) proposed treatments, mitigations, and best management practices for managing weeds on Bureau-administered lands that are affected by project maintenance, operation, and use. The Bureau specifies that the section of the plan that addresses threatened, endangered, and sensitive plant species include (1) a protocol for surveying Bureau-administered lands affected by the project consistent with accepted protocols to determine or verify the distribution of threatened, endangered, and sensitive plant species; (2) a protocol for documenting, protecting, and mitigating for effects on threatened, endangered, and sensitive plant species, including review of Bureau special status species and Oregon Natural Heritage Information Center, California Natural Diversity Database, and California Native Plant Society records; and (3) a protocol for surveying adjacent to project roads that cross seasonally wet meadows for occurrence of threatened, endangered, and sensitive plant species. The Bureau specifies that PacifiCorp implement the plan upon Commission approval, including any changes required by the Bureau.

On April 28, 2006, PacifiCorp proposed an alternative condition to the Bureau of Land Management's preliminary section 4(e) condition no. 7. In its alternative condition, PacifiCorp proposes limiting the scope of the vegetation resources management plan to Bureau of Land Management reservation lands within the project boundary and along roads for which PacifiCorp has sole or joint responsibility (as determined by the Commission), deleting references to "invasive plants," and modifying the plan to include provisions for periodic follow-up noxious weed surveys, rather than the "timeline for systematic survey of land affected by the project" as specified by the Bureau of Land Management. PacifiCorp also removes the Bureau's right to require changes to the vegetation management plan after it has been submitted to the Commission for approval.

In its May 12, 2006, response to the Bureau of Land Management vegetation management condition, PacifiCorp proposes to complete the vegetation resources management plan within 2 years, rather than 1 year, of license issuance. PacifiCorp points out that it may need 2 years to coordinate development of the plan with other resource management plans, to coordinate with other adjacent landowner activities related to cooperative weed management, and to coordinate with the Bureau of Land Management. PacifiCorp disagrees with the scope of the area addressed in the vegetation resources management plan specified by the Bureau of Land Management and suggests limiting the scope of the plan to Bureau reservation lands needed for project operations, including areas surrounding project facilities, project-related transmission lines, and project roads for which PacifiCorp has sole or joint responsibility (as determined by the Commission), as well as areas within the project boundary. PacifiCorp does not believe that a new systematic weed survey is needed. PacifiCorp proposes to use the existing weed inventory data as a baseline for identifying target species and management areas, conduct periodic follow-up project weed inventories, and coordinate regularly with resource agencies cooperatively involved in noxious weed control efforts through county-based cooperative weed management programs. PacifiCorp points out that, as a cooperator, it would be responsible for focusing the appropriate level of effort within the project boundary and attempting to manage weeds comprehensively in tandem with other cooperators.

In its response to comments, PacifiCorp disagrees with the Bureau of Land Management's contention that its surveys for threatened, endangered, and sensitive plants were inadequate and additional surveys are needed. PacifiCorp states that its surveys used stakeholder-approved methods, and focused on areas with a high probability of supporting targeted threatened, endangered, and sensitive plant species that were in areas associated with project facilities or affected by project operations. PacifiCorp asserts that it conducted reasonable surveys in areas affected by project operations and that it has adequate information to protect threatened and endangered species plants within the project boundary. PacifiCorp states that it would continue to share sensitive species information with the Bureau and if new populations of threatened, endangered, or sensitive plants are found within the project boundary, it would protect them through its vegetation management plan.

Our Analysis

Vegetation management encompasses a wide variety of activities, such as roadside mowing, weed control, revegetation of eroding soils, and fire suppression. Vegetation management can have adverse or beneficial effects, or both, on natural resources, cultural values, recreation, aesthetics, health and safety, and socioeconomics. Field surveys have identified numerous sensitive plant populations throughout the project area. In addition, numerous populations of noxious and invasive plants have been documented. For this reason, consultation with the resource agencies, including the Bureau of Land Management, FWS, Oregon Fish & Wildlife, Cal Fish & Game, and tribal representatives, as appropriate, to develop and implement a comprehensive vegetation management plan that would include measures to enhance and protect rare plants, wetlands, riparian communities, and sensitive wildlife habitats is reasonable. However, it is appropriate for PacifiCorp to be responsible only for aspects of vegetation management that have a nexus to the project, which would generally include lands within the project boundary and access roads for which PacifiCorp has shared or sole responsibility for maintaining because they are needed for project purposes. Oregon Fish & Wildlife and the Hoopa Valley Tribe recommend PacifiCorp prepare a vegetation and noxious weed resource management plan within 1 year of license issuance and a vegetation management plan within 2 years of license issuance. We are not convinced that there is sufficient difference between these two plans to warrant preparation of two separate plans at 1-year intervals. It would be more efficient for all parties involved in developing, reviewing, and approving a vegetation management plan to develop a single, comprehensive plan for the entire project. Allowing 2 years for plan development and consultation prior to filing the plan with the Commission for approval would enable the many aspects associated with vegetation management in the broad geographical expanse of the project to be addressed thoroughly.

In the following section, we address development of a vegetation management plan, and focus on four aspects of vegetation management related to terrestrial resources: protection of special status plants, control of noxious and invasive weeds, management of upland vegetation to improve forest health, and enhancement of ethnobotanical resources. We address the use of vegetation for screening purposes in section 3.3.7, *Land Use and Aesthetic Resources*.

<u>Protection of Special Status Plant Species</u>. PacifiCorp documented 67 occurrences of 12 plant species with special status in the project vicinity either during its 2002 surveys or previously by the Bureau of Land Management, Oregon Natural Heritage Program, or the California Natural Diversity database. In its March 27, 2006, letter to the Commission, Interior points out that, subsequent to PacifiCorp's 2002 surveys, the Bureau of Land Management found bristly sedge (*Carex comosa*) along the J.C. Boyle reservoir and at the Topsy Campground. Bristly sedge is considered an assessment species by the Bureau of Land Management, which means that it is not presently eligible for official federal or state status but is of concern in Oregon and may, at a minimum, need protection; the Oregon Natural Heritage Information Center includes it on its List 2-ex (extirpated from the state of Oregon) and the California Native Plant Society also includes it on its List 2 (rare, threatened, or endangered in California, but more common elsewhere). The Bureau of Land Management specified that PacifiCorp survey Bureau

of Land Management-administered lands affected by the project as well as adjacent to project roads that cross seasonally wet meadows for occurrence of threatened, endangered, and sensitive plant species. PacifiCorp proposes to monitor the locations of sensitive plant species it identified in its surveys and any additional populations of sensitive plant species documented in the project boundary. We see no reason to require PacifiCorp to conduct additional surveys for sensitive plant species, particularly since PacifiCorp proposes to monitor populations identified by others subsequent to its surveys, and additional surveys would not provide additional information.

A few special status species could potentially be threatened by noxious and invasive weed populations that are in proximity and share the same habitat, such as Greene's mariposa lily and Bolander's sunflower which were found in association with yellow starthistle and annual bromes. Because all of these special status plant species could be affected by the spread of noxious and invasive weeds or a variety of vegetation management activities (e.g., brushing, mowing, herbicide application, replanting projects), recreation-related activities (e.g., camping, wood-cutting, OHV use), and other ground disturbances, we conclude that consultation with the Bureau of Land Management, FWS, Oregon Department of Agriculture, Oregon Natural Heritage Program, Cal Fish & Game, and California Native Plant Society to aid in the identification and development of any measures that may be needed to protect these species is appropriate.

Control of Noxious and Invasive Weeds. Noxious weeds are a growing threat to the environment of Oregon and California because of their potential to degrade native plant communities, outcompete rare species, and reduce wildlife habitat values. Both federal and state laws require landowners to manage noxious weeds within their ownerships. PacifiCorp determined that 21 noxious and invasive weed species occur in the vicinity of the Klamath Hydroelectric Project. Currently, the species of greatest concern at the project is yellow starthistle, identified by Oregon Department of Agriculture with both a B designation, which is a noxious weed of economic importance, and a T designation, which is a priority noxious weed designated by the State Weed Board as a weed species targeted for biological control. Yellow starthistle is also identified by CalEPPC as a Class A-1 species, which is a widespread invasive wildland pest, and identified by California Department of Food and Agriculture as a Class C weed, which is not subject to any state enforced action outside of nurseries except to retard spread. An additional 18 species are identified by Oregon Department of Agriculture with B designations; 5 of these species are also identified by CalEPPC as Class A-1 species and another 3 species are identified by California Department of Food and Agriculture as Class A weeds, which are subject to state enforced action such as eradication, quarantine, containment, rejection, or other holding action.

Successful weed control requires a cooperative effort by all landowners and land managers in the vicinity, because untreated weeds on adjacent lands provide a ready seed source for infestation by new species and re-infestation after treatment of existing problem weeds. Developing an invasive weed management plan in consultation with the Bureau of Land Management, FWS, Oregon Fish & Wildlife, Oregon Department of Agriculture, Cal Fish & Game, California Department of Food and Agriculture, Klamath County, Siskiyou County, the tribes, and local landowners as part of the vegetation management plan would facilitate an integrated approach to control effects, and is appropriate for all project lands. Implementation of weed control measures on adjacent non-project lands would help reduce the risk of spread of weed infestations. We agree that weed management on lands affected by project operations is necessary to control the spread of invasive plants. Eradication may be attainable for species that are currently limited in distribution, but attempts to eradicate species that are already well-established and widespread, such as yellow starthistle, would not be likely to succeed, except at an unacceptably high cost to other resource values.

Noxious and invasive weeds can interfere or degrade ecological function of native species or impair recreational experiences. As such, noxious and invasive weed monitoring should be included as an element within other plans that could entail monitoring for erosion, such as the recreational resource management plan (discussed in section 3.3.6, *Recreational Resources*), the project roadway management plan (discussed in section 3.3.7, *Land Use and Aesthetic Resources*), and the historic properties management plan (discussed in section 3.3.9, *Cultural Resources*).

Management of Upland Vegetation to Improve Forest Health. Years of fire suppression have allowed the accumulation of fuels over large portions of California and Oregon's forest and range habitat, on both public and private lands. Accumulation of fuels increases the risk of devastating wildfire. In some stands, fire suppression results in a dense understory that prevents sunlight from reaching the forest floor, reducing the abundance of annual herbaceous cover that would provide forage for deer and other wildlife species. On shrub-dominated sites, old shrubs may become woody, less palatable, and less nutritious as browse for wildlife.

The deer and elk populations in the project vicinity, which is located within the Keno Wildlife Management Unit in Oregon and the Cascade-North Sierra Nevada Deer Assessment Unit in California, are affected by elevation that influences snowfall in the winter and the pattern of forage and cover habitats throughout the area. The long-term changes in management of forests and shrublands that occurred in the project vicinity since the early 1900s have caused a decline in the disturbances that perpetuate early-successional habitats, which provide important deer habitat. Since the 1960s, a combination of intensive timber harvest and fire suppression (or in some cases inappropriate timing of prescribed fire) has brought about more forage-limited, second-growth forests and more decadent shrublands that have unavailable or low quality browse and little herbaceous vegetation. Forage condition on winter range is also declining because of infestations of exotic weeds.

Prescribed fire, as recommended by Interior and Oregon Fish & Wildlife, could increase soil fertility, promote plant vigor by removing old shoots and foliage, and enhance herbivorous wildlife food sources by increasing the palatability and protein content of resprouting shrubs. A controlled fire component of a vegetation management plan for land within the project boundary could reduce the danger of wildfires and improve the quality of the deer and elk winter range. Implementation of prescribed fire may benefit several species associated with young forested stands, including deer and black bear. It would also help to protect habitat over the long-term for several species using mature forests in the project area, including pileated woodpeckers, hairy woodpeckers, and wood ducks. Similar actions on adjacent non-project lands also would benefit a variety of wildlife species.

Enhancement of Ethnobotanical Resources. Interior identified a number of plants that grow in the project area, such as redbud and willow, as being of special importance for food, medicine, basket materials, art, and cultural use. Incorporating plants of ethnobotanical importance into revegetation projects that would be implemented during the new license period, such as stabilization of spoil piles, road improvements, and vegetative screening at recreational sites, would enhance ethnobotanical resources, provided PacifiCorp schedules time to investigate sources of native plant materials and the possibility of contract growing well in advance of the dates the plants are needed.

Riparian and Wetland Habitat Connectivity

There are about 244 acres of wetland and riparian vegetation types in the proposed project boundary. The distribution of riparian and wetland habitats at the Klamath Hydroelectric Project is important for a wide variety of wildlife species. Habitat conditions vary along the shorelines of the project reservoirs and river reaches, with a patchy distribution of riparian species and invasive species outcompeting native vegetation in some locations. Several factors could potentially affect and influence riparian and wetland vegetation along the shorelines of project reservoirs and river reaches; project-related factors include recreational activities, reservoir fluctuation regimes, and minimum flow releases.

The ongoing operation of the J.C. Boyle, Copco No. 1 and No. 2, and Iron Gate developments would affect the reservoir fluctuation zone and the varial zone and shoreline vegetation along 11.5 miles of the J.C. Boyle peaking reach, 4.4 miles of the J.C. Boyle bypassed reach, and 1.5 miles of the Copco No. 2 bypassed reach, as well as vegetation resources adjacent to project facilities and recreation sites.

Without active management, it is unlikely that riparian habitat conditions would improve in the project area even with the proposed or recommended changes in the minimum flow releases and ramping rates. Changes in vegetation at the upper and lower ends of the current varial zone may occur as plant communities adjust to the new peaking restrictions. Current operations also affect up to 58 acres of the varial zone in the J.C. Boyle peaking reach where daily fluctuations may be contributing to conditions favoring certain species, such as reed canarygrass. We describe proposed and recommended flow regimes in project reaches in detail in section 3.3.3.2.1, *Instream Flows*.

PacifiCorp recognizes that the closer that instream flows mimic the natural hydrograph (peaking in late winter or spring and then gradually declining), the more likely that conditions suitable for native plant seed dispersal, germination, and growth would be present along river systems. However, PacifiCorp states that it is beyond the capacity of the project to restore the natural hydrograph and also recognizes that ongoing private non-project land uses are expected to continue. Therefore, PacifiCorp proposes to protect the existing riparian and wetland habitat within the project boundary, and where necessary, to restore currently degraded riparian habitat along approximately 10 miles of reservoir and Klamath River shoreline.

Based on its consultation with resource agencies, PacifiCorp proposes to implement site-specific measures to rehabilitate and stabilize shorelines and overgrazed or otherwise damaged riparian sites within the project boundary. PacifiCorp proposes to focus much of this effort on portions of the J.C. Boyle reservoir where PacifiCorp owns land, the J.C. Boyle peaking reach, Fall Creek, and Iron Gate reservoir. PacifiCorp proposes restoration activities including small-scale, site-specific removal of unwanted plant species (reed canarygrass and blackberry), inter-planting of desirable species (willows, sedges, and rushes) to increase diversity, and controlling livestock access with additional fencing where necessary. PacifiCorp acknowledges that it would probably continue to use cattle production as a property management tool on its lands within the project boundary, but states that its priority would be meeting habitat needs for wildlife and botanical resources.

Currently, between 19 and 30 percent of the J.C. Boyle, Copco, and Iron Gate reservoirs are bordered by riparian and wetland habitat. PacifiCorp proposes to protect and restore riparian habitat along the margin of the J.C. Boyle reservoir by developing shoreline trees and shrubs, protecting wetland sites from livestock or people, and developing a plan for protecting wetlands near recreational areas. PacifiCorp would also focus its habitat protection measures on the large and ecologically diverse wetland adjacent to Sportsman's Park along the shoreline of the J.C. Boyle reservoir. PacifiCorp proposes to protect the existing riparian areas located in the project boundary on the margins of the Copco and Copco No. 2 reservoirs. At the Iron Gate reservoir, PacifiCorp proposes to establish additional riparian vegetation to improve its distribution and increase the width of existing riparian vegetation by fencing or redirecting human use.

PacifiCorp also proposes to protect and restore riparian habitat along 5.3 miles of the Klamath River upstream of Copco reservoir and to protect the following tributary and river reaches: (1) 2.2 miles of Shovel Creek/Negro Creek; (2) 1.5 miles of Fall Creek; (3) 1 mile of Jenny Creek (PacifiCorp proposes a protection zone of 100 feet on each side of Jenny Creek because of its relatively well developed riparian forest habitat); (4) 0.9 mile of Long Gulch Creek; (5) 1.3 miles of Bogus Creek; and (6) 0.5 mile of the Klamath River downstream of Iron Gate dam. In addition, PacifiCorp proposes to create a setback and, if needed, an erosion control strip to protect the wetland located near Copco Village from road runoff.

FWS recommends that PacifiCorp consult with FWS, NMFS, the Bureau of Land Management, Oregon Fish &Wildlife, Cal Fish & Game, and the affected tribes within 1 year of license issuance to develop a riparian habitat management plan to conserve, develop, and enhance fish and wildlife resources and file it with the Commission for approval. FWS recommends that the plan identify actions to minimize the effects of project operations on riparian habitats and identify site-specific restoration measures for riparian habitat affected by the project. The recommended riparian habitat management plan would include the following objectives for Bureau of Land Management-administered lands: (1) mitigate effects of project facilities and/or operations by restoring degraded riparian habitats within all project reaches; (2) inventory riparian areas as needed to develop restoration goals based on riparian ecological type and potential condition; (3) identify activities necessary to restore hydrologic connectivity in the varial zone and diversity of riparian species; (4) coordinate riparian habitat restoration activities with other plans for aquatic habitat, streamflow, geomorphologic processes and features, wildlife habitat, and vegetation management, including treatment of noxious weeds; (5) monitor implementation of the riparian habitat management plan to determine whether planned actions are meeting license condition objectives, conform to accepted monitoring protocols, and meet reporting requirements; and (6) monitor effectiveness of riparian mitigation and restoration and apply adaptive management principles to ensure the plan objectives are accomplished. FWS recommends that PacifiCorp implement measures to (1) increase riparian habitat on the low terraces in the Oregon portion of the J.C. Boyle peaking reach; (2) improve riparian conditions in the J.C. Boyle peaking reach varial zone; (3) improve habitat conditions for threatened, endangered, and sensitive plant and animal species associated with riparian, wetland, or open water habitats; and (4) reduce conditions that that are conducive to the establishment of reed canarygrass, yellow starthistle, and other noxious weeds or invasive plant species.

In its response to FWS, in a letter filed with the Commission on May 12, 2006, PacifiCorp disagrees with FWS' assertion that reed canarygrass can be controlled in 2 or 3 years with continued monitoring and follow up treatments for another 5 to 10 years. PacifiCorp states that it would be extremely difficult, if not impossible, to eradicate reed canarygrass within the project boundary. It points out that it found reed canarygrass in river segments with stable flows as well as in the J.C. Boyle peaking reach and that long-term control would be extremely difficult given the extensive agricultural areas upstream of J.C. Boyle reservoir that would continue to be an abundant seed source. PacifiCorp states that large-scale control of reed canarygrass requires extensive efforts, and many methods described in the literature cited by FWS may not be practical for implementation at the project, such as long-duration flooding to kill reed canarygrass, due to other upstream demands for the available water and the lack of water control structures to produce sustained flooding. PacifiCorp states that it would consider mechanical and chemical controls within the riparian zone but because there would always be a seed bank and an upstream seed source, it would need to repeat these methods every 3 to 4 years. PacifiCorp suggests focusing on sites with the best potential for establishing alternative native vegetation and areas that would benefit the most from restoration.

Siskiyou County recommends that over the next 5 to 10 years PacifiCorp fund approximately $26 million worth of programs identified by the Shasta Valley and Siskiyou resource conservation districts including habitat improvement programs focused on minimizing the impacts on riparian areas, ensuring adequate flows, and addressing temperature related issues; water quality programs focused on implementing riparian plantings projects to increase shade needed to cool water temperatures; and monitoring and assessment programs. Siskiyou County suggests that PacifiCorp should use the local knowledge, track record, and commitment of the resource conservation districts.

Our Analysis

Several amphibian species as well as small mammals, aquatic furbearers, and some reptiles use riparian habitats for breeding, foraging, or cover. Several special status species and riparian focal species including the yellow warbler, song sparrow, willow flycatcher, blackcrowned night heron, yellow rail, western yellow-billed cuckoo, purple martin, yellowbreasted chat, Oregon spotted frog, and western toad use riparian habitats substantially more often than upland habitats. Floodplain woodlands support higher densities of breeding birds than upland woodland or herbaceous habitats. Although birds are highly mobile, there has been some documentation that riparian connectivity plays an important role especially during dispersal. Juvenile birds are often more dependent on continuous riparian habitat for dispersal than are adults of the same species.

Under the current flow regime, riparian vegetation is encroaching into the active stream channel onto formally active gravel bar, floodplain, and bank surfaces, particularly in the J.C. Boyle bypassed reach. The vegetated banks, which include some of the stream channel, are typically wider with riparian grass covering a large area. Most of this riparian grass is reed canarygrass. PacifiCorp proposes to release an additional 100 cfs either into the J.C. Boyle peaking reach (over the existing minimum flow released at J.C. Boyle dam and spring accretion that occurs in the bypassed reach) or at the J.C. Boyle powerhouse as well as reducing the ramping rates in the peaking reach, which may slightly reduce the competitive advantage that reed canarygrass has in the upper portion of the varial zone, and therefore, may enhance conditions for native vegetation.

Proposed flows would increase water velocities somewhat, decrease sediment deposition, and help reduce further encroachment of vegetation in the stream channel while promoting the establishment of beneficial vegetation on gravel bars, floodplains, and terraces. The amount of vegetation that would become established would likely vary from site to site along the affected stream reaches, depending on factors such as aspect, slope, width of the floodplain, substrate, stream gradient, and existing plant community, in addition to flow volumes. Higher stem densities may reduce water velocities along the edges of the channel, allowing increased sediment deposition and further encroachment of native vegetation. The peaking reach flow regimes recommended by others would substantially increase minimum flows, reduce ramping rates, or require run-of-river operations. Daily fluctuations of water levels would be eliminated, which could result in a more stable riparian environment. This could result in more favorable conditions for re-establishment of native riparian vegetation and a reduction in the competitive reed canarygrass, which are adapted to harsh conditions (The Nature Conservancy, 2004). However, it is extremely difficult to predict how the altered flows would affect the already established reed canarygrass or new willow establishment. Monitoring of invasive plant species following implementation of the flow regime specified in a new license would facilitate development of adaptive management measures that are tailored to the response of the affected populations.

The proposed flows would not likely enhance coyote willow reproduction and distribution in the J.C. Boyle peaking reach because they do not include peak (flood) flows that would disturb and create fresh, bare surface; declining spring and summer flows that would be timed coincident with seed dispersal; and declining flows during the growing season to allow coyote willow an opportunity to establish. As described in section 3.3.1.2.5, *Fluvial Geomorphic Effects on Riparian Vegetation*, spring peak flows (those able to scour soil surfaces) and the descending limb of the annual hydrograph relative to seed dispersal are the most important aspects for riparian establishment. As described above, flows recommended by others would eliminate daily fluctuations of water levels, but would not provide the degree of seasonal variability that would be associated with an unregulated river, because flows through the project would still be governed by the requirements of the BiOp for coho salmon that requires Reclamation to release specified flows to the project for release by PacifiCorp at Iron Gate dam. Consequently, it is difficult to predict how the flows recommended by others would affect new willow establishment. We consider the most efficient way to increase the rate of expansion and abundance of willow in most reaches and reservoirs would be to actively implement willow restoration measures, including planting willow and excluding herbivores. PacifiCorp proposes to protect and restore riparian habitat along the margin of the J.C. Boyle reservoir, Copco and Copco No. 2 reservoirs, and Iron Gate reservoir. Establishing additional riparian vegetation would likely enhance habitat for riparian wildlife, and fencing or redirecting human use would increase the width of existing riparian vegetation by protecting wetland sites from encroachment from livestock or people. PacifiCorp may plant coyote willow as part of its site restoration activities. If that is the case, once it is established, coyote willow is likely to maintain its presence in the reach by clonal growth in many instances and potentially would serve as important habitat for fish and wildlife.

PacifiCorp also proposes to protect and restore riparian habitat along about 5.3 miles of the peaking reach of the Klamath River upstream of Copco reservoir as well as 7.4 miles of tributary and river reaches including 2.2 miles of Shovel and Negro creeks. Protection and restoration of these areas is appropriate because of the presence of sensitive species along some of these reaches and extensive grazing in the project vicinity. Protection measures, such as exclusion fencing, would protect sensitive species and increase habitat connectivity between mainstem and tributary riparian habitat. Protection of riparian vegetation along Shovel and Negro creeks, which are the primary spawning streams for redband trout in the peaking reach, would retain shade and prevent excessive warming of water during the summer and serve as cover for trout fry that likely remain in these tributaries for much of the summer.

Wetlands provide habitat for numerous plant and wildlife species, collect and hold water, buffer the effects of floods, and conserve moisture for drier seasons of the year. Currently, wetland habitat along the project reservoirs is limited mostly to small patches in protected locations and near inlets/tributaries. PacifiCorp's proposal to protect wetlands near recreational areas, including the large and ecologically diverse wetland adjacent to Sportsman's Park along the shoreline of J.C. Boyle reservoir and the wetland located near Copco Village, also would benefit those species of fish and wildlife that use wetland habitats.

FWS recommends that PacifiCorp develop a riparian habitat management plan to conserve, develop, and enhance fish and wildlife resources. PacifiCorp has proposed including riparian enhancement measures in its wildlife habitat management plan, and details of the elements of the plan would be addressed during consultation with the resource agencies. PacifiCorp's approach would enable riparian habitat management measures to be addressed in an efficient manner that would achieve the same objectives specified by FWS without the need to develop a separate plan. Cross-referencing vegetation management aspects to a vegetation management plan would ensure that the vegetative aspects of riparian habitat management are integrated with the wildlife habitat management aspects.

Siskiyou County recommends that over the next 5 to 10 years PacifiCorp fund approximately $26 million worth of programs identified by the Shasta Valley and Siskiyou resource conservation districts. Although we recognize that these resource conservation districts may have local knowledge and expertise, Siskiyou County has not identified specific measures that would be implemented with these funds, and thus we cannot assess the benefits of such programs. The Commission must establish a connection of environmental measures that it includes in a new license to project purposes and there is no basis for us to make this connection with the information provided by Siskiyou County.

3.3.4.2.2 Wildlife Resource Management

PacifiCorp proposes to develop and implement a wildlife habitat management plan that would describe all wildlife enhancement measures and provide a mechanism for coordinating with the PacifiCorp environmental management system and best management practices and for protecting and monitoring threatened, endangered, and sensitive species. PacifiCorp proposes to include the following key components in its wildlife habitat management plan: (1) restore riparian habitat along river and reservoir shorelines to improve habitat structure and connectivity; (2) install wildlife crossing structures on the J.C. Boyle canal to enhance connectivity; (3) manage habitats within the project boundary for deer winter range objectives; (4) monitor transmission lines and retrofit poles on lines where birds have died to improve avian protection; (5) develop amphibian breeding habitat along Iron Gate reservoir; (6) fund annual aerial bald eagle surveys to document new nests and productivity of territories, and protect bald eagle and osprey habitat within the project boundary; (7) selectively close roads that are unnecessary for project operation or other management activities; (8) install turtle basking structures in selected sites; (9) install bat roosting structures near project sites known to support roosting bats; (10) conduct surveys for threatened, endangered, and sensitive species in areas to be affected by new recreation development; and (11) monitor effectiveness of enhancement measures over the course of the new license.

Oregon Fish & Wildlife recommends that, within 1 year of license issuance, PacifiCorp consult with it and other state, federal, and tribal agencies to develop a wildlife mitigation resource management plan and a fish and wildlife habitat restoration resource management plan and submit them to the

Commission for approval. Oregon Fish & Wildlife recommends that both of these plans be updated every 5 years in consultation with the agencies to reflect new information, new management needs, and updated implementation strategies. Oregon Fish & Wildlife also recommends that PacifiCorp prepare its wildlife mitigation resource management plan and fish and wildlife habitat restoration resource management plan in consultation with it and other state, federal, and tribal stakeholders, and allow a minimum of 60 days for these entities to comment and make recommendations prior to PacifiCorp filing the plans with the Commission for approval. In addition, Oregon Fish & Wildlife recommends that PacifiCorp submit annual reports of activities completed the previous year as part of these two plans, along with an annual work plan, to the Commission, Oregon Fish & Wildlife, and other state and federal agencies and tribes.

Oregon Fish & Wildlife recommends that PacifiCorp address monitoring and compliance in its annual report on the wildlife mitigation resource management plan. It recommends a narrative and graphs summarizing an annual compilation of information and data on wildlife environmental measures including (1) monitoring for raptor injury and mortality at power poles and implementing protective measures, as appropriate; and (2) monitoring for wildlife entrapment and mortality at power canals and other project features and implementing protective measures, as appropriate. Oregon Fish & Wildlife also recommends a monitoring and compliance report in PacifiCorp's annual report on the fish and wildlife habitat enhancement resource management plan with a narrative and compilation of information summarizing progress toward restoring fish and wildlife habitat within, below, and above the project. Cal Fish & Game and the Hoopa Valley Tribe recommendations are nearly identical.

In its May 12, 2006, response to Oregon Fish & Wildlife's and Cal Fish & Game's recommendations, PacifiCorp proposes allocating 2 years to develop the wildlife mitigation resource management plan and the fish and wildlife habitat restoration resource management plan to allow time for coordinating among plans and among agencies. PacifiCorp also states that it should not be required to mitigate for habitat inundated by the construction of the Klamath Hydroelectric Project because this effect was pre-project.

Oregon Fish & Wildlife recommends that PacifiCorp develop, within 2 years of license issuance, a comprehensive wildlife mitigation plan in consultation with it and affected resource agencies, which would include routine monitoring and evaluation of wildlife and their habitats associated with the project and a long-term plan for implementation and monitoring consistent with federal, state, local, and tribal wildlife management objectives. Oregon Fish & Wildlife recommends that the wildlife mitigation plan compensate in-kind, to the extent feasible, for project development and ongoing effects of project operations and facilities such as riverine and reservoir fluctuations, habitat loss, habitat degradation, and hazards from power canals, power poles, and transmission lines. Oregon Fish & Wildlife further recommends that any new project development or effects authorized by project relicensing be consistent with its Fish and Wildlife Habitat Mitigation Policy and applicable wildlife management policies such as the Wildlife Diversity Plan and the Comprehensive Wildlife Conservation Strategy. Cal Fish & Game makes a similar recommendation.

Oregon Fish & Wildlife recommends that PacifiCorp develop, within 1 year of license issuance, a fish and wildlife habitat enhancement plan in consultation with it, the Bureau of Land Management, Cal Fish & Game, FWS, and NMFS to develop strategies to implement mitigation measures for ongoing project-related effects on fish and wildlife populations. Oregon Fish & Wildlife recommends that the plan identify strategies for enhancing and improving wetlands, riparian and riverine habitats, and riparian, aquatic, and terrestrial species connectivity in mainstem reaches and tributaries containing native fish and wildlife species that may be affected by the continued operation of the project; it recommends that PacifiCorp fund implementation of these strategies.

This recommended plan would focus on restoring riparian areas, wetlands, instream flow, and water quality, and acquiring land in appropriate reaches within and above the project. Oregon Fish & Wildlife recommends that the plan include procedures based on common methods used in wildlife science, including state of the art techniques for prioritizing and selecting habitat restoration, conservation, and/or acquisition projects. In addition, Oregon Fish & Wildlife recommends that PacifiCorp establish a habitat fund to conduct restoration, conservation, and/or acquisition projects as described in the annual work plan for its habitat enhancement program; the amount of the fund would be determined in consultation with it, the Bureau of Land Management, and other fish and wildlife agencies, and would be adjusted annually based on the consumer price index. PacifiCorp would annually deposit the designated amount into the fund beginning the second year after license issuance on the submittal date of the annual report of activities completed the previous year as part of the fish and wildlife habitat enhancement plan. Operation and maintenance costs associated with habitat enhancement also would be covered by this fund. The Hoopa Valley Tribe makes a similar recommendation.

If unanticipated circumstances or emergency situations arise in which wildlife species not listed as threatened or endangered by FWS are being killed, harmed or endangered by any of the project facilities or as a result of project operations, Oregon Fish & Wildlife recommends that PacifiCorp immediately take appropriate action to prevent further loss in a manner that does not pose a risk to human life, limb, or property. Within 48 hours of such an occurrence, PacifiCorp would notify Oregon Fish & Wildlife's nearest office as well as the nearest offices of NMFS, FWS, Bureau of Land Management, Cal Fish & Game, Water Board, Oregon Environmental Quality, and Oregon Water Resources Department, as appropriate, and would comply with any restorative measures required by the resource agencies to the extent such measures do not conflict with the conditions of its license. PacifiCorp would notify the Commission as soon as possible but no later than 10 days after each occurrence and inform the Commission as to the nature of the occurrence and restorative measures taken.

The Bureau of Land Management specifies that PacifiCorp develop, in consultation with the Bureau, and file for Commission approval, within 2 years of license issuance, a wildlife habitat management plan for Bureau-administered land affected by project operations and maintenance. The Bureau specifies that the plan include measures for (1) wildlife crossings and escape ramps for the J.C. Boyle canal and effectiveness monitoring; (2) western pond turtle habitat enhancements and effectiveness monitoring; and (3) threatened, endangered, sensitive, and special status species surveys and monitoring including (a) survey protocols for long-term surveys and monitoring of threatened, endangered, and sensitive species and their habitat for Bureau-administered lands within the project boundary to assess effects and develop necessary protective measures; (b) identification of restoration, protection, and/or enhancement measures for threatened, endangered, or sensitive species; and (c) seasonal restrictions for active nest sites on Bureau-administered lands for bald eagles, golden eagles, ospreys, peregrine falcons, and other raptors affected by project operations. The Bureau specifies that PacifiCorp implement the plan upon Commission approval, including any changes required by the Bureau.

PacifiCorp proposed an alternative condition to the Bureau of Land Management's preliminary section 4(e) condition no.8 by letter dated April 28, 2006. In its alternative condition, PacifiCorp proposes to limit the scope of the wildlife habitat management plan to Bureau of Land Management reservation lands within the project boundary, suggests that, instead of monitoring the effectiveness of the wildlife crossings and escape ramps for the J.C. Boyle canal, it would monitor use instead, and suggests that monitoring of escape ramps would be limited to existing escape ramps. PacifiCorp also suggests that, instead of monitoring the effectiveness of western pond turtle basking structures, it would monitor use instead. PacifiCorp also removes the Bureau of Land Management's right to require changes to the wildlife habitat management plan after it has been submitted to the Commission for approval.

In its May 12, 2006, response to agency terms and conditions, PacifiCorp points out that there are few opportunities for adding wildlife crossings at sites where animals might benefit from such enhancements and states that it would work with the Bureau of Land Management to assess sites for wildlife crossings at feasible locations along the J.C. Boyle canal. PacifiCorp also states that additional wildlife escape ramps are not needed at the J.C. Boyle canal since it already has two wildlife escape ramps that have backwater eddies and gradual ramps that animals can use to escape the system.

PacifiCorp believes that monitoring the effectiveness of wildlife crossings and escape ramps is not appropriate because there is no generally accepted criteria by which to judge effectiveness and suggests monitoring use instead. Similarly, PacifiCorp suggests that it would monitor observed use of western pond turtle basking structures and the availability of the structures to turtles at various springtime flows rather than their effectiveness, because there is no generally accepted criteria by which to judge effectiveness. PacifiCorp clarifies that it concluded that, based on occurrence and distribution in its study area, threatened, endangered, and sensitive species are tolerant of current conditions and, even though its proposed flows would slightly reduce the varial zone, its proposed enhancement measures would benefit riparian habitat. PacifiCorp also states that it does not believe that continuous protocol surveys and monitoring of threatened, endangered, and sensitive species and their habitat are needed to assess continuing effects of routine operation and maintenance of the project. However, PacifiCorp states that it recognizes that new surveys may be needed when planning for new, non-routine activities on Bureau of Land Management lands within the Project boundary and proposes to consult with the Bureau of Land Management to determine the need for any new surveys. Finally, PacifiCorp suggests working with Interior to establish seasonal restriction guidelines to avoid disturbing certain wildlife species during critical breeding and young-rearing time periods and to apply those guidelines as appropriate.

Our Analysis

A comprehensive wildlife resources plan detailing the actual measures that PacifiCorp would implement that the appropriate resource agencies can review and comment on would provide an effective approach to managing wildlife species affected by project operations. At a minimum the plan should address all lands within the project boundary, not only those lands administered by the Bureau of Land Management. Oregon Fish & Wildlife, Cal Fish & Game, and the Hoopa Valley Tribe recommend PacifiCorp prepare a wildlife mitigation resource management plan within 1 year of license issuance. The Bureau of Land Management and Oregon Fish & Wildlife also respectively recommend that PacifiCorp prepare a wildlife habitat management plan and a wildlife mitigation plan within 2 years of license issuance. Oregon Fish & Wildlife and the Hoopa Valley Tribe also recommend that PacifiCorp prepare a fish and wildlife habitat restoration resource management plan within 1 year of license issuance.

We note that our baseline for potential action to be considered in a new license entails protection and enhancement measures, rather than mitigation for effects of initial project construction. We are not convinced that there is sufficient difference between these plans to warrant preparation of two separate sets of plans at 1-year intervals. It is more efficient for all parties involved in the development, review, and approval of protection and enhancement measures for wildlife to develop a single, comprehensive wildlife management plan for the entire project. Although measures that would protect or enhance aquatic habitat also could benefit from measures that pertain primarily to wildlife, it is more efficient to address aquatic management issues in a separate focused aquatic management plan. Allowing 2 years to consult with the agencies and prepare this plan is appropriate, considering the breadth of the measures. It would be beneficial to have a comprehensive plan to guide interpretation of monitoring results and consideration of potential effects on wildlife resources, if any measures are adjusted via adaptive management.

With the exception of measures regarding the bald eagle, which we discuss in section 3.3.5.2.7, *Threatened and Endangered Species*, and measures regarding managing upland vegetation, which we discuss in section 3.3.4.2.1, *Vegetation Management/Noxious and Invasive Species Control*, we discuss specific measures associated with the proposed, specified, and recommended wildlife management plans in the following section.

Wildlife Movement

Project canals and roads can create barriers to wildlife movement and mortalities. The 3,800-foot-long East Side water conveyance system on the east side of the Link River, the 5,600-foot-long West

Side canal on the west side of the Link River, the approximately 2-mile-long J.C. Boyle canal along the J.C. Boyle bypassed reach, and the 4,600-foot-long Fall Creek canal, along Fall Creek, can cause disruption in wildlife movement by acting as barriers to migration. The East Side water conveyance system consists of a 3,100-foot-long flowline and 700 feet of canal and forebay. The flowline is mounted on concrete supports allowing between 0.5 and 3 feet of clearance under the pipe. One side of the East Side canal has earthen banks and the other side has a vertical concrete block wall less than 2 feet tall. No bridges cross the canal, but there is little to no barrier to animal entrance to the canal on either side. The West Side canal is built into the hill slope west of the Link River and is formed entirely by earthen banks with moderate to steep sloping terrain. There are no barriers for animal entrance to the canal on either side. About 600 feet from the intake at Link River dam, one 15- to 20-foot-wide vehicle bridge with a gravel surface crosses the canal. A 60-foot-long section of aboveground flowline is located at the southern end of the West Side canal, as well as a 60-foot-long section of flume serving as a spillway. The Fall Creek canal is relatively narrow (4 to 10 feet wide) with rock and earthen banks. The east (downslope) side of the J.C. Boyle canal is a 16-foot-tall concrete wall; the west (upslope) side of the canal is a concrete wall that varies in height from less than 2 to 16 feet tall. Just over half of the west wall is less than 4 feet tall but is located in steep terrain and not likely to be used for wildlife movement. Except for two existing vehicle access points which also serve as wildlife escape points and the forebay, wildlife must currently travel around the ends of the J.C. Boyle canal.

To enhance wildlife connectivity in the J.C. Boyle bypassed reach, PacifiCorp proposes to install and maintain eight wildlife crossings on the J.C. Boyle canal: one 12-foot-wide big game crossing near the middle of the canal and seven small (about 2 feet wide) animal bridges and ramps along the canal. PacifiCorp proposes to provide crossings in sections of the canal that are near already documented big game trails, have both gentle to moderate terrain and low wall height on the west side, have relatively good access to the river and riparian habitat, and have adequate space for construction of access ramps on both sides of the canal. PacifiCorp proposes to implement a monitoring program developed in consultation with the resource agencies to document the use of the wildlife bridges and continue to record any mortalities or live entrapped animals observed at the J.C. Boyle and Fall Creek canals. PacifiCorp would prepare periodic reports for agency review and if design-related problems occur or if mortality becomes a problem, would consult with the resource agencies to implement additional measures.

There are about 48 miles of roads within the proposed project boundary, and about 54 percent of them are on PacifiCorp land. Roads are known to create barriers to wildlife movement and can cause direct wildlife mortality from collisions with vehicles. PacifiCorp proposes to develop a road access management plan, in coordination with its wildlife resources management plan, which would assess the feasibility of closing unnecessary roads and establishing seasonal restrictions on unimproved roads to prevent resource damage and disturbance to wildlife during sensitive time periods. Additionally, PacifiCorp proposes to restore sites along roads that are known to have environmental damage.

The wildlife habitat management plan specified by the Bureau of Land Management includes measures for wildlife crossings and escape ramps for the J.C. Boyle canal and effectiveness monitoring.

Oregon Fish & Wildlife recommends that PacifiCorp install additional large animal wildlife crossings at least 36 feet wide and escape ramps at J.C. Boyle canal, within 2 years of license issuance. PacifiCorp would determine the number and locations of crossings that would maximize opportunities for wildlife movement through survey results and consultation with Oregon Fish & Wildlife and FWS. Oregon Fish & Wildlife also recommends that PacifiCorp install additional structures at project canals at least 2 feet wide to specifically provide crossing opportunities for small animals, within 2 years of license issuance. The design and location of these structures would be based on small mammal trapping and survey results and in consultation with Oregon Fish & Wildlife, FWS, and the Bureau of Land Management. Oregon Fish & Wildlife also recommends that PacifiCorp consult with it, FWS, and the Bureau of Land Management to develop a wildlife crossing monitoring plan to evaluate the efficacy of wildlife crossings along project canals and waterways within 1 year of license issuance. PacifiCorp would complete and implement the monitoring plan immediately upon installation of the new crossings and when upgrading existing crossings. Based on monitoring results, Oregon Fish & Wildlife suggests that it, FWS, and the Bureau of Land Management may require PacifiCorp to install additional wildlife crossings 5 years following license issuance. Finally, Oregon Fish & Wildlife recommends that PacifiCorp continue to maintain wildlife crossings and escape ramps at canals and waterways to prevent entrapment of wildlife and within 2 years of license issuance, consult with it, FWS, and the Bureau of Land Management, to prepare an annual inspection and maintenance report on the wildlife crossings and escape ramps; this annual inspection and maintenance report would be provided to the agencies by March 1 of each year.

Oregon Fish & Wildlife recommends that PacifiCorp continue to cooperate with it, the Bureau of Land Management, and major landowners in the project area to seasonally restrict motor vehicles during the critical winter period (the Pokegama seasonal road closure) to (1) reduce harassment to wintering big game and other wildlife, (2) improve law enforcement, and (3) reduce damage to roads and soils. Oregon Fish & Wildlife recommends that PacifiCorp continue maintenance activities including gate repair and appropriate signage to help achieve the closure objectives. Oregon Fish & Wildlife also recommends that PacifiCorp permanently close and rehabilitate any primitive roads within the project boundary that are identified as non-essential for public access or for project operation and maintenance.

In its response to Oregon Fish & Wildlife, in a letter filed with the Commission on May 12, 2006, PacifiCorp disagrees with Oregon Fish & Wildlife's recommendation for a 36-foot-wide big game bridge and states that this width is excessive and unsubstantiated. PacifiCorp also disagrees with the need for new small animal trapping and surveys prior to installing small animal crossings. PacifiCorp states that installation of the big game bridge and the small animal crossings should be after Commission approval of the wildlife habitat management plan rather than 2 years after license issuance. PacifiCorp points out that guidance for monitoring the crossings would be included in the wildlife habitat management plan and should be finalized after construction of the crossings, rather than within 1 year of license issuance. PacifiCorp disagrees with the recommendation that it evaluate the efficacy of the crossings because there is no reliable standard for judging efficacy. Finally, PacifiCorp states that it wishes to avoid unnecessary or duplicative reporting so the timing of any reports should be coordinated with the completion of appropriate plans and implementation of necessary actions.

Our Analysis

From 1983 until 2003, PacifiCorp reported no mortality of medium to large size wildlife at the East Side and West Side canal trashracks; however, it did not keep records on small animals that could pass through the 2-inch grates. From 1997 until 1999, when fyke nets were monitored as part of its sucker entrainment study, PacifiCorp discovered one double-crested cormorant, one muskrat, one mallard, one doe, and one unknown duck in the West Side canal fyke nets, all dead. It is possible that the duck, cormorant, mallard, and muskrat were in the canal voluntarily and were killed by becoming entangled in the sampling net. PacifiCorp was unable to determine if the deer was dead or alive when it entered the net or if it would have successfully escaped if it had not been caught in the net. PacifiCorp also observed live raccoon, salamanders, frog, beaver, pelican, bullfrog tadpoles, unidentified frogs, newt, western grebe, unidentified snake, and garter snake alive in the West Side canal. The tadpoles would likely have been washed into the penstocks, but the adult frogs and other species could have escaped along the gradual, vegetated slopes of the canal. PacifiCorp found a beaver, two newts, three unidentified frogs, one bullfrog tadpole, and an unidentified snake in the East Side canal fyke nets. The beaver had been swimming in the forebay, but was caught when the net was lifted. The East Side canal is very short so it is possible that the smaller animals passed through the trashrack grating at the diversion from Upper Klamath Lake.

Since 1988, PacifiCorp has documented six wildlife mortalities at the J.C. Boyle canal and forebay including four deer and one skunk collected from the J.C. Boyle forebay trashrack, and one deer mortality from jumping off of the J.C. Boyle canal emergency spillway. PacifiCorp documented deer mortalities in March, June, August, and September. Broken legs on two of the dead deer found in the J.C. Boyle canal suggest that they probably fell from the surrounding cliffs. PacifiCorp has not collected any deer from the trashrack since 1990. PacifiCorp has not assessed entrainment of small animals in this canal because the trashrack grates are too widely separated to stop small animals.

PacifiCorp did not document any wildlife mortality at the Fall Creek trashracks. However, it is possible that some small animals, especially amphibians and reptiles, enter the canal either at the diversion or along its length and then are passed through the Fall Creek powerhouse turbines because of the spacing of the trashrack grating.

PacifiCorp's review of studies addressing the effects of hydroelectric projects on wildlife movement and habitat connectivity revealed that, in some cases, project waterways do not prevent movement throughout the landscape, but may alter movement patterns or corridors, which, in turn, may make animals more susceptible to predation or hunting mortality. Another study showed that deer were found to use different crossing locations during spring and fall migration periods, suggesting that location of escape mechanisms in canals is extremely important because animals cross at specific locations. Several studies demonstrated that deer bridges and escapes are effective at reducing mortality.

It is unlikely that the J.C. Boyle bypassed reach is used consistently by big game due to its steep and rocky nature. However, through its field surveys, PacifiCorp determined that several small mammal species, particularly the deer mouse, bushytail woodrat, dusky-foot woodrat, montane vole, canyon mouse, and least chipmunk, were relatively common immediately along one or more of the canals, and several species of snakes and lizards also were found using habitats along the J.C. Boyle canal. It is possible that lizard species could climb the concrete walls of the J.C. Boyle canal while the other species would be able to access the inside of the canal only at certain locations with low or no walls. The J.C. Boyle canal probably blocks movement by individual terrestrial mammals and reptiles. The effect likely is limited to individuals, but enhancing crossing opportunities could benefit local populations.

PacifiCorp proposes to install and maintain eight wildlife crossings on the J.C. Boyle canal and develop a monitoring program to document the use of the wildlife bridges. The Bureau of Land Management specified and Oregon Fish & Wildlife recommended wildlife crossings and escape ramps for the J.C. Boyle canal and effectiveness monitoring. Providing wildlife crossings that connect suitable habitat would eliminate a need for animals to enter the J.C. Boyle canal and would ultimately enhance connectivity. Oregon Fish & Wildlife recommends that PacifiCorp consult with it, FWS, and the Bureau of Land Management to develop a wildlife crossing monitoring plan to evaluate the efficacy of wildlife crossings along project canals and waterways within 1 year of license issuance, but recommends installation of the wildlife crossings within 2 years of license issuance. We do not consider it appropriate to install wildlife crossings prior to completion and approval of a comprehensive wildlife resource management plan, which would encompass monitoring enhancement measures as part of the plan. Oregon Fish & Wildlife also recommends that PacifiCorp prepare an annual inspection and maintenance report on the wildlife crossings and escape ramps beginning within 2 years of license issuance. Again, any specific inspection and maintenance procedures would be defined in the comprehensive wildlife resource management plan. Monitoring wildlife use of any crossings that may be installed would enable consulted entities to assess effectiveness. However, a determination of effectiveness would be somewhat subjective, because it would not be possible to determine whether wildlife that use the crossings would have chosen not to cross the canal if the crossings were not provided, and if not, whether this would adversely influence any life history function.

Roads throughout the project vicinity potentially can affect small animal connectivity and be a source of mortality. PacifiCorp documented 30 wildlife mortalities on roads traveled by project personnel during the spring and summer of 2003. The majority of the observed carcasses were California ground squirrels. PacifiCorp also found seven snake carcasses along these roads during that time period and observed five live snakes basking on roads. Four of the carcasses were found on roads most heavily used for project purposes, while three were on more heavily traveled public roads. PacifiCorp reported that wildlife mortality appeared to be most evident along road sections with relatively high traffic volumes and those areas with visitor access and potential for higher vehicular speeds.

Most PacifiCorp roads are located near the Keno, J.C. Boyle, Copco No. 1 and No. 2 dams, and Iron Gate reservoir. PacifiCorp proposes to develop a road access management plan, whereby it would assess the feasibility of closing unnecessary roads and establishing seasonal restrictions on unimproved roads to prevent resource damage and disturbance to wildlife during sensitive time periods. Additionally, PacifiCorp proposes to restore sites along roads that are known to have environmental damage. Even though wildlife mortality due to roads at the Klamath Hydroelectric Project is relatively light, wildlife would benefit from closing and restoring roads, due to the maintenance of wildlife habitat connectivity and limited opportunity for collisions with vehicles.

Avian Transmission Line Protection

PacifiCorp has retrofitted most of its project transmission lines to raptor-safe standards; however, Line 15, located south of the Copco No. 2 bypassed reach, still has a few poles with configurations that do not meet current raptor electrocution safety standards. Although PacifiCorp has not documented any avian electrocutions or avian collision deaths along the project transmission lines since its personnel began tracking them in the late 1980s, avian mortalities are still possible. Additionally, transmission lines located near areas of high waterfowl and wading bird use are of particular concern because waterfowl and other large-bodied birds are most at risk of colliding with the transmission lines. To document bird mortalities that may have resulted from electrocution or collision at their transmission lines, PacifiCorp follows guidelines included in its memorandums of understanding with Oregon Fish & Wildlife, Cal Fish & Game, and FWS for reporting, removing, and disposing of electrocuted birds. These guidelines include mortality reporting, bird power line management program guidelines, and raptor-safe distribution line construction standards.

PacifiCorp proposes to continue to maintain its database of all reported electrocutions and to continue to support the memorandums of understanding with Oregon Fish & Wildlife, Cal Fish & Game, and FWS. PacifiCorp also proposes to continue to monitor all power lines within the project boundary and, whenever feasible, to retrofit structures where avian electrocutions have occurred. PacifiCorp proposes to conduct baseline monitoring surveys once during the first year following license acceptance to search for dead birds under its transmission lines within the project boundary and also to conduct additional power line monitoring during the first several years after license acceptance. Remedial actions would be conducted whenever feasible where dead birds are found, and a follow-up survey would be conducted the following year. If no more dead birds are found, PacifiCorp proposes to follow its standard monitoring and reporting method thereafter.

FWS recommends that PacifiCorp consult with it, the Bureau of Land Management, the Forest Service, and Oregon Fish & Wildlife within 1 year of license issuance to complete an avian collision and electrocution hazard avoidance plan to ensure that adverse interactions between project transmission and distribution lines and birds are minimized. FWS recommends including monitoring strategies in the plan that are sufficiently repetitive to detect sites causing mortalities and that any pole or tower involved in a bird fatality and all new or rebuilt power poles conform to guidelines established by the Avian Power Line Interaction Committee and FWS. FWS recommends that PacifiCorp develop and implement this plan based on the existing Avian Protection Plan for the Klamath Basin (PacifiCorp and FWS, 2005, as cited in the letter from Interior to the Commission dated March 27, 2006) and upon any existing memorandums of understanding between PacifiCorp, FWS, and other agencies. If deemed necessary by the Forest Service or the Bureau of Land Management, FWS recommends that PacifiCorp develop a memorandum of understanding specific to the Klamath Hydroelectric Project in consultation with those agencies and file it with the Commission for approval within 2 years of license issuance.

In its response to FWS, in a letter filed with the Commission on May 15, 2006, PacifiCorp states that there has been no indication that project-related transmission lines are causing bird mortalities. It does not believe that developing another plan, more memorandums of understanding, or implementation of other measures are needed to reduce avian interactions with power lines within the project boundary.

Oregon Fish & Wildlife recommends that PacifiCorp implement measures to minimize adverse interactions between project power lines and birds including (1) retrofitting or rebuilding any power pole involved in a bird fatality to increase safety for large perching birds; and (2) constructing new or rebuilt power poles in accordance with guidelines in the most current edition of *Avian Protection Plan Guidelines* (APLIC, 2005) which is to be used in conjunction with *Suggested Practices for Raptor Safety on Power Lines: The State of the Art in 1996* (APLIC, 1996) and *Mitigating Bird Collisions with Power Lines: The State of the Art in 1994* (APLIC, 1994). Oregon Fish & Wildlife recommends that PacifiCorp install bird flight diverters on any new transmission lines and that it retrofit any existing transmission lines that have been documented to cause mortality. Oregon Fish & Wildlife recommends that PacifiCorp conduct operation and maintenance activities in the project area in accordance with the most current spatial and temporal guidelines for avian protection (APLIC, 1996 and 2005). Oregon Fish & Wildlife also recommends that PacifiCorp follow the existing Agreement for Management of Birds on Powerlines between PacifiCorp, Oregon Fish & Wildlife, and FWS dated February 18, 1988. According to Oregon Fish & Wildlife, the agreement promotes cooperation between PacifiCorp and the signatory agencies and includes procedures for dealing with bird mortality and problem nests. According to Oregon Fish & Wildlife, records of dead birds found near project facilities are kept in a database, and annual reports summarizing avian protection program activities within the project area are submitted to Oregon Fish & Wildlife, FWS, and the Bureau of Land Management.

In its response to Oregon Fish & Wildlife, in a letter filed with the Commission on May 12, 2006, PacifiCorp states that it does not believe that the conditions recommended by Oregon Fish & Wildlife to minimize adverse interactions between project power lines and birds are necessary because PacifiCorp is already implementing a company-wide program to minimize adverse interactions between power lines and birds that includes all project-related lines. PacifiCorp states that its company-wide program and memorandums of understanding address all power lines in a comprehensive manner and already provide adequate protection for the resource.

Our Analysis

Approximately 67 percent of all birds documented by PacifiCorp during its field surveys were waterfowl and other water-related birds. PacifiCorp observed 47 species of water birds including 20 species of waterfowl and 19 species of open-water, marsh, and wading birds other than waterfowl. Additionally, PacifiCorp documented 19 birds of prey, including six species of hawk, two eagle species, three falcon species, seven owl species, and one species of vulture. Fourteen of these species of birds of prey have special status as do seven of the water-related birds.

PacifiCorp evaluated the potential of the transmission lines to cause raptor electrocutions. Most electrocutions occur when spacing between energized conductors or between conductors or grounding sources are less than 60 inches, or when poles are configured such that birds can come into contact with transformers, lightning arrestors, jumper wires, or switches (APLIC, 1996). PacifiCorp found that Line 15, located south of the Copco No. 2 bypassed reach, still has a few poles with configurations that do not meet current raptor electrocution safety standards. All other support structures meet current Avian Power Line Interaction Committee guidelines, and there are no records of electrocutions in the past.

PacifiCorp evaluated the potential of the transmission lines to cause raptor collision mortality. Collision risk is generally highest when transmission lines cross flight paths that birds use during seasonal migration or daily movements between foraging and roosting areas (APLIC, 1996). Most collisions occur where power lines cross rivers, reservoirs, wetlands, or flooded fields, and involve ducks, geese, and other large waterbirds such as great blue herons that are less maneuverable in flight than raptors. PacifiCorp determined that there are four segments of project transmission lines located near areas of high waterfowl and wading bird use: one at Link River, one near the upstream end of Iron Gate reservoir, and two segments of line that cross Iron Gate reservoir. At Link River, the transmission line crosses a flight corridor between Upper Klamath Lake and Keno reservoir heavily used by many ducks, waterbirds, and colonial nesting wading birds that fly between the two water bodies to forage and roost. The line segment at the upper end of Iron Gate reservoir crosses Fall Creek before it parallels a part of the reservoir heavily used by shorebirds and waterfowl. One of the segments of line crossing Iron Gate reservoir crosses the Jenny Creek inlet, which is an area consistently used by many ducks, waterbirds, and colonial nesting wading birds. The other segment of line crosses Iron Gate reservoir more than half a mile south of the mouths of Camp and Scotch creeks, which is also an area of concentrated waterfowl use. No bird mortalities or collision-induced power outages have been reported from these lines. In fact, PacifiCorp's avian mortality databases indicates that no collisions or electrocutions have been documented by PacifiCorp personnel since implementing memorandums of understanding with Oregon Fish & Wildlife and Cal Fish & Game in the late 1980s.

PacifiCorp proposes to continue to support the memorandums of understanding with Oregon Fish & Wildlife, Cal Fish & Game, and FWS. The memorandums of understanding have been in place since the late 1980s and provide guidelines for the reporting and disposal of birds found near PacifiCorp lines or facilities. The guidelines include (1) mortality reporting-PacifiCorp employees report any large dead bird found in or around project facilities; since 1988, PacifiCorp has maintained a bird mortality tracking system where all observations are documented; (2) bird power line management program guidelines - created for PacifiCorp field employees and distributed to all offices (most recently in early 2003) to provide information on mortality reporting forms, agency contacts, raptor identification, and information for making existing structures raptor-safe; and (3) raptor-safe distribution line construction standards - new and rebuilt rural distribution lines require a minimum of 60 inches of clearance between conductive or conductive and grounded parts of a transmission line to meet raptor-safe construction standards. Problem poles, where an eagle or other birds have been killed, also are identified and retrofitted with insulator covers, brushing caps, triangles or perches, or jumper wire hose when feasible or replaced if they cannot be retrofitted adequately.

According to the April 2005 version of the Avian Protection Plan Guidelines, power lines are considered avian-safe (will prevent electrocutions) if they are designed and constructed to provide conductor separation of 60 inches between energized conductors and grounded hardware, or if energized parts and hardware are covered if such spacing is not possible. PacifiCorp's construction standards clearly meet the guidelines.

We conclude that the risk of electrocution or collision is low at the Klamath Hydroelectric Project because (1) only one of PacifiCorp's support structures does not meet current Avian Power Line Interaction Committee guidelines, (2) no bird mortalities or collision-induced power outages have been reported from lines located near areas of high waterfowl and wading bird use, and (3) PacifiCorp's new and rebuilt rural distribution lines require a minimum of 60 inches of clearance between conductive or conductive and grounded parts of a transmission line to meet raptor-safe construction standards. We also conclude that risks at the Klamath Hydroelectric Project have been further reduced by the existing memorandums of understanding that provide guidelines for monitoring, tracking, and reporting adverse avian power line interactions. PacifiCorp indicated that it distributed its most current edition of its bird power line management program guidelines in early 2003. The Avian Power Line Interaction Committee and FWS updated its Avian Protection Plan Guidelines in 2005, so PacifiCorp's guidelines also may need to be updated to reflect any changes in the guidelines. It is possible that revisions to guidelines for raptor protection at transmission lines would occur during the term of the new license. Provisions to respond to updated protection guidelines when support structures need replacement or repair should be incorporated into the avian protection element of a wildlife habitat plan.

FWS recommends that PacifiCorp develop an avian collision and electrocution hazard avoidance plan to ensure that adverse interactions between project transmission and distribution lines and birds are minimized. PacifiCorp has pointed out, and we agree, that there has been no indication that project-related transmission lines are causing bird mortalities. PacifiCorp proposes to include avian protection as an element of a comprehensive wildlife resource management plan, and would address monitoring project transmission lines and retrofitting structures where avian electrocutions have occurred.

Oregon Fish & Wildlife recommends that PacifiCorp implement several measures to minimize adverse interactions between project power lines and birds, including retrofitting or rebuilding any power pole involved in a bird fatality to increase safety for large perching birds and constructing new or rebuilt power poles in accordance with the most current guidelines. PacifiCorp has not proposed any new transmission lines at the project but has proposed including avian protection as an element of a comprehensive wildlife resource management plan, and would address monitoring project transmission lines and retrofitting structures where avian electrocutions have occurred. Oregon Fish and Wildlife also recommends that PacifiCorp continue to follow the existing Agreement for Management of Birds on Powerlines between PacifiCorp, Oregon Fish & Wildlife, and FWS dated February 18, 1988. We have not obtained a copy of this agreement, but assume that PacifiCorp's proposal to support the existing memorandums of understanding would result in PacifiCorp following the existing agreement. Oregon Fish & Wildlife also recommends that PacifiCorp conduct operation and maintenance activities in the project area in accordance with the most current spatial and temporal guidelines for avian protection. We assume that Oregon Fish & Wildlife was referring to the operation and maintenance of the project transmission lines, which is what the Avian Power Line Interaction Committee guidelines address.

Special Status Wildlife

Several sensitive wildlife species occur within the project boundary. Of these, the western toad, northwestern pond turtle, the Yuma myotis, and the Pacific western big-eared bat could potentially be affected by project operations. The western toad occurs in the J.C. Boyle peaking reach, along the north shore of Iron Gate reservoir, and along the Klamath River between the confluence of Bogus and Cottonwood creeks. All known western toad breeding sites are located along Iron Gate reservoir, and daily water level fluctuations in the reservoir could potentially affect breeding western toads, from February until early May. PacifiCorp proposes to try to minimize Iron Gate reservoir fluctuations from March until July during the spring and summer amphibian and waterfowl breeding season by scheduling routine maintenance drawdowns outside of this time period, but recognizes that future water level fluctuations may be similar to current water level fluctuations due to daily and weekly project operations. Therefore, as part of its wildlife habitat management plan PacifiCorp proposes to create a small (less than 0.5-acre) swale near the current toad breeding site on Iron Gate reservoir just west of Scotch Creek. PacifiCorp believes that the swale would be sufficiently isolated from the reservoir to prevent predatory fish from entering it, and it would be designed to hold surface water at a more stable level than can occur in the reservoir and provide better conditions for developing egg masses, tadpoles, and larvae.

Western pond turtles occur at several locations throughout the project area, but are concentrated in locations where basking structures (exposed rocks and occasionally logs) are present near slack water. The water level fluctuations in the river reaches and reservoirs may adversely affect turtles by making some of the basking sites unavailable, increasing the risk of predation, and reducing forage resources. Project recreation also affects western pond turtles because several basking sites and nesting sites are located near recreational sites (Frain Ranch, Klamath River Campground), and basking turtles are regularly disturbed by whitewater rafters. PacifiCorp expects that its proposed changes in operation of the J.C. Boyle powerhouse would enhance conditions for turtles in the J.C. Boyle peaking reach by increasing the amount of permanently inundated aquatic habitat, decreasing the width of the exposed varial zone that turtles would have to navigate to reach upland habitats, and slowing the ramping rate. As part of its wildlife habitat management plan, PacifiCorp proposes to add basking structures (rocks, tethered logs, or other permanent objects that cannot be flushed downstream) at selected sites on reservoirs or in backwater turtle habitat. PacifiCorp would determine the number and distribution of these structures based on known turtle concentrations, locations of recreational activity, and suitability of adjacent uplands for nesting and overwintering.

Yuma myotis are known to use various project buildings including the Copco No. 1 powerhouse, Copco No. 1 gatehouse, the Copco No. 2 dam gatehouse, and the Copco No. 2 powerhouse. Most buildings are used by small numbers of bats without much conflict with project operations. However, at Copco No. 2 powerhouse, PacifiCorp's annual operation of the crane mechanism on the ceiling track sometimes kills a small number (three or four) of bats that are roosting inside the mechanism. As part of its wildlife habitat management plan, PacifiCorp proposes to install bat roost structures outside of the J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate facilities to provide safer roost sites. PacifiCorp also proposes to investigate the feasibility of excluding bats from at least the most dangerous sites to minimize the possibility of direct mortality and would implement such measures if feasible.

PacifiCorp proposes to expand or add 10 recreation sites near the project (Boyle Bluffs recreation area, J.C. Boyle car-top boat launch, J.C Boyle loop trail, J.C Boyle dam river access and trails, J.C. Boyle powerhouse river access and trail, Fall Creek trail extension, Wanaka Springs modification, Camp Creek expansion, Long Gulch Bluff recreation area, and Bogus Creek trail) which would affect approximately 79 acres of wildlife habitat. Most of the habitat is montane hardwood oak-juniper (40 acres) and annual grassland (28 acres); no wetland or riparian habitat would be affected. As part of its wildlife habitat management plan, PacifiCorp proposes to survey for special status plant and wildlife species and significant wildlife habitat or use areas prior to conducting ground-disturbing activities. PacifiCorp proposes to provide the results of the surveys to the resource agencies and develop site-specific mitigation plans for each site that may include use of native plant species; potential seasonal restrictions; and if necessary, on-site or off-site habitat replacement.

The wildlife habitat management plan specified by the Bureau of Land Management includes measures for western pond turtle habitat and effectiveness monitoring and sensitive and special status species surveys and monitoring including (1) protocols for long-term surveys and monitoring of sensitive species and their habitat for Bureau of Land Management-administered lands within the project boundary to assess effects and develop necessary mitigation; (2) identification of restoration, protection, and/or enhancement measures for sensitive species; and (3) seasonal restrictions for active nest sites on Bureau of Land Management-administered lands for golden eagles, ospreys, peregrine falcons, and other raptors that are affected by project operations.

Our Analysis

All known western toad breeding sites are located along Iron Gate reservoir, and daily water level fluctuations in the reservoir could potentially affect breeding western toads, which typically breed between January and September. Western toads attach long strings of eggs in a jelly-like substance to vegetation in still, shallow water. The tadpoles emerge from the eggs and live in the shallows feeding on vegetation until they lose their tails and metamorphose into toads. In 2002, the Iron Gate western toad breeding site was apparently unsuccessful, while in 2003, numerous young toads were produced at the same site. In 2002, the Iron Gate western toad breeding site experienced a 2-foot water level drop during egg development, which entirely dried the egg strands. New egg strands were found in the shallow water near the new lower water line. By May 10, 2002, the reservoir had been refilled and had deeply inundated the eggs that were found on April 25, 2002. This rapidly fluctuating water level likely resulted in either desiccation or detachment of the egg masses, which would increase their exposure to predation by yellow perch and bullfrogs. However, PacifiCorp observed numerous (more than 100) western toad egg strings at the Iron Gate breeding site in early spring 2003. PacifiCorp subsequently confirmed successful hatching and dispersal of metamorphosed juvenile toads from the site.

PacifiCorp's proposals to try minimizing Iron Gate reservoir fluctuations from March until July and create a small (less than 0.5-acre) swale near the current toad breeding site would minimize water level fluctuations during the breeding season and provide stable habitat, thus facilitating survival and maturation of the western toad egg strings. If PacifiCorp discontinues its peaking operation, this measure would no longer be necessary.

Western pond turtles have been found in the project vicinity in a variety of aquatic habitats and are common to abundant in many project reservoirs and river reaches. In general, the combination of relatively low-gradient flow, adequate food supplies, presence of adequate basking structures (emerging boulders, mats of emergent vegetation, or logs), and access to suitable nesting habitat is required for consistent western pond turtle use. Basking sites for thermoregulation are an important component of western pond turtle habitat. Few basking structures are located downstream of some of the project facilities, and the existing structures are used extensively by turtles in the project area. PacifiCorp proposes to add basking structures (rocks, tethered logs, or other permanent objects that cannot be flushed downstream) at selected sites on reservoirs or in backwater turtle habitat. The wildlife habitat management plan specified by the Bureau of Land Management includes measures for western pond turtle habitat and effectiveness monitoring. Providing additional basking structures would compensate for project peaking operations and whitewater boating flows, which result in inundation of basking habitat and displacement of turtles downstream. Additional basking structures should accommodate more turtle basking at different surface water elevations, thus enhancing the ability of the turtles to thermoregulate. Basking structures also would provide foraging and roosting habitat for other wildlife species using the project area.

Bats roosting in project structures can create human health issues for personnel engaged in operations and maintenance activities in the structures. Conversely, routine operations and maintenance activities can disturb roosting bat colonies and disrupt breeding activities. Providing alternative roosting sites outside of the J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate facilities can reduce these potential adverse effects on humans and bat species with special status, as well as other bat species using the project area. Implementing measures to exclude bats from the most dangerous project sites would minimize the possibility of bat mortality and enhance survival of sensitive species.

PacifiCorp proposes to survey for special status plant and wildlife species and significant wildlife habitat or use areas prior to conducting ground-disturbing activities. PacifiCorp proposes to provide the results of the surveys to the resource agencies and develop site-specific mitigation plans for each site that may include use of native plant species, potential seasonal restrictions, and if necessary, on-site or off-site habitat replacement. Surveys would provide baseline data on species using areas proposed for disturbance and could guide decisions on methods and timing of ground-disturbing activities. Site-specific plans for avoiding or minimizing the biological effects of current and proposed project recreational facilities and related activities would provide a reasonable level of protection to biological resources in the project area. A more detailed discussion of the recreation resources management plan and associated monitoring is found in section 3.3.6, *Recreational Resources*.

3.3.4.2.3 Development Decommissioning and Dam Removal

Various entities have advocated the removal of some or all project dams to facilitate restoration of anadromous fish to historic habitat upstream of Iron Gate dam and as a potential means to enhance water quality in the Klamath River downstream of Iron Gate dam. Decommissioning and removing project dams would affect riparian habitat throughout the project area, from Keno reservoir to the Klamath River below Iron Gate dam. Riparian vegetation would likely re-establish along the banks of the new river channel in the reservoir reaches, while most of the area exposed by drawdown of each of the project reservoirs would be colonized by a mix of upland vegetation series, similar to those that are currently present. Assuming an average riparian corridor width of 100 feet along the 20.1-mile length of the Keno reservoir, the 3.6-mile length of the J.C. Boyle reservoir, the 4.5-mile length of the Copco No. 1

reservoir, the 0.3-mile length of the Copco No. 2 reservoir, and the 6.8-mile length of the Iron Gate reservoir, we estimate that decommissioning would add about 428 acres of riparian vegetation and about 3,950 acres of upland vegetation to the land base, as well as about 460 acres of riverine habitat in the areas now occupied by reservoirs.

The benefits that new riparian and upland areas might have as wildlife habitat would depend to a great extent on how they were restored and managed. If managed primarily for wildlife, the reservoirs could provide habitat for a variety of small mammals and songbirds, foraging opportunities for raptors, and high-quality winter range for deer.

The loss of a total of about 4,840 reservoir acres would reduce the area of resting habitat for migratory waterfowl. The loss of open water habitat would also reduce foraging opportunities for osprey, bald eagles, and other piscivorous birds, and for several species of bats. Nesting habitat for waterfowl could also be reduced with the conversion of the Keno, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate reservoirs to riverine or upland environments. Depending on the hydrologic characteristics following dam removal, there could actually be an increase in wetland habitat at some locations, which may offer an increase in nesting habitat for certain species of waterfowl.

A return to unregulated flows in the Klamath River would increase the average annual flow and the magnitude and frequency of floods. Klamath River flows would likely continue to be regulated to some degree because of operations of the Klamath Irrigation Project. Adverse effects would be likely to occur within the first few years following project or dam decommissioning and removal, as a result of erosion, bank failure, development of debris jams and gravel bars, scour, deposition, and changes in side channel connections. Such effects would need to be addressed in a dam or project decommissioning proceeding. However, riparian systems are characteristically resilient, and over time, riparian plant and wildlife communities along the Klamath River would likely equilibrate to changes in seasonal flows and changes caused by those flows.

3.3.4.3 Unavoidable Adverse Effects

None.

3.3.5 Threatened and Endangered Species

3.3.5.1 Affected Environment

3.3.5.1.1 Lost River and Shortnose Sucker

The Lost River sucker (*Delistes luxatus*) and shortnose sucker (*Chasmistes brevirostris*) are large, long-lived fish species that occur in the upper portions of the Klamath River Basin. Both species are known to occur in Upper Klamath Lake and its tributaries; the Lost River; Tule Lake; Clear Lake; and Gerber,[79] J.C. Boyle, Copco, and Iron Gate reservoirs. These two sucker species primarily reside in lake habitats and spawn in tributary streams or at springs and shoreline areas within Upper Klamath Lake. Historically, the two species were very numerous in the shallow lakes that occurred in the upper basin, but most of these lakes have been substantially altered and reduced in size to support agricultural development. Native Americans and white settlers exploited concentrations of migrating and spawning suckers as a food source.

Although Tule Lake once supported a large population of suckers, habitat conditions there are currently degraded and the lake now supports only a few hundred suckers. Upper Klamath Lake currently

[79] Clear Lake and the Gerber reservoir, which were historically part of Lower Klamath Lake, are currently used to store and convey water as part of the Klamath Irrigation Project (see figure 2-4).

supports the largest remaining population of both species (FWS, 2002a). Recent sampling conducted in the J.C. Boyle, Copco, and Iron Gate reservoirs indicate that the populations in these reservoirs are not large, and they appear to be supported by downstream movement of fish from Upper Klamath Lake (Desjardins and Markle, 2000). The number of suckers collected from the Klamath reservoirs and from the Klamath River in the project area is reported in section 3.3.3.1.1, *Aquatic Habitat Conditions*.

Both species of suckers were listed as endangered by FWS on July 18, 1988,[80] which issued a recovery plan for the listed suckers in 1993 (FWS, 1993). Several petitions have been filed to delist the species based on new information on the abundance and geographic range of the species. On May 14, 2002, FWS published a 90-day finding that the petitions did not present substantial scientific or commercial information indicating that delisting was warranted.[81] This initial finding was remanded on September 3, 2003, and FWS published a revised 90-day finding on July 21, 2004, again concluding that delisting was not warranted, but also stating that FWS would initiate a 5-year review of the listing of these species.[82] FWS proposed to designate a total of about 182,400 hectares (456,000 acres) of stream, river, lake, and shoreline areas as critical habitat for the shortnose sucker, and about 170,000 hectares (424,000 acres) of stream, river, lake, and shoreline areas as critical habitat for the Lost River sucker on December 1, 1994.[83] However, no critical habitat for these species has been designated to date.

At the time that the species were listed, FWS found that survey work performed from 1984 through 1986 indicated that there had been drastic declines in the population of both species in Upper Klamath Lake.[84] During the 1984 survey, the population of shortnose suckers moving out of Upper Klamath Lake in the spawning run was estimated at 2,650 individuals, but the 1985 and 1986 surveys found too few shortnose suckers to accurately estimate the population size. The catch per unit effort of shortnose suckers declined 34 percent between 1984 and 1985 and 74 percent between 1985 and 1986. The estimated spawning population of Lost River suckers in Upper Klamath Lake declined from 23,123 fish in 1984 to 11,861 fish in 1985. They found that no significant recruitment into the adult population of either species had occurred in approximately 18 years.

In its 2004 revised 90-day petition finding, FWS concluded that, although some population increase had occurred in the mid-1990s following closure of the sport fishery and good recruitment in 1991, 3 consecutive years of water quality-related die-offs in 1995 through 1997 killed a major portion of the adult populations.[85] Following these die-offs, the number of suckers spawning in the Sprague River declined 80 to 90 percent based on weekly netting surveys conducted during the spawning season.

The 1988 notice listing the Lost River and shortnose suckers and status assessments in two BiOps on Reclamation's operation of the Klamath Irrigation Project (FWS, 2001a; 2002a) concluded that the species were subject to the following threats: (1) drastically reduced adult populations and reduction in range; (2) extensive habitat loss, degradation and fragmentation; (3) small or isolated adult populations; (4) isolation of existing populations by dams; (5) poor water quality leading to large fish die-offs and reduced fitness; (6) lack of sufficient recruitment; (7) entrainment into irrigation and hydropower diversions; (8) hybridization with the other native Klamath sucker species; (9) potential competition with introduced exotic fishes; and (10) lack of regulatory protection from federal actions that might adversely affect or jeopardize the species.

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[80] 53 FR 27,130-27,134.

[81] 67 FR 34,422-34,423.

[82] 69 FR 43,554-43,558.

[83] 59 FR 61,744-61,759.

[84] 53 FR 27,130-27,134.

[85] 69 FR 43,554-43,558.

The 2002 FWS BiOp (FWS, 2002a) found that Reclamation's 10-year operating plan was likely to jeopardize the survival of Lost River and shortnose suckers based on the effects of sucker entrainment at project dams[86] and diversions in Upper Klamath Lake, effects of project operations on water quality in Upper Klamath Lake, and sucker habitat loss in Upper Klamath Lake. FWS identified a reasonable and prudent alternative that included three primary elements and four sub-elements: (1) maintaining higher water levels in Upper Klamath Lake by using the 50 percent exceedance forecast to determine minimum lake levels instead of the 70 percent exceedance forecast proposed by Reclamation; (2) reducing the entrainment of juvenile, sub-adult and adult suckers at Link River dam and associated hydropower intake bays; and (3) (a) developing a DO risk assessment model for Upper Klamath Lake and incorporating results into project management; (b) assessing and managing Upper Klamath Lake sucker water quality refuge areas; (c) assessing ongoing sucker population monitoring and implementing needed monitoring improvements; and (d) developing and implementing a sucker die-off assessment plan.

Measures that have been implemented to benefit the listed suckers since the 2002 BiOp include maintaining higher lake levels in Upper Klamath Lake, the installation of fish screens at the Reclamation's A canal diversion in 2003, and the installation of a new fish ladder at Link River dam in 2005 to enable suckers that pass downstream over Link River dam to migrate upstream back into Upper Klamath Lake.

3.3.5.1.2 Coho Salmon

Coho salmon (*Oncorhynchus kisutch*) in the Klamath River are part of the Southern Oregon/Northern California Coast coho salmon ESU (the SONCC coho ESU), which includes all naturally spawned populations and their progeny in streams between Cape Blanco in southern Oregon and Punta Gorda in northern California. NMFS listed this ESU as threatened on May 6, 1997,[87] and critical habitat was designated on May 5, 1999.[88] The California Fish and Game Commission found that the ESU warranted listing under the California Endangered Species Act as a threatened species on August 30, 2002, but they elected not to formally list the species while a recovery strategy was being prepared. The recovery strategy was completed in 2004 (Cal Fish & Game, 2004b). In this section we describe the species designated critical habitat, the status of the SONCC coho ESU at the time that it was listed, available information on abundance trends since listing, and measures that are being undertaken to promote recovery of the ESU. Information on the species biology and population trends within the Klamath River Basin itself is presented in section 3.3.3.1.2, *Anadromous Fish Species*.

Within the Klamath River Basin, designated critical habitat for the SONCC coho ESU includes all rivers within accessible reaches including estuarine areas and tributaries, excluding areas on tribal lands. NMFS concluded that the current range of the species encompasses all essential habitat features and is adequate to ensure the species conservation, and excluded habitat upstream of existing impassable barriers including Iron Gate dam on the Klamath River, Dwinnell dam on the Shasta River, and Lewiston dam on the Trinity River. NMFS identified five essential habitat types for the SONCC coho ESU: (1) juvenile summer and winter rearing areas; (2) juvenile migration corridors; (3) areas for growth and development to adulthood; (4) adult migration corridors; and (5) spawning areas. NMFS identified important features of coho salmon critical habitat including adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions.

[86] In addition to Link River dam, Reclamation manages operation of five other primary dams within the Lost River and Tule Lake system: Clear Lake, Gerber, Malone, Wilson, and Anderson-Rose dams.

[87] 62 FR 24,588-24,609.

[88] 64 FR 24,049-24,062.

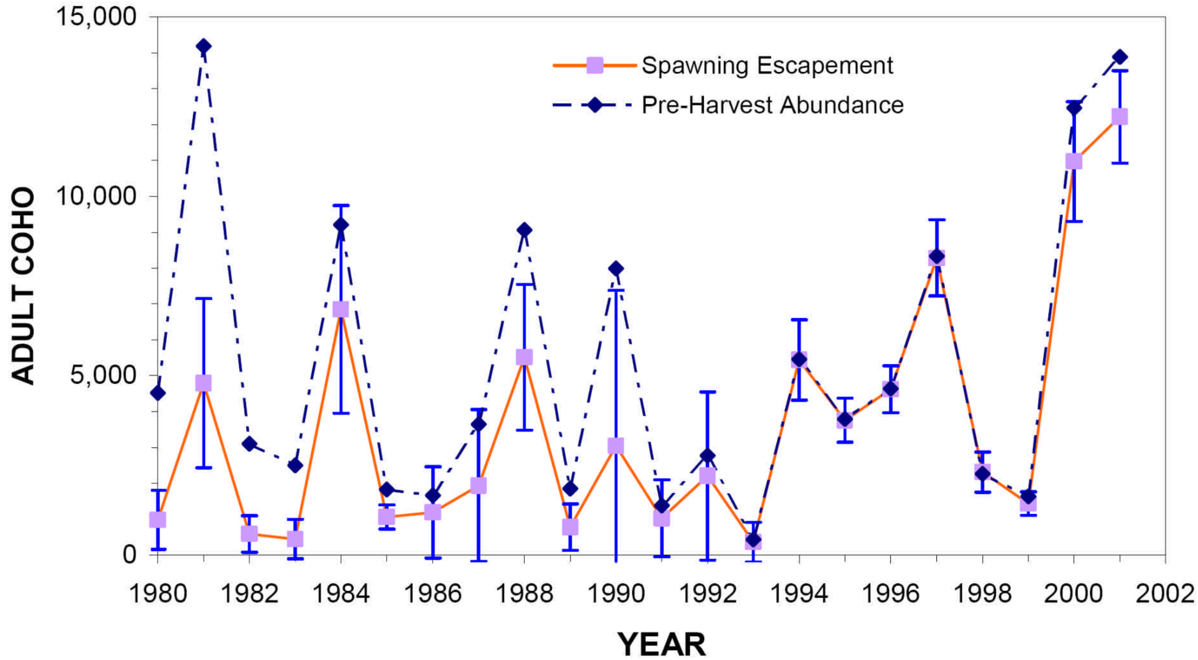
In its May 6, 1997, final rule listing the SONCC coho ESU, NMFS estimated that the coho population within the ESU had declined from 150,000 to 400,000 naturally produced fish in the 1940s to less than 10,000 naturally produced adults at the time of listing.[89] Threats to the ESU identified in the final rule listing the ESU included habitat degradation, harvest, and artificial propagation, exacerbating the adverse effects of natural environmental variability brought about by drought, floods, and poor ocean conditions. For the two hatcheries in the Klamath basin, NMFS determined that the Trinity River Hatchery stock should be included in the ESU, and considered the relationship of the Iron Gate Hatchery stock to the ESU to be uncertain. Because none of the hatchery stocks were deemed to be essential to recovery of the ESU, hatchery stocks were not included in the listing. However, NMFS determined that the Trinity River Hatchery stock may play an important role in recovery efforts because there appears to be essentially no natural production in the Trinity basin.

NMFS recently completed an updated status review of federally listed ESUs of west coast salmon and steelhead (Good et al., 2005). They concluded that there is little trend data on adult returns for stocks in the California portion of the SONCC coho ESU that are not substantially influenced by hatchery production. In the Oregon portion of the ESU, estimates of naturally produced adult coho are available only for the Rogue River Basin. About half of the total spawning run in the Rogue River Basin is of hatchery origin and most of these fish return to the Cole Rivers Hatchery, rather than spawning in natural habitat (Good et al., 2005). Based on fin-mark observations during spawning-ground surveys, in recent years the percentage of natural spawners that are of hatchery origin has ranged from less than 2 percent in 2000 to 20 percent in 1998.

Although both short and long-term trends in naturally produced spawners in the Rogue River Basin are upward, Good et al. (2005) reports that this increasing trend is largely due to reduced harvest, as trends in pre-harvest recruits are smaller (figure 3-81). Estimates of the contribution of SONCC fish to harvest prior to listing of the ESU are not available but Good et al. (2005) concludes that ocean exploitation rates have dropped substantially in response to prohibitions on retaining wild (unmarked) coho put in place in 1994 as well as restrictions imposed on Chinook-directed fisheries. Additional detail on harvest management is given in 3.3.3.1.5, *Salmon and Steelhead Harvest and Harvest Management*.

Analysis of survey data from streams where coho were historically known to occur within the SONCC coho ESU indicate that the proportion of streams occupied by rearing coho juveniles generally fluctuated between 36 and 61 percent between brood years 1986 and 2000 (Good et al., 2005). Occupancy rates were highest between brood years 1991 and 1997 (54 to 61 percent), then declined between 1998 and 2000 (39 to 51 percent) before rebounding in 2001. The number of streams surveyed in each year where data analysis had been completed ranged from 136 streams in 1986 to 396 streams in 2000. Although preliminary data indicated that 2001 was a strong brood year, data from only 52 streams had been analyzed at the time that the status review was published.

[89] 62 FR 24,588-24,609.



Note: Vertical bars represent 95 percent confidence intervals for estimates of spawner abundance.

Figure 3-81. Trends in wild spawning escapement and wild pre-harvest abundance of Rogue River coho salmon, 1980-2001. (Source: Jacobs et al., 2002)

Cal Fish & Game's recovery strategy[90] for California coho salmon (Cal Fish & Game, 2004b) identifies 85 range-wide recommendations, 320 watershed recommendations for the SONCC coho ESU, 205 watershed recommendations for the California Central Coast ESU, and 145 watershed recommendations specific to the Shasta and Scott basins as part of the Shasta-Scott Pilot Program. Of the 320 watershed recommendations that are not included within the Shasta-Scott Pilot Program, 116 recommendations pertain to the Klamath River Hydrologic Unit, 12 pertain to the Salmon River Hydrologic Unit, 15 pertain to the Shasta Valley and Scott River Hydrologic Unit, and 23 pertain to the Trinity River Hydrologic Unit. Most of the watershed recommendations relate to water management measures for increasing instream flows, improving fish passage, screening of irrigation diversions, enhancement measures to improve riparian habitat and to increase large woody debris, livestock exclusion, sediment management, and the re-establishment of natural fire regimes to reduce the risk of severe fires.

There are 13 measures identified in the Cal Fish & Game recovery strategy that specifically relate to the mainstem Klamath River. These measures include (1) development of an adaptive management plan for low flow emergencies; (2) developing a plan to restore and maintain tributary and mainstem habitat connectivity where low flow or sediment aggradation is restricting coho passage; (3) conducting a feasibility analysis for coho passage over Iron Gate and Copco dams to access historic habitat; (4) completing a comprehensive (Hardy Phase II) flow study for the mainstem Klamath River; (5) applying

[90]The goal of this recovery strategy is to return coho salmon to level of sustained viability while protecting the genetic integrity of both the SONCC and California Central Coast ESUs, such that regulations or other protections under the California Endangered Species Act (FGC §2050 et seq.) are not necessary.

protective downramping rates at Iron Gate dam; (6) improving the water quality from the upper basin; (7) performing a cost/benefit analysis of full or partial removal of the Klamath Hydroelectric Project dams; (8) preserving and enhancing coldwater tributary flows; (9) studying and protecting temperature refugia; (10) addressing problems relating to water quality, disease, and hatchery operations; (11) restoring coarse sediment supply and transport near Iron Gate dam; (12) acquiring additional water for instream flows through conservation easements, purchase and/or transfer of water and water rights from willing sellers; and (13) funding a water master service at all diversions (Cal Fish & Game, 2004b).

Cal Fish & Game (2004b) estimated that the total cost of implementing its recovery strategy would be between 4.5 and 5 billion dollars, and although they did not attempt to quantify the economic benefits of recovery, they concluded that benefits are likely to exceed the cost of recovery. They state that the benefits of achieving recovery to the point of delisting include providing an economic stimulus to the coastal economy due to the lifting of regulatory requirements associated with a listed species, increased commercial land and water use activities, the flow of restoration dollars to economically depressed coastal communities, and the expansion of commercial, recreational, and tribal fisheries and the businesses and communities that depend on them.

3.3.5.1.3 Bull Trout

Bull trout exhibit both resident and migratory life-history strategies. Migratory bull trout spawn in tributary streams where juvenile fish rear one to four years before migrating either to a lake (adfluvial form) or river (fluvial form). Resident and migratory forms may be found together, and either form may give rise to offspring exhibiting either resident or migratory behavior. Bull trout are found primarily in cold streams, and water temperature above 15°C is believed to limit bull trout distribution (FWS, 2002c). Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a watershed.

The populations of bull trout in the Columbia and Klamath rivers were listed as threatened by the FWS in 1998 (63 FR 31,647). The Jarbridge River population was listed on April 8, 1999 (64 FR 177,110), and the Coastal-Puget Sound and St. Mary-Belly River populations were listed in 1999 (64 FR 58,910), which resulted in all bull trout in the coterminous United States being listed as threatened. The five populations noted above are listed as distinct population segments; that is, they meet the joint policy of FWS and NMFS regarding the recognition of distinct vertebrate populations (61 FR 4,722). Reasons for the decline in the distribution and abundance of bull trout include habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, angler harvest and poaching, entrainment into diversion channels and dams, and introduced non-native species (FWS, 2002a).

FWS published a draft bull trout recovery plan in 2002, and critical habitat was designated in 2005 (70 FR 56,212). The critical habitat designation includes currently or historically occupied habitat that was found to be essential to the conservation of the species. A total of 42 stream miles and 33,939 acres of critical habitat was designated in the Klamath River Basin. The Upper Klamath Lake Subunit includes Agency Lake and part of Sun Creek, the Sycan Marsh Subunit includes the Sycan Marsh and part of Coyote and Long creeks, and the upper Sprague River Subunit includes parts of Boulder, Brownsworth, Deming, Dixon, Leonard, and Sheepy creeks and of the North Fork Sprague River.

In the final rule designating critical habitat, FWS discuss the potential for any bull trout that migrate into Agency Lake could be exposed to infection by *C. shasta*. They note, however, that infection and mortality from *C. shasta* is temperature dependant, and that Chinook salmon do not appear to be affected by *C. shasta* when water temperatures remain below 15°C, indicating that migrating bull trout may not be infected since they are unlikely to migrate into Agency Lake when the water is warm.