United States Department of the Interior

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81333-2007-F-80
81333-2007-F-01(TAILS)

December 3, 2007

Honorable Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

Subject: Formal Consultation on the Proposed Relicensing of the Klamath Hydroelectric Project, FERC Project No. 2082, Klamath River, Klamath County, Oregon, and Siskiyou County, California

Dear Ms. Bose:

This responds to your March 21, 2007, request for formal consultation on your proposed relicensing of the Klamath Hydroelectric Project (Project) as described in your Draft Environmental Impact Statement (DEIS) as the Staff alternative, as modified by the agencies' mandatory conditions (Staff Alternative with Mandatory Conditions). Your request for initiation of consultation was received in this office on March 21, 2007. This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion (BO), based on the Service's review of the Project and effects on the federally listed endangered Lost River sucker (*Delistes luxatus*) (LRS), endangered shortnose sucker (*Chasmistes brevirostris*) (SNS), threatened bull trout (*Salvelinus confluentus*), threatened slender Orcutt grass (*Orcuttia tenuis*), endangered Applegate's milk-vetch (*Astragalus applegatei*), endangered Gentner's fritillary (*Fritillaria gentneri*), threatened northern spotted owl (*Strix occidentalis caurina*), threatened California red-legged frog (*Rana aurora draytonii*), threatened western snowy plover (*Charadrius alexandrinus nivosus*), threatened Canada lynx (*Lynx canadensis*), and threatened gray wolf (*Canis lupus*), and critical habitat for the northern spotted owl and bull trout. In addition, this document further transmits the conference opinion regarding the proposed critical habitat for the listed sucker species. This opinion is based on information provided in your September 25, 2006, Draft Environmental Impact Statement for Hydropower License. This opinion evaluates the effects of implementing the proposed action, in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) (ESA).

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A complete administrative record of this consultation is on file in this office. Through this document, the Service also submits the administrative record supporting the BO.

As described more fully in Appendix 2 to this document, the Service provided a draft of this Biological Opinion to the Federal Energy Regulatory Commission and to PacifiCorp for review and comment. Comments were received from the Commission by letter dated November 2, 2007 (hereafter FERC comments) and from PacifiCorp by letters dated November 2, 2007 (hereafter PC comments) and November 15, 2007. The Service has considered the comments received and the views of the action agency and applicant in developing this final BO. The Service's response to the comments is described in Appendix 2 and as relevant, in particular sections of this document.

Consultation History

In 1996, the Service consulted with the Bureau of Reclamation (Reclamation) on the effects of PacifiCorp's proposed Klamath Hydroelectric Project operations and actions that are contracted with Reclamation in conjunction with its lands and operations of the Klamath Irrigation Project. These operations and actions affect the SNS and LRS and proposed critical habitat for these species. A biological assessment was completed on June 7, 1996 by Reclamation in coordination with PacifiCorp. On July 15, 1996, the Service issued a BO on the effects of the proposed operations and actions on SNS and LRS and a conference opinion on the effects of the proposed operations and actions on proposed critical habitat for SNS and LRS, in accordance with the ESA. The Service's BO concluded that the proposed action was not likely to jeopardize the continued existence of the LRS and SNS, and was not likely to adversely modify or destroy proposed critical habitat.

The Reasonable and Prudent Measures within the Incidental Take Statement of the 1996 BO required PacifiCorp to monitor sucker entrainment at the Eastside and Westside hydropower facilities, determine the status of endangered suckers in PacifiCorp's Klamath River reservoirs, study sucker genetics, re-evaluate its flood operations plan for Upper Klamath Lake, restore sucker nursery habitat at the Lower Williamson River Delta (Upper Klamath Lake), develop a Service-approved endangered species operations and maintenance plan for PacifiCorp's Klamath hydrofacilities activities, and other measures.

The 1996 BO became ineffective in 2002 when the Service issued a BO covering Reclamation's operations for the Klamath Irrigation Project which specifically superceded the 1996 BO. In the 2002 BO, Reclamation was authorized to take federally-listed suckers on the Klamath Irrigation Project. Only Reclamation's activities were covered under the 2002 BO. Thus, while incidental take by Reclamation is currently authorized for operations at Link River Dam, PacifiCorp's Klamath Hydroelectric Project operations are not currently covered.

In its comments on the Draft BO, PacifiCorp requests that the revised BO include a consultation history description that reflects the application of the Incidental Take Statements in the 1996 and 2002 BOs to PacifiCorp's operations. (PC comments at 8). This comment is fully addressed in Appendix 2.

The Federal Energy Regulatory Commission (Commission) requested a species list of federally listed species that may be affected by the proposed action on May 31, 2006. The Service provided the species list on July 21, 2006. The Commission originally requested the initiation of consultation by letter dated October 5, 2006. The Service responded on November 3, 2006, that insufficient information had been provided because the proposed action had not been fully developed or described. The Commission clarified that the proposed agency action is the Staff Alternative as modified by the Agencies' Mandatory Conditions, as described in the DEIS, by letter on March 21, 2007. The Service initiated formal consultation on March 21, 2007, and requested additional information to complete consultation by letter dated April 20, 2007. On May 23, 2007, John Hamilton of the Fish and Wildlife Service met with representatives of the Commission, PacifiCorp, and the National Marine Fisheries Service to clarify the additional information requested. Additional information was provided by PacifiCorp by electronic mail received from Michael Ichisaka and Linda Prendergast during May and June, 2007.

In the Commission's request for consultation on the proposed action, consultation was requested on effects to the bald eagle. However, as of August 8, 2007, the bald eagle is no longer listed under the ESA; therefore, consultation on the bald eagle is no longer required. However, take is prohibited under the Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act. In our review of the information provided for this consultation, we find that the proposed action is not likely to result in take of the bald eagle because PacifiCorp will implement a Bald Eagle Management Plan and an Avian Collision and Electrocution Hazard Avoidance Plan that will protect bald eagles from adverse effects ((Federal Energy Regulatory Commission 2006) page 5-7, lines 30-39). Transmission lines are not likely to cause mortality of bald eagles because, with monitoring since 1980, no mortalities have been documented. Potential effects to foraging eagles from recreation or other activities will be avoided through implementation of the Bald Eagle Management Plan. Currently, only one bald eagle nest is located near a facility where fishway construction has been prescribed, on the south side of Copco No. 1 Dam. Given the topography and current location of structures associated with this dam, it is unlikely that non-blasting construction of fishways would disturb nesting, as the nest is more than 0.25 mile from construction areas. However, blasting, if needed, could disturb this nest. Therefore, PacifiCorp has agreed to conduct blasting for fishway construction at Copco No. 1 Dam outside of the period of nesting activity, January 1 through July 30, unless surveys document that the nest is not active or nestlings have fledged (Ichisaka 2007).

Service Concurrence

After review of the DEIS and other information pertaining to these species ((USDI Fish and Wildlife Service 1987, 2001b, 2002f), 65 FR 16052, 71 FR 15266), the Service concurs with your determinations that the proposed action will have no effect on the California red-legged frog, western snowy plover, Canada lynx, and gray wolf. These determinations are based on the fact that the known ranges of these species are outside of the Action Area. The Service also finds that the proposed action is not likely to adversely affect the slender Orcutt grass and Gentner's fritillary because these species were not present in surveys of the Project area. The Service finds that the proposed action is not likely to adversely affect Applegate's milk vetch, which is present in surveys of the Project, but is outside of the area that will be affected by Project operations ((Federal Energy Regulatory Commission 2006) page 3-381, lines 1-15). In addition, PacifiCorp proposes to survey for the presence of these plants prior to any ground-

disturbing activity and to not disturb these plants should they be found to be present ((Federal Energy Regulatory Commission 2006) page 3-381, lines 44-46; page 3-382, lines 1-2; page 5-4, line 5). In the unlikely event that these protected plants may be found in the disturbance path of fishway construction, the Applicant will contact the Service and measures to avoid or minimize impacts will be developed through reinitiation of consultation.

The Service finds that the proposed action is not likely to adversely affect the northern spotted owl or its critical habitat because there are no plans to remove large trees, which could degrade northern spotted owl habitat, and nesting disturbance from the proposed action is unlikely. Surveys found no nesting activity in the Project area, and habitat conditions in the vicinity of existing facilities, future fishways, and roads that would be used during fishway construction, are unlikely to support nesting due to lack of structure associated with nesting by northern spotted owls.

The above species will not be addressed further in this BO. If new information reveals effects of the proposed action that may affect these species in a manner or to an extent not considered, reinitiation of consultation may be required. We recommend that the Commission include in any new license a condition requiring reinitiation of consultation under the Endangered Species Act when new information reveals effects to listed species that were not previously considered.

The Service finds that the proposed action is likely to adversely affect LRS, SNS, and bull trout, but, as analyzed below, is not likely to jeopardize any of these species. The LRS and SNS are likely to be adversely affected because there will be continued potential for entrainment or impingement of young at Project powerhouse intakes and spillways, false attraction and harm at downstream tailrace barriers, stranding of fish, restricted passage at Project dams, degradation and loss of instream habitat, degraded water quality related to Project operations, and predation and competition with non-native fishes that thrive in Project impoundments. The bull trout is likely to be adversely affected because provision of fish passage will allow anadromous fish to re-occupy habitats where bull trout currently exist, and adverse interactions between the species, such as predation or competition, may result. While we believe the potential for positive effects to bull trout may be stronger (see bull trout section, below), not all effects to bull trout would be beneficial. The remainder of this BO will address only the effects of the proposed action on LRS, SNS, and bull trout.

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BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

On February 25, 2004, PacifiCorp filed an application under the Federal Power Act (FPA) with the Federal Energy Regulatory Commission (Commission) for a new license for the Klamath Hydroelectric Project, located principally on the Klamath River in Klamath County, Oregon and Siskiyou County, California, between Klamath Falls, Oregon, and Yreka, California (Figure 1). The Project's license expired on March 1, 2006, and the Project is currently operating under an annual license. The Project consists of five mainstem dams (four of which supply powerhouses), two powerhouses at the federal Link River Dam, and one tributary facility (Fall Creek Powerhouse). The dams are small to medium size, ranging from 25 to 173 feet in height, and impound small to medium sized, narrow reservoirs. The segment of the Klamath River between Link River Dam (upstream) and Iron Gate Dam (downstream) consists of about 24 miles of river reaches and about 36 miles of reservoirs, as follows:

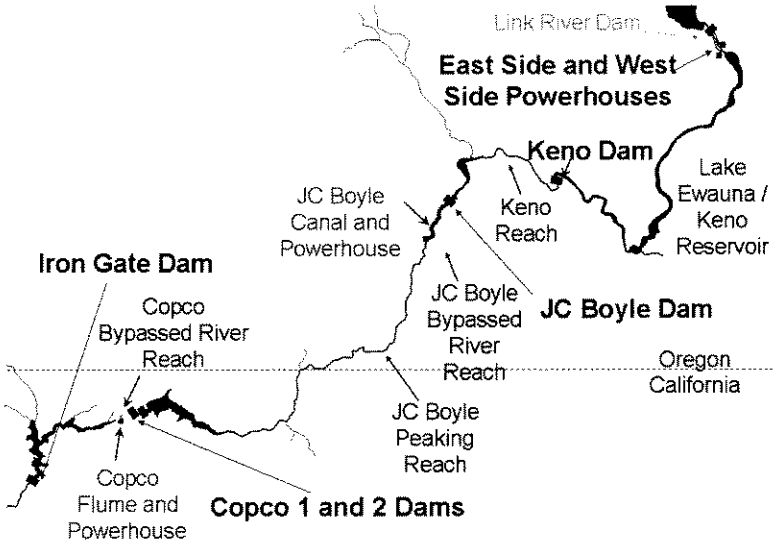

Figure 1. Project location.

- The most upstream structure, the Bureau of Reclamation's (Reclamation) Link River Dam at River Mile (RM) 254.3, is located at the lower end of Upper Klamath Lake (UKL), in Oregon. The Eastside and Westside Powerhouses receive water diverted into canals on each side of the river. The Link River flows into Keno Reservoir. The Keno Reservoir is controlled by Keno Dam.
- Keno Dam is at River Mile (RM) 233.0, approximately 20 miles downstream from Link River Dam. Below Keno Dam, the 4.7-mile long Keno Reach flows into J.C. Boyle Reservoir (also known as Topsy Reservoir), created by the J.C. Boyle Dam.
- J.C. Boyle Dam is at RM 224.7. Here most of the flow is diverted out of the river through a canal around the four-mile J.C. Boyle Bypassed River Reach. The canal extends to the J.C. Boyle Powerhouse at RM 220.4. Below the powerhouse, the 17-mile J.C. Boyle Peaking Reach of the Klamath River receives a daily peaking regime.

- Near RM 209.0, the Klamath River crosses into California, and enters Copco Reservoir near RM 204.0. Copco Reservoir is impounded by Copco 1 Dam at RM 198.7, where flow is diverted into the adjacent Copco 1 Powerhouse. About one-half mile below this powerhouse, Copco 2 Dam diverts almost the entire flow from Copco 2 Reservoir into a penstock around the 1.4-mile Copco Bypassed River Reach to Copco 2 Powerhouse at RM 196.8.
- Below Copco 2 Powerhouse, the Klamath River flows into Iron Gate Reservoir, impounded by Iron Gate Dam at RM 190.0. This is the furthest downstream of the Project facilities. Here the flow passes through the Iron Gate Powerhouse, and then the Klamath River continues for 190 miles to the Pacific Ocean.
- The Fall Creek development is the smallest in terms of generation, the oldest, and the only development not on the mainstem Klamath River. Flow from Spring Creek (in the Jenny Creek watershed) is diverted into Fall Creek in Oregon, and these waters flow through the Fall Creek Powerhouse about one mile above Fall Creek's juncture with the upper end of Iron Gate Reservoir. PacifiCorp proposes to include existing diversion facilities at Spring Creek as part of the Fall Creek development.

PacifiCorp proposes to decommission the Eastside and Westside Powerhouses at Link Dam and to continue operation of Keno Dam, outside of the project boundary and Commission's jurisdiction. Because these developments are part of the existing Project and may remain in the new license, our Section 18 Prescriptions included measures for these facilities. Therefore, we include the operation of these facilities in the Proposed Action because the action, as defined to us by the Commission in the March 21, 2007, request for consultation, included all mandatory conditions. [1]

Following is a list of the environmental measures included in the Proposed Action. The list contains measures listed in the Staff Alternative, PacifiCorp's proposal, and discussed elsewhere in the DEIS. It also includes measures contained within mandatory conditions of the Bureau of Land Management (BLM) and the Reclamation Section 4(e) Conditions, and the Services'[2] Section 18 Fishway Prescriptions.

Water Resources

1P. Implement instream flow and ramping rate measures in Project reaches to protect and/or enhance various flow-dependent resources, including water quality.

2P. Implement a low-level release of cooler hypolimnetic water from Iron Gate Reservoir during summer to provide some cooling of the Klamath River downstream of the Project.

#2P--Modified by Commission staff to include development of a temperature management plan that would include: (1) a feasibility study to assess modifications of existing structures at Iron Gate Dam to enable release of the maximum volume of cool, hypolimnetic water during emergency circumstances; (2) an assessment of methods to increase the dissolved oxygen of waters that may be released on an emergency basis; and (3) development of protocols that

[1] Should the Commission decide to exclude Keno and/or the Eastside and Westside Powerhouses from the Project, such a new proposed action (the terms of which are unknown at this time) will require the reinitiation of consultation to address its effects on listed species.

[2] Services' here refers to both the U. S. Fish and Wildlife Service and the National Marine Fisheries Service.

would be implemented to trigger the release of hypolimnetic water by using existing, unmodified structures at Iron Gate development or, if determined to be feasible, modified structures, when conditions for downstream salmonid survival approach critical levels.

3P. Install a reservoir oxygenation diffuser system at Iron Gate development as needed to prevent adverse downstream effects caused by seasonally low levels of dissolved oxygen in hypolimnetic generation flows.

#3P--Modified by Commission staff to delay implementation of reservoir oxygen diffuser until potential adverse effects are evaluated as part of #4P, but implement turbine venting at Iron Gate development, as described in Mobley (Mobley Engineering 2005), and monitor and evaluate the response of the downstream dissolved oxygen regime.

4P. Implement reservoir management plans for improving water quality in J.C. Boyle, Copco, and Iron Gate Reservoirs that include evaluating the effectiveness and feasibility of hypolimnetic oxygenation, epilimnetic or surface aeration or circulation, and copper algaecide treatment, for controlling water quality conditions.

#4P-- Modified by Commission staff to include development of a single, comprehensive water quality management plan for all Project-affected waters, rather than three separate reservoir management plans, and expanded to include: (1) consideration of spillage of warm water at Iron Gate Dam during late spring; (2) consideration of spillage at Copco No. 1, Copco No. 2, and Iron Gate Dams during the summer to enhance dissolved oxygen released at Iron Gate development; (3) consideration of turbine venting at Copco No. 1 and No. 2 Powerhouses to increase dissolved oxygen in the epilimnion of Iron Gate Reservoir and, potentially, downstream of Iron Gate development; (4) specification of water quality monitoring that would be used to evaluate the effectiveness of any implemented water quality management measures; (5) specification of long-term water quality monitoring programs (e.g., temperature and dissolved oxygen) that would enable adaptive management decisions to occur; and (6) provisions for periodically updating the water quality management plan.

5P. Consult and coordinate with appropriate agencies on the annual scheduled outages for Project maintenance events where flows in Project reaches are required to be outside the normal operations.

Aquatic Resources

6P. Decommission the Eastside and Westside facilities to eliminate entrainment of ESA listed suckers from UKL.

#6P-- Modified by Commission staff to include consultation with National Marine Fisheries Service (NMFS), Department of the Interior (Interior), and Reclamation during development of the decommissioning plan to ensure that PacifiCorp's actions to safely secure the developments and restore the landscape in proximity to both developments would not forestall the future installation of a smolt collection facility at this site.

In the event that Eastside and Westside facilities are not decommissioned, the Service's fishway prescriptions for these facilities would be implemented (see below), and 6P and #6P, above, would be removed.

Measures 7P through 10P are replaced by BLM 4(e) conditions, see below.

11P. Install a synchronized bypass valve on each of the two J.C. Boyle Powerhouse units to ensure ramping rates could be met if a unit trips off-line.

Measures 12P and 13P are replaced by NMFS and the Service's fishway prescription for J.C. Boyle development, see below.

14P. Eliminate the gravity-fed water diversions from Shovel Creek and its tributary, Negro Creek (located adjacent to the Klamath River in the California segment of the J.C. Boyle peaking reach), to prevent trout fry from being entrained and lost in the various ditches on PacifiCorp's Copco Ranch (a non-hydro related property).

Measures 15P and 16P are replaced by BLM 4(e) conditions and Staff measure 7S, respectively, see below.

17P. Limit flow down-ramp rates to 125 cubic feet per second (cfs) per hour (equivalent to less than 2 inches per hour in most of the expected flow ranges) in the Copco No. 2 bypassed reach, except for flow conditions beyond PacifiCorp's control.

18P. Release a minimum flow of 5 cfs into the Fall Creek bypassed reach, and release a minimum flow of 15 cfs downstream of the bypass confluence.

19P. Divert no flow from Spring Creek during July and August, and release 1 cfs, or inflow, downstream of the Spring Creek diversion dam for the remainder of the year; install a Parshall flume to measure the minimum flow.

#19P-- Modified by Commission staff so that the period during which no flow would be diverted from Spring Creek would extend from June 1 to September 15.

20P. Install canal screens and fish ladders for both the Fall Creek and Spring Creek diversions (consistent with NMFS and Service Section 18 fishway prescription).

21P. Maintain the instream flow schedule and ramp rates downstream of Iron Gate Dam according to Reclamation's Klamath Project Operations Plans consistent with BOs issued by the Service and NMFS.

Measure 22P is replaced by Staff measure 1S, see below.

23P. Maintain current obligation of funding for operation and maintenance of the Iron Gate Hatchery.

#23P-- Modified by Commission staff to increase the level of Iron Gate Hatchery funding from 80 percent to 100 percent.

24P. Purchase, construct, and operate a mass-marking facility at the Iron Gate Hatchery that provides for marking 25 percent of all Chinook salmon released.

#24P-- Modified by Commission staff to provide for marking 100 percent of Chinook and coho salmon released from Iron Gate Hatchery.

Terrestrial Resources

25P. Implement a vegetation resource management plan to include the following environmental measures: (1) Project facility (including roads and transmission line right-of-way) vegetation management activities; (2) noxious weed control; (3) restoration of Project-disturbed sites; (4) protection of threatened, endangered, and sensitive plant populations; (5) riparian habitat restoration; and (6) long term monitoring.

#25P-- PacifiCorp's proposed measure for a vegetation management plan is expanded by Commission staff to include consultation with affected tribes regarding opportunities for re-establishment of plants of tribal significance in Project-affected areas, and include in the upland vegetation management program measures to reduce fire fuels, such as controlled fires, to reduce the risk of wildfires and enhance wildlife habitat.

26P. Implement a wildlife resource management plan to include the following environmental measures: (1) installation of wildlife crossing structures on the J.C. Boyle Canal; (2) deer winter range management; (3) monitoring power lines and retrofitting poles to decrease electrocution risk to raptors; (4) development of amphibian breeding habitat along Iron Gate Reservoir; (5) support aerial bald eagle surveys and protection of bald eagle and osprey habitat; (6) selective road closures; (7) installation of turtle basking structures; (8) installation of bat roosting structures; (9) surveys for threatened, endangered, and sensitive wildlife species in areas to be affected by new recreation development; and (10) long-term monitoring of environmental measures.

#26P-- This measure is modified by Commission staff to address deer winter range management in the vegetation management plan, rather than the wildlife resource management plan, because it would entail primarily vegetation management measures.

The DEIS states that PacifiCorp will conduct surveys for threatened, endangered, and sensitive species prior to any ground-disturbing activities (page 3-385, lines 20-22).

The DEIS states that PacifiCorp would conduct rare plant surveys prior to ground-disturbing activities (page 3-382, lines 1-2) and that if any populations of threatened, endangered, or sensitive plants are found, they would be monitored and protected from adverse effects (page 3-381, lines 44-46).

Additional Measures Identified by Commission Staff

Geology and Soils

1S. Develop and implement a sediment and gravel resource management plan that includes mapping and evaluating gravel distribution in Project reaches and the Klamath River from Iron Gate Dam to the confluence of the Shasta River; determining specific amounts and locations for gravel augmentation based on the mapping; monitoring gravel and spawning use after placement; and supplementing gravel placement based on monitoring results. **This measure does not apply to the BLM reaches where BLM Section 4(e) condition 4D, as described below, applies.**

2S. Develop and implement a plan to restore slope failures and the affected channel, including the slope below the emergency spillway and removal of sidecast material, along the J.C. Boyle Bypassed Reach. Retain the right bank slope that is within the existing Project boundary in the Project boundary of a new license to ensure Commission oversight of restoration and protection measures and to ensure continued stability of the intake canal and Project access road.

3S. Develop protocols for contacting agencies that would be followed in the event of a water conveyance system failure. In addition, promptly notify resource agencies in the event of all unanticipated or emergency Project-related situations that may result in harm to fish or wildlife to obtain guidance on appropriate remedial measures that should be implemented. Develop thresholds of harm that would trigger such notification in consultation with the resource agencies, and provide the thresholds to the Commission. Provide reports to the Commission following each event that triggers agency notification, indicating the nature of the event, the actions taken in response to the event, and any follow-up monitoring to ensure that the response is effective.

4S. If a proposed Project-related activity entails ground-disturbing activities, develop a site-specific erosion and sedimentation control plan to address erosion and dust control and measures that would be taken to restore such areas following the activity. If the activity would generate spoils, include measures to (1) characterize the spoils; (2) identify where the spoil would be disposed in an environmentally responsible manner; and (3) restore, stabilize, and monitor the spoil disposal site following its use. As appropriate, include this plan in the broader plan for the activity (e.g., the final plan for development of a specific recreational site, or in annual road maintenance plans developed pursuant to a road management plan).

Water Quantity and Quality

5S. Develop and implement a Project operations management plan that includes provisions for installing gages to appropriately monitor the flow regime specified in a new license, coordinating operation of the Klamath Hydroelectric Project with the Klamath Irrigation Project, reporting Project-related flows to appropriate entities, minimizing water level fluctuations at Iron Gate Reservoir from March through July to protect breeding wildlife, and periodically updating the plan.

6S. Develop and implement a monitoring plan for *Microcystis aeruginosa* and its toxin in Project reservoirs and immediately downstream of Iron Gate Dam.

7S. Release 70 cfs or inflow, whichever is less, to the Copco No. 2 Bypassed Reach.

Aquatic Resources

Measures 8S through 11S would be replaced by NMFS and Interior's fishway prescriptions.

12S. Develop a fish passage resource management plan in consultation with resource agencies that includes designs for any fishways included in a new license, provisions for developing fishway operation and maintenance plans, provisions for evaluating and monitoring fish passage at the fishways, and provisions for modifying the fishways in response to evaluation and monitoring.

13S. Allow state and federal resource agency personnel access to Project developments to inspect fishways and records to monitor compliance with license conditions.

14S. Develop and implement a decommissioning plan for Eastside and Westside developments, that includes addressing public safety at the sites following decommissioning. In this consultation, the Service has not analyzed this measure and has instead analyzed the applicable mandatory conditions. This measure does not apply because we are assuming these developments would not be decommissioned.

15S. Rehabilitate the Fall Creek rearing ponds, and fund 100 percent of the operation and maintenance costs to facilitate a shift to production of yearling fall Chinook salmon.

16S. Sponsor a fishery technical advisory committee that would provide input to guide Project-related fish passage, hatchery, and anadromous fish restoration activities.

17S. Develop and implement a cooperative fish disease risk monitoring and management plan to control disease risk in the Klamath River, including measures to reduce infection rates between Iron Gate Dam and the Shasta River.

18S. Develop and implement an aquatic resources monitoring and management plan that includes provisions for recommending Project operations and facility modifications in response to monitoring results.

The DEIS, page 5-55, states that, in the event the Commission should include the Keno development in a new license, the following environmental measures would likely be included in the license:

> Operate the Keno development in a run-of-river mode, with hourly outflows to be held within 10 percent of a 3-day running average of inflows. Maintain a minimum Keno Reservoir water surface elevation of 4,085.0 feet from May 1 through October 15 (the irrigation season). Specify in the Project operations management plan (#5S), provisions for refilling Keno Reservoir when it is drawn down that ensure maintenance of Keno reach flows.
>
> Evaluate the Keno Dam spillway for fish passage survival, and, if appropriate, modify the spillway to accommodate safe downstream passage of smolts and suckers.
>
> Address enhancements at the Keno Recreational Area in the final Recreation Resources Management Plan.

DEIS page 5-62 states that PacifiCorp would develop a Keno Reservoir water quality plan within 1 or 2 years of license issuance and implement appropriate measures to address water quality problems, if Keno is included in the project license.

Terrestrial and Threatened and Endangered Resources

19S. Within 2 years of license issuance develop a bald eagle management plan for the Project in consultation with Service, the BLM, California Department of Fish and Game (CDFG), and Oregon Department of Fish and Wildlife (ODFW) that includes provisions for (1) conducting annual aerial bald eagle surveys to document new nests and productivity of territories; (2) monitoring and protecting bald eagle nest sites, roost sites, and regular foraging areas from human disturbance within the Project boundary, including seasonal restrictions for active nest sites; and (3) evaluating changes in prey base relationships. The bald eagle management plan should be prepared in coordination with the wildlife habitat management plan, which includes provisions for monitoring transmission lines and retrofitting poles on lines where birds have died to improve avian protection.

U.S. Fish and Wildlife Service Modified Fishway Prescriptions

The Service's Modified Fishway Prescriptions are summarized in Table 1. For a complete description, see U.S. Department of the Interior 2007, which is hereby incorporated by reference.

Table 1. Summary of U.S. Fish and Wildlife Modified Fishway Prescriptions and Timetable for the Klamath Hydroelectric Project (Commission Project #2082)

Development	**Target Species**	**Fish Ladder and Passage Impediment Modification (in Chronological Order)**	**Tailrace Barrier[1]**	**Screens and Bypass**	**Spillway Modifica -tions[1]**	**Interim, Seasonal Trap and Haul**
Copco 2 Bedrock Sill	Salmonids (includes resident trout), lamprey	2 yrs (Bypass Barrier/Impediment Elimination)	Not Applicable (NA)	NA	NA	NA
J.C. Boyle (Bypass)	Salmonids, lamprey	2 yrs (Bypass Barrier/Impediment Elimination)	NA	NA	NA	NA
Eastside Powerhouse	Salmonids, lamprey, suckers	Reclamation current facility	3 yrs[2]	3 yrs[3] (to sucker criteria)	NA	Seasonal downstream trapping and hauling for Chinook
Westside Powerhouse	Salmonids, lamprey, suckers	Reclamation current facility	3 yrs[2]	3 yrs[3] (to sucker criteria)	NA	Seasonal downstream trapping and hauling for Chinook
Fall Creek	Resident trout	3 yrs (0.5 ft/drop and ≤ 10% slope)	5 yrs[4]	3 yrs	NA	NA
Spring Creek	Resident trout	3 yrs (0.5 ft/drop and ≤ 10% slope)	NA	3 yrs	NA	NA
Keno Dam	Salmonids, lamprey	3 yrs (0.5 ft/drop and ≤ 10% slope)	NA	NA	3 yrs	Seasonal upstream trapping and hauling for Chinook
J.C. Boyle Dam	Salmonids, lamprey	4 yrs (0.5 ft/drop and ≤ 10% slope)	4 yrs	4 yrs	4 yrs	NA
Iron Gate Dam	Salmonids, lamprey	5 yrs (0.5 ft/drop and ≤ 10% slope)	NA	5 yrs	5 yrs	Modify existing trapping facility
Copco 2 Dam	Salmonids, lamprey	6 yrs (0.5 ft/drop and ≤ 10% slope)	8 yrs[4]	6 yrs	6 yrs	NA
Copco 1 Dam	Salmonids, lamprey	6 yrs (0.5 ft/drop and ≤ 10% slope)	8 yrs[4] (if adults in C2 pool)	6 yrs	6 yrs	NA

[1] In accordance with a stipulation with the Applicant, the U.S. Fish and Wildlife Service and National Marine Fisheries Service have revised the prescriptions for spillway modifications and tailrace barriers in the Modified Prescriptions to allow the Applicant to conduct site-specific studies on the need for and design of spillway modifications

[2] Study of impacts to and the potential design and construction of tailrace barrier is given priority due to the presence of federally listed suckers

[3] Screen and bypass system given priority due to the presence of federally listed suckers

[4] Timing of Tailrace Barrier design and construction deferred for study to determine optimal design

Reclamation = Bureau of Reclamation, NA = not applicable, yrs = years.

Bureau Land Management Modified 4(e) Conditions

The BLM Modified 4(e) Conditions for this Project that pertain to natural resources are listed below. For a complete description of these conditions, see U.S. Department of the Interior 2007 (U.S. Department of the Interior 2007).

BLM Modified Condition 4: River Corridor Management

A. J.C. Boyle Bypassed River Reach

1. Required Minimum Streamflows – The Licensee shall, within one year after license issuance, operate J.C. Boyle Development to accomplish the following:

(a) Proportional flow requirement: Provide no less than 40 percent of the inflow to J.C. Boyle Reservoir to the J.C. Boyle Bypassed River Reach, to be measured at a new gage below the J.C. Boyle Dam near RM 225. Inflow to J.C. Boyle Reservoir shall be calculated by averaging the previous three days of the combined daily flows as measured at the Keno gage #11509500 and Spencer Creek gage #11510000 (Calculated Inflow).

(b) Minimum base flow requirement: When Calculated Inflow is less than 1,175 cfs, no less than 470 cfs shall be provided to the J.C. Boyle Bypassed River Reach, except that when the Calculated Inflow is less than 470 cfs, then flow shall be provided to the J.C. Boyle Bypassed River Reach in an amount equal to the Calculated Inflow.

(c) Seasonal high flow requirement: When Calculated Inflow to J.C. Boyle Reservoir exceeds 3,300 cfs during the period between February 1st and April 15th, diversion to the J.C. Boyle Power Canal shall be suspended at least once and continued for a minimum of 7 days.

2. Ramping During Controlled Events – The Licensee shall, within one year after license issuance, operate J.C. Boyle Development to not exceed an up-ramp rate or down-ramp rate of two inches per hour as measured at the new gage below J.C. Boyle Dam when conducting controlled flow events (e.g., scheduled maintenance and changes in minimum flow requirements), except when implementing the seasonal high flow or when turbine capacity is exceeded. The Licensee, in consultation with the BLM, shall develop and implement an appropriate ramp rate to follow after the seasonal high flow to prevent stranding fish in the J.C. Boyle Bypassed Reach.

B. J.C. Boyle Peaking Reach

1. Streamflow Requirements – The Licensee shall, within one year after license issuance, operate the J.C. Boyle Development from May 1st to October 31st to provide a minimum streamflow of 1,500 cfs a maximum of once a week, such that these flows occur at the Spring Island Boat Launch between 0900 and 1400 hours from Friday through Sunday, in the priority of Saturday, Sunday, and then Friday.
2. Ramping During Controlled Events – The Licensee shall, within one year after license issuance, operate the J.C. Boyle development to not exceed an up-ramp rate or down-ramp rate of two inches per hour when conducting controlled flow events (e.g. scheduled maintenance, power generation, changes in streamflow requirements), except during implementation of the seasonal high flow, as measured at the J.C. Boyle Powerhouse gage (USGS) #11510700.
3. Flow Continuation Measure – The Licensee shall, within one year of license issuance, implement a flow continuation measure at the J.C. Boyle Canal and Powerhouse to

provide a minimum of 48 hours of continuous flow under powerhouse shutdown conditions.

C. Streamflow Measurement and Reporting: J.C. Boyle Bypassed River and Peaking Reaches

1. Instream Flow Measurement – The Licensee shall, within one year after license issuance:
   (a) Continuously measure the stage of water at three existing gage sites. Existing gage stations shall include the Klamath River below Keno Dam (#11509500), Spencer Creek above the confluence with the J.C. Boyle Reservoir (#11510000), and Klamath River below the J.C. Boyle Powerhouse (#11510700). The Licensee shall operate and maintain the gages at these sites if the gages are no longer operated or maintained by the current operators.
   (b) The Licensee shall establish and operate one additional gage on the Klamath River J.C. Boyle Bypassed River Reach below all outlets from the J.C. Boyle Dam and above the springs near RM 225, using the most current USGS protocol for gage station installation, maintenance, and data collection.

2. Instream Flow Reporting - The Licensee shall, within one year after license issuance:
   (a) Provide instantaneous 30-minute real time streamflow data in cfs via remote access that is readily available and accessible to the public.
   (b) Design and maintain a database, similar to the most current version of the USGS National Water Information System (NWIS) for reporting on surface water. The database shall store gage network data and streamflow tracking procedures. BLM shall review and approve the database.
3. The Licensee shall, within two years after license issuance, submit a report for each water year (i.e., October 1 through September 30) of streamflow data reported in cfs to the BLM. The report shall be filed with the BLM within six months of the end of each water year.

D. Sediment Management Plan

Within one year of license issuance, the Licensee shall develop, in consultation with and approval of the BLM, a Sediment Management Plan (SMP) and file the SMP with the Commission for approval. The Licensee shall prepare a draft SMP after consultation with the BLM and other stakeholders that are willing to participate, including, but not limited to Service, Reclamation, NMFS, USGS, Oregon Department of Environmental Quality (ODEQ) /Environmental Protection Agency, ODFW, CDFG, North Coast Regional Water Quality Control Board, Oregon Department of State Lands, and affected Tribes. The Licensee shall allow a minimum of 60 days for the BLM and other stakeholders to comment and make recommendations on the draft SMP before finalizing the plan and filing it with the Commission. The Licensee shall include with the SMP documentation of consultation, copies of comments and recommendations, and a description of how the comments and recommendations are accommodated by the SMP. If the Licensee does not adopt a recommendation, the filing shall include the Licensee's reasons, based on Project-specific information. At the time it files the SMP with the Commission, the Licensee shall serve a copy of the filed documents upon the BLM. The SMP shall be designed to meet the following objectives:

-increase channel complexity;
-increase spawning habitat for resident and anadromous fish

The SMP, at a minimum, shall adhere to the following 1. Overall strategy; 2. Goals; 3. Elements, 4. Performance measures, and 5. Reporting requirements:

1. Overall Strategy – increase sediment storage in the J.C. Boyle Bypassed River Reach (gravel/cobble sized material in boulder/bedrock pockets, gravel/cobble sized material on bars and in pools, and sand/gravel sized material on bar tops and along channel margins); improve coarse sediment transport (distribute introduced and existing accumulations downstream); and restore a balance between sediment supply and transport using high flows and sediment introduction.

2. Goals – improvement of physical habitat attributes corresponding to sediment storage in the reach. Broadly, the goals to be achieved include (a) increasing fish spawning habitat; (b) increasing stream channel complexity; and (c) improving riparian habitat quality.

3. Elements – The above goals may be achieved by meeting all of the following:

(a.) In one large introduction effort establish bed-stored sediment to its potential in the J.C. Boyle Bypassed River Reach. Determine capacity for gravel and cobble sediment to be trapped in boulder pockets and pools, and capacity for sand and gravel trapped on bar surfaces and along the channel margins. An estimate of the large introduction quantity for gravel/cobble in spawning pockets and pools is 1 foot of gravel depth in pockets likely to trap coarse sediment, which cover approximately one third of the low flow channel. Similar estimates for bar top and channel margin trapping of sands and gravels to meet riparian goals need to be developed. If restoring seasonal high flows mobilizes and distributes the sediment accumulated at the J.C. Boyle emergency spillway deposit sufficiently to meet the capacity of the bypassed river reach downstream from that deposit, then the sediment introduction criteria can be reduced by a corresponding quantity to attain the potential for the bypassed river reach upstream from the emergency spillway.

(b.) Establish a sediment transport model to initially estimate sediment exports, per grain size, from the reach in order to estimate and plan for implementation of subsequent sediment infusion quantities and qualities. Annually refine the model with annual flood season bed material and suspended sediment transport measurements.

(c.) Establish a SMP, using standardized techniques, that adaptively manages the program over time and evaluates whether the sediment augmentation program is effective. Effectiveness shall be determined based on the Performance Measures (See part 4 below). The monitoring results shall be reported to sufficiently inform annual adaptive management decisions for sediment infusion quantities and qualities after the initial large sediment input. Monitoring results may also be used to adapt additional aspects of the augmentation, including, but not limited to, timing, location, augmentation methods, and particle size composition.

(d.) Maintain sediment continuity per grain size in the J.C. Boyle Bypassed River Reach through adaptive infusions of sediment quantities sized to replace sediment exported from the reach.

(e.) Develop spawning habitat suitability criteria for the J.C. Boyle Bypassed River Reach for steelhead, coho, Chinook, and resident trout by modeling the quantity and quality of salmonid spawning habitat for a flow of 470 cfs plus accretion flows. Establish a periodic monitoring program to validate model estimates of spawning habitat quantity and quality.

(f.) Annually monitor and identify locations of salmonid spawning activity in the bypass reach for each salmonid species or stock.

4. Performance Measures – The following shall be considered for inclusion in the SMP:

(a.) Achieve the determined capacity for gravel and cobble sediment to be trapped in boulder pockets and pools within three years of SMP approval.

(b.) Achieve the determined capacity for sand and gravel trapped on bar surfaces and along the channel margins within three years of SMP approval.

(c.) Maintain sediment continuity and a balanced sediment budget, such that gravel/cobble spawning patches and sand/gravel riparian bar surfaces remain within an average of +/- 10 percent of the estimated sediment trap capacity.

5. Reporting –

(a.) The Licensee shall submit to the BLM and the Commission an annual report on the activities of the SMP implementation during the previous year. The report shall include a description of the quantities, sizes, composition, timing, method(s), and location of sediment added and any monitoring data. The report shall integrate data from year to year, such that an analysis of trends is included.

(b.) At least every five years, the Licensee shall consult with the BLM to review and update or revise the SMP as appropriate. Upon Commission approval, the Licensee shall implement the revised SMP.

E. Adaptive Management Plan

Within one year of license issuance, the Licensee shall develop, in consultation with the BLM, an Adaptive Management Plan (AMP) and file the AMP with the Commission for approval. The Licensee shall prepare a draft AMP after consultation with the BLM. The Licensee shall allow a minimum of 60 days for the BLM to comment and make recommendations on the draft AMP before finalizing the plan and filing it with the Commission. The Licensee shall include with the AMP documentation of consultation, copies of comments and recommendations and a description of how the comments and recommendations are accommodated by the AMP. If the Licensee does not adopt a recommendation, the filing shall include the Licensee's reasons, based on Project-specific information. At the time it files the AMP with the Commission, the Licensee shall serve a copy of the filed documents upon the BLM. At a minimum, the AMP shall address all BLM-administered lands that are affected by the Project in the J.C. Boyle Bypassed River and Peaking Reaches. After Commission approval, the Licensee shall implement the AMP.

The AMP, at a minimum, shall:

1. Be 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, with emphasis on spawning habitat.
2. Be designed to monitor how implementation of the River Corridor Management Condition is effective in increasing channel complexity and riparian habitat quality.
3. Be designed to monitor how implementation of the River Corridor Management Condition affects flows for recreational boating.
4. Be designed to monitor how implementation of the River Corridor Management Condition is affecting fish migration, spawning, and rearing conditions for salmonids.
5. Contain annual reporting requirements of the Licensee for monitoring results, data collection, and an evaluation of these results for all monitoring efforts in the river corridor.

BLM Modified Condition 7: Vegetation Resources Management Plan

Within one years of license issuance, the Licensee shall develop, in consultation with the BLM, a Vegetation Resources Management Plan (VMP) and file the VMP with the Commission for approval. The Licensee shall prepare a draft VMP after consultation with the BLM. The Licensee shall allow a minimum of 60 days for the BLM to comment and make recommendations on the draft VMP before finalizing the plan and filing it with the Commission. The Licensee shall include with the VMP documentation of consultation, copies of comments and recommendations, and a description of how the comments and recommendations are accommodated by the VMP. If the Licensee does not adopt a recommendation, the filing shall include the Licensee's reasons, based on Project-specific information. At the time it files the VMP with the Commission, the Licensee shall serve a copy of the filed documents upon the BLM. At a minimum, the VMP shall address all BLM-administered lands that are affected by the Project, including those affected by Project-related recreation. After Commission approval, the Licensee shall implement the VMP.

The VMP, at a minimum, shall include:

1. Provisions to re-survey lands affected by the Project, including, at a minimum, BLM-administered lands affected by Project-related activities, according to accepted protocols to determine or verify the distribution of threatened, endangered and sensitive (TES) species.
2. Provisions for establishing a weed management area (WMA) that includes the Project area and interested stakeholders.
3. Provisions for surveying, documenting, managing, and monitoring noxious weed and invasive plant species; including periodic review of federal, state, and local noxious weed lists in the Project area.
4. Provisions for surveying, documenting, monitoring and protecting TES plants, including periodic review of BLM sensitive species, Oregon Natural Heritage Information Center (ORNHIC), California Natural Diversity Database, and California Native Plant Society records.
5. Proposed vegetation management activities for, at a minimum, the J.C. Boyle Powerhouse and Canal, maintenance of transmission line and road rights-of-way (ROW), and use of Project-related roads on or affecting BLM-administered lands.

6. Proposed remediation measures and subsequent monitoring program for the eroded area below the J.C. Boyle emergency spillway.
7. A geospatial map (e.g., Graphic Information System 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.
8. Proposed treatments, mitigations, and best management practices for managing weeds on BLM-administered lands that are impacted by Project-related activities.
9. Descriptions as to how the Plan is consistent with BLM guidance for integrated pest management.
10. Principles of integrated pest management that include prevention and detection, application of integrated control methods, education, coordination, native plant community restoration, monitoring, and evaluation. Integrated control methods may include cultural, physical, biological, and chemical control techniques.
11. Provisions for annual review and periodic modifications or revisions of the VMP.

BLM Modified Condition 8: Wildlife Habitat Management Plan

Within two years of license issuance, the Licensee shall develop, in consultation with the BLM, a Wildlife Habitat Management Plan (WHMP) and file the WHMP with the Commission for approval. The Licensee shall prepare a draft WHMP after consultation with the BLM. The Licensee shall allow a minimum of 60 days for the BLM to comment and make recommendations on the draft WHMP before finalizing the plan and filing it with the Commission. The Licensee shall include with the WHMP documentation of consultation, copies of comments and recommendations and a description of how the comments and recommendations are accommodated by the WHMP. If the Licensee does not adopt a recommendation, the filing shall include the Licensee's reasons, based on Project-specific information. At the time it files the WHMP with the Commission, the Licensee shall serve a copy of the filed documents upon the BLM. At a minimum, the WHMP shall address all BLM-administered lands that are affected by the Project, including those affected by Project-related recreation. After Commission approval, the Licensee shall implement the WHMP.

The WHMP, at a minimum, shall include:

1. Measures with use monitoring for wildlife crossings and escape ramps for the J.C. Boyle Canal.
2. Measures with use monitoring for western pond turtle habitat improvement.
3. TES species and Special Status (SS) species survey and monitoring, including survey protocols for long-term survey and monitoring of TES and SS species and their habitat for BLM-administered lands affected by Project-related activities to assess impacts and develop necessary mitigations. This information shall supplement the previous study completed by PacifiCorp (PacifiCorp 2004a) - Threatened, Endangered, Sensitive and Special Status Species Assessment.
4. Restoration, protection, and/or enhancement measures for wildlife and/or wildlife habitat affected by Project-related activities.

5. Seasonal restrictions for active nest sites on BLM-administered lands for bald eagles, golden eagles, ospreys, peregrine falcons, and other raptors affected by Project-related activities.
6. An Avian Protection Plan (APP) for the Upper Klamath River. This plan shall address avian interaction (electrocution, collision, nesting, perching) with all transmission facilities and follow guidelines in the Avian Protection Plan Guidelines (Avian Power Line Interaction Committee and USDI Fish and Wildlife Service 2005), "Suggested Practices for Raptor Protection on Power Lines: The State of the Art in 1996" (Avian Power Line Interaction Committee (APLIC) 1996) and/or the most current publication for avian protection at the time.
7. Provisions for annual review and periodic modifications or revisions of the WHMP.

Reclamation Modified Conditions

Following is a summary of Reclamation's modified seven 4(e) conditions. Please see previous filing by Interior on March 27, 2006, and January 24, 2007, for specific details associated with each condition.

Condition 1: The Licensee shall enter into a new or amended contract with Reclamation for the operation and maintenance of Link River and Keno Dams under terms and conditions satisfactory to the Secretary of the Interior as follows: (1) ensure continued operation and maintenance consistent with annual operating plans, (2) ensure cost of service power rates for agricultural users, (3) maintain the "A" Canal approach channel, (4) assume liability for damages due to Link River operations, (5) not limit the rights of the United States to Klamath Water or lands surrounding UKL, and (6) operate Keno Dam ensuring continued operations consistent with irrigation and endangered species requirements.

Condition 2: Develop operating criteria, in consultation with Reclamation, to allow Reclamation to meet its responsibilities.

Condition 3: Develop operating criteria that provides for coordination with the operations of Keno Dam and Iron Gate Dam, or the most downstream dam within Project No. 2082.

Condition 4: Provide Reclamation with area capacity curves and real-time access to reservoir elevations and releases for facilities within Project No. 2082.

Condition 5: Cause no affect to the Federal Klamath Reclamation Project unless approved by Reclamation.

Condition 6: Make no claim against the United States arising from the effect of any changes in releases from, operations of, or elevation changes in and facility above Keno Dam or use of water for the Upper Klamath, Lower Klamath, or Tule Lake National Wildlife Refuges.

Condition 7: Reserves the Commission authority to require the Licensee to implement such conditions for the protection and utilization of Reclamation reservations. This general

reservation of authority allows the Secretary of the Interior to consider additional data as it becomes available; to respond to changed circumstances, and modify the existing section 4(e) conditions as may be necessary. The Secretary's reservation of mandatory authorities under the FPA has been accepted by the Commission and judicially affirmed. *Wisconsin Public Services Corp.*, 62 FERC ¶ 61,905 (1993), *aff'd*, *Wisconsin Public Serv. Corp. v. FERC*, 32 F.3d 1165 (7th Cir. 1994).

Implementation Schedule

The proposed action is to issue a new license for the Klamath Hydroelectric Project for a term of 30 to 50 years. The relicensing decision is expected to occur in late 2007 or 2008. After relicensing, construction of fishways will begin according to the schedule outlined in the Description of the Proposed Action section, above, and will be completed 6 years later. Throughout the term of the license, it is expected that endangered or threatened species will continue to be protected as described in this BO, and that as new species are determined to be endangered or threatened that exist within the action area or new impacts are indicated, consultation must be reinitiated to ensure that these species would not be jeopardized by the continuing effects of the action and that the effects of incidental take would be minimized.

Action Area

The action area is defined at 50 CFR 402.02 to mean "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action." The appropriate scale to analyze effects is Project specific and depends on numerous factors including the proposed action. For the purpose of this consultation, the Service defines the Action Area to include the Project area (its complete unit of improvement and development, including all Project works) and the adjacent area where the Project's effects extend, including UKL and the Klamath River extending downstream to Iron Gate Dam, the areas approximately 0.25 miles up slope from the Klamath River, all areas where disturbance will be created by the construction of new facilities (e.g., fishways), and all tributaries that may be indirectly affected by new fishways becoming operational at Project facilities, including those upstream of UKL.

LOST RIVER AND SHORTNOSE SUCKERS

Status of the Species/Critical Habitat

Taxonomy

The Lost River sucker (LRS) was first described by Cope in 1879 as *Chasmistes luxatus*, based on specimens collected in UKL. Shortly afterward, Eigenmann (Eigenmann 1891) described *Catostomus rex,* from the Lost River and Tule Lake, in south-central Oregon and northern California. *C. rex* has been regarded as a synonym of *D. luxatus*. Seale (1896) (as cited in 53 FR 27130) created the monotypic genus *Deltistes* for *C. luxatus* based on its unique gill raker morphology. Other authors have placed LRS either in the genus *Deltistes* or *Catostomus*, but currently *Deltistes* is the generic name most widely used by fish taxonomists, and it is the name

accepted by the American Fisheries Society and the Service (Andreasen 1975; Miller and Smith 1981); 53 FR 27130.

The shortnose sucker (SNS) was described by Cope in 1879 as *Chasmistes brevirostris*, based on specimens collected from UKL. Gilbert (Gilbert 1898) recognized two species of *Chasmistes* in UKL which were "so similar in all their characters that it is difficult to decide to which one the name *brevirostris* properly belongs." One with "a smaller, more nearly horizontal mouth" he referred to *C. brevirostris,* while he describes the new species *C. stomias,* which had "a larger, deeper head, with larger, more obliquely placed mouth." Further, Gilbert (Gilbert 1898) recognized two species within the small-headed form: one with "lips thin, the lower interrupted at symphysis (lower lip gap present), which he called *C. brevirostris* Cope; and the other with the lower lip deeply incised, with one or two papillae between symphysis and base of cleft." The two smaller-headed forms still exist as fish we call *C. brevirostris* and *Catostomus snyderi.* Fowler (Fowler 1913) suggested that *C. brevirostris* should be transferred to the genus *Lipomyzon,* but this was not adopted by later workers. Two additional nominal taxa, *C. stomias* and *C. copei* were synonomized with *C. brevirostris* by Miller and Smith (Miller and Smith 1981). Markle et al. (Markle et al. 2005) believe that *C. brevirostris* is the appropriate name to apply to the lake-dwelling form, especially in UKL; the large-headed, thin-lipped, oblique-mouthed form is much rarer in current collections.

Physical Description

Lost River suckers are large fish (up to 1 meter long and 4.5 kg in weight) that are distinguished by their elongate body and sub-terminal mouth with a deeply notched lower lip. They have dark brown to black backs and brassy sides that fade to yellow or white on the belly. They are native to the Lost River and upper Klamath River systems where they have adapted to lake living (Moyle 2002).

Shortnose suckers are distinguished by their large heads with oblique, terminal mouths with thin but fleshy lips. The lower lips are deeply notched. They are dark on their back and sides and silvery or white on the belly. They can grow to about 50 cm, but growth is variable among individuals (Moyle 2002). Shortnose suckers have been recorded to live as long as 33 years (Moyle 2002).

Listing History

The LRS and SNS were federally-listed by the Service as endangered on July 18, 1988 (53 FR 27130). A recovery plan was completed in 1993 (USDI Fish and Wildlife Service 1993). Critical habitat was proposed in 1994 (59 FR 61744), but not finalized. Several petitions seeking the delisting of LRS and SNS have been submitted to the Service. On May 14, 2002, the Service published a finding under section 4(b)(3)(A) of the ESA that the petitions did not present substantial scientific or commercial information indicating that delisting was warranted. (67 FR 34422). On remand, the Service published a revised "90-day finding" on July 21, 2004, again concluding that delisting was not warranted (69 FR 43554). In this notice, and as provided in section 4(c)(2) of the ESA, the Service initiated a "five-year review" of the status of the species, seeking information from the public about the status of the LRS and SNS. As part of this 5-year review process, the Service convened a panel of scientists in 2005 that was familiar with the

suckers to provide input on the biology of and the threats to the fish. In October 2005, a status recommendation was developed by a panel of Service scientists and resource managers. The Service completed comprehensive reviews of the two listed fish on July 19, 2007 (USDI Fish and Wildlife Service 2007b, c). The reviews recommended that the fish should remain protected by the ESA by maintaining the SNS status as endangered and by reclassifying the LRS as threatened. The Service has not initiated action on this recommendation regarding the reclassification of LRS.

The two species are also on the protected species lists of California and Oregon (California Department of Fish and Game 2004; Oregon Department of Fish and Wildlife 2004). In California, the LRS and SNS were state-listed in 1974 (California Department of Fish and Game 2004). LRS and SNS are considered fully protected fish and thus, under California law, may not be taken or possessed at any time [California Fish and Game Code Section 5515(b)(4) and (b)(6)].

Life History

All four native sucker species of the Klamath basin are endemic (LRS, SNS, Klamath largescale sucker (KLS), Klamath smallscale sucker (KSS)). The endangered LRS and SNS are part of a group of suckers that are large, long-lived, late-maturing, and live in lakes and reservoirs but spawn primarily in streams; collectively, they are commonly referred to as lake suckers (National Research Council 2004). The lake suckers differ from most other suckers in having terminal or sub-terminal mouths that open more forward than down, an apparent adaptation for feeding on zooplankton rather than suctioning food from the substrate (Scoppettone and Vinyard 1991). Zooplanktivory can also be linked to the affinity of these suckers for lakes, which typically have greater abundance of zooplankton than do flowing waters.

LRS and SNS grow rapidly in their first five to six years, reaching sexual maturity sometime between years four and six for SNS and four and nine for LRS Perkins et al 2000 (Perkins et al. 2000b). LRS and SNS have been aged to 43 and 33 years, respectively. Females produce a large number of eggs, 44,000-236,000 for LRS and 18,000-72,000 for SNS, per year when they spawn. Some females spawn every year, while others spawn every 2 or 3 years. Larger, older females produce substantially more eggs and, therefore, can contribute relatively more to recruitment than a recently matured female. However, only a small percentage of the eggs survive to become larvae.

The majority of LRS and SNS spawn from March to early-May for LRS and early-April to mid-May for SNS in tributaries to UKL. River spawning habitat is riffles or runs with gravel and cobble substrate, moderate flows, and depths of less than 1.3 m (Buettner and Scoppettone 1990). The most common spawning alignment observed by Buettner and Scoppettone (Buettner and Scoppettone 1990) was one female flanked by two males, but up to seven males were observed spawning with one female. Males tended to remain on or immediately adjacent to the spawning area and would spawn with other active females. Occasionally more than one female would spawn in a group. No aggressive behavior was observed among fish. Females broadcast their eggs and they were buried within the top several centimeters of the substrate. Some LRS have been noted to spawn in UKL, particularly at springs occurring along the shorelines. Spawning site fidelity has been documented suggesting two discrete spawning stocks of LRS

(i.e., those using UKL springs and Williamson/Sprague Rivers). LRS and SNS do not die after spawning and can spawn many times during their lifetime. Individual males and females of both species commonly spawned in consecutive years.

Millions of sucker larvae are produced each year primarily in the Williamson and Sprague Rivers (Klamath Tribes 1996). Estimated larval suckers emigrating into UKL include 14 million, 35.4 million, and 73.3 million in 1987, 1988, and 1999, respectively. Large numbers of larvae are produced annually but the natural life history is for most of these to perish. Estimated survival from eggs through the larval life stage is estimated at 0.01 percent (Miller 2001).

Soon after hatching, sucker larvae move out of the gravel; they are about 7-10 mm long and mostly transparent with a small yolk sac (Buettner and Scoppettone 1990). Larvae generally spend relatively little time upriver before drifting downstream to the lakes. However, in 2006, the Service documented a large number of larvae residing in the Sprague River until June when they were 25 to 35 mm, probably related to better flow and stream habitat conditions (J. Hodge, USFWS, pers. comm.). In the Williamson River, larval sucker out-migration from spawning sites begins in April and is generally completed by mid-July. Downstream movement takes place at night and near the water surface (Klamath Tribes 1996; Tyler et al. 2004). Once in the lake, larval suckers disperse to near shore areas (Cooperman and Markle 2004). Larval dispersion may be governed in part by major lake currents, which predominantly circulate in a clockwise direction (Wood et al. 2006).

In UKL, larval suckers are first captured in early April during most years, with peak catches occurring in June, and densities dropping to very low levels by late July (Cooperman and Markle 2000). Larval habitat is generally along the shoreline, in water 10-50 cm deep and associated with emergent aquatic vegetation, such as bulrush (Buettner and Scoppettone 1990; Cooperman and Markle 2004). Emergent vegetation provides cover from predators, protection from currents and turbulence, and abundant prey (including zooplankton, macroinvertebrates, and periphyton). Larvae transform into juveniles at about 25 mm in length. This generally occurs by the end of July. Whether or not larval survival translates into improved year class production is unknown. However, Cowan and Shaw (Cowan and Shaw 2002) suggest that most evidence indicates little or no correlation, and Houde (Houde 1994) theorizes that most freshwater fish year classes are determined in the juvenile period.

Juvenile sucker (age 0) habitat is inversely related to depth (depth range 0.4 m to 3.0 m (Burdick et al. 2007)). Juveniles are more likely to use habitat with small substrate (<64 mm) than large substrate and habitats with vegetation than without vegetation (VanderKooi et al. 2006).

Adult LRS are generally limited to lake habitats when not spawning, and no large populations are known to occupy stream habitats (USDI Fish and Wildlife Service 2002a). In contrast, SNS have resident populations in both lake and some riverine habitats. Adult suckers use water depths of 1 to 4.5 m, but appear to prefer 1.5 to 3.4 m (National Research Council 2004; Reiser et al. 2001). Sub-adults are assumed to be similar to non-spawning adults in their requirements and habitats (National Research Council 2004).

Population Abundance and Trends

Information gathered since listing indicates that there may be several tens of thousands of adult LRS and SNS in UKL (Independent Scientific Review Panel (ISRP) 2005). Gerber Reservoir and Clear Lake also have SNS populations numbering in the thousands of adults (Independent Scientific Review Panel (ISRP) 2005). Clear Lake has a LRS population in the thousands of adults.

A small population of about one thousand adult LRS and SNS occurs in the Tule Lake sumps at the terminus of the Lost River (J. Hodge, USFWS, pers. comm.). It is isolated from upstream spawning areas by a series of dams. Small populations of adult SNS (probably in the hundreds of individuals) also occur in the Lost River, Keno Reservoir, J.C. Boyle Reservoir, Copco Reservoir, and Iron Gate Reservoir (Buettner 1993; Desjardins and Markle 2000; Piaskowski 2003; U.S. Geological Survey 2000; USDI Bureau of Reclamation 1993; Ziller and Buettner 1987).

Population trends in UKL have been evaluated by comparing an adult abundance index or cumulative catch-per-unit effort in the Williamson River (R. Shively, USGS, pers. comm.). These data indicate that sucker populations in UKL have varied considerably in size and age structure owing to fluctuating recruitment and periodic die-offs (National Research Council 2004), and that sharp and substantial population declines can occur in a span of just a few years (Perkins et al. 2000a).

In 1995, the adult abundance index for LRS and SNS populations spawning in the Williamson River system were the highest observed between 1995 and 2005 (Independent Scientific Review Panel (ISRP) 2005; U.S. Geological Survey 2003). Between 1995 and 1997, die-offs in UKL reduced the Williamson River abundance index by over 90 percent. In 2000 and 2001, recruitment increased for both species, although it was greater for LRS than SNS (U.S. Geological Survey 2007). In 2003, another die-off occurred but was much smaller in magnitude than those in 1995-1997. From 2003-2005, the LRS index increased gradually, but is still only about 40 percent of the 1995 value. The SNS index has remained low, less than 10 percent of the 1995 level (Independent Scientific Review Panel (ISRP) 2005; U.S. Geological Survey 2007).

Mark-recapture data from 1995 through 2004 have been analyzed to estimate annual survival rates for SNS and LRS in UKL (Janney and Shively 2007). Based upon a mean survival rate of 0.76 for the 10 year period, it is estimated that the average life expectancy of SNS entering the spawning population was only 3.6 years. Mean annual survival rate for UKL shoreline spawning LRS from 1995 to 2004 was estimated at 0.88. Based on this survival probability, average life expectancy of LRS after recruiting into the spawning population was approximately 7.8 years. This short estimated life expectancy is of concern because the species is believed to be normally long-lived (up to 30 years); thus suggesting that adults are dying before reproducing often enough for population replacement.

Although Clear Lake LRS and SNS populations appear to number in the thousands of individuals, a substantial reduction in mean body size has occurred in the last decade. Between 1996 and 2000 there was a reduction of over 30 percent in mean size of adult LRS and SNS

(Barry et al. 2007). In 2005 and 2006, adult suckers were represented by mostly smaller size classes.

The Gerber Reservoir SNS population appears to be viable with evidence of frequent recruitment and large numbers of adults (Barry et al. 2007; Piaskowski and Buettner 2003).

Population monitoring at Tule Lake, Lost River, and Klamath River reservoirs has not been intensive enough to determine trends. However, the limited survey information collected over the last two decades suggests populations have remained at relatively low levels (hundreds of individuals) (Buettner and Scoppettone 1991; Desjardins and Markle 2000; USDI Fish and Wildlife Service 2007a).

Distribution

At the time of listing, the LRS and SNS were reported from UKL and its tributaries (Klamath Co., Oregon); from the Lost River (Klamath Co., Oregon, and Modoc and Siskiyou Co., California) and Clear Lake (Modoc Co., California), and in one or more of the Klamath River reservoirs below Keno Dam (Klamath Co., Oregon, and Siskiyou Co., California; 53 FR 27130, see Figure 2).

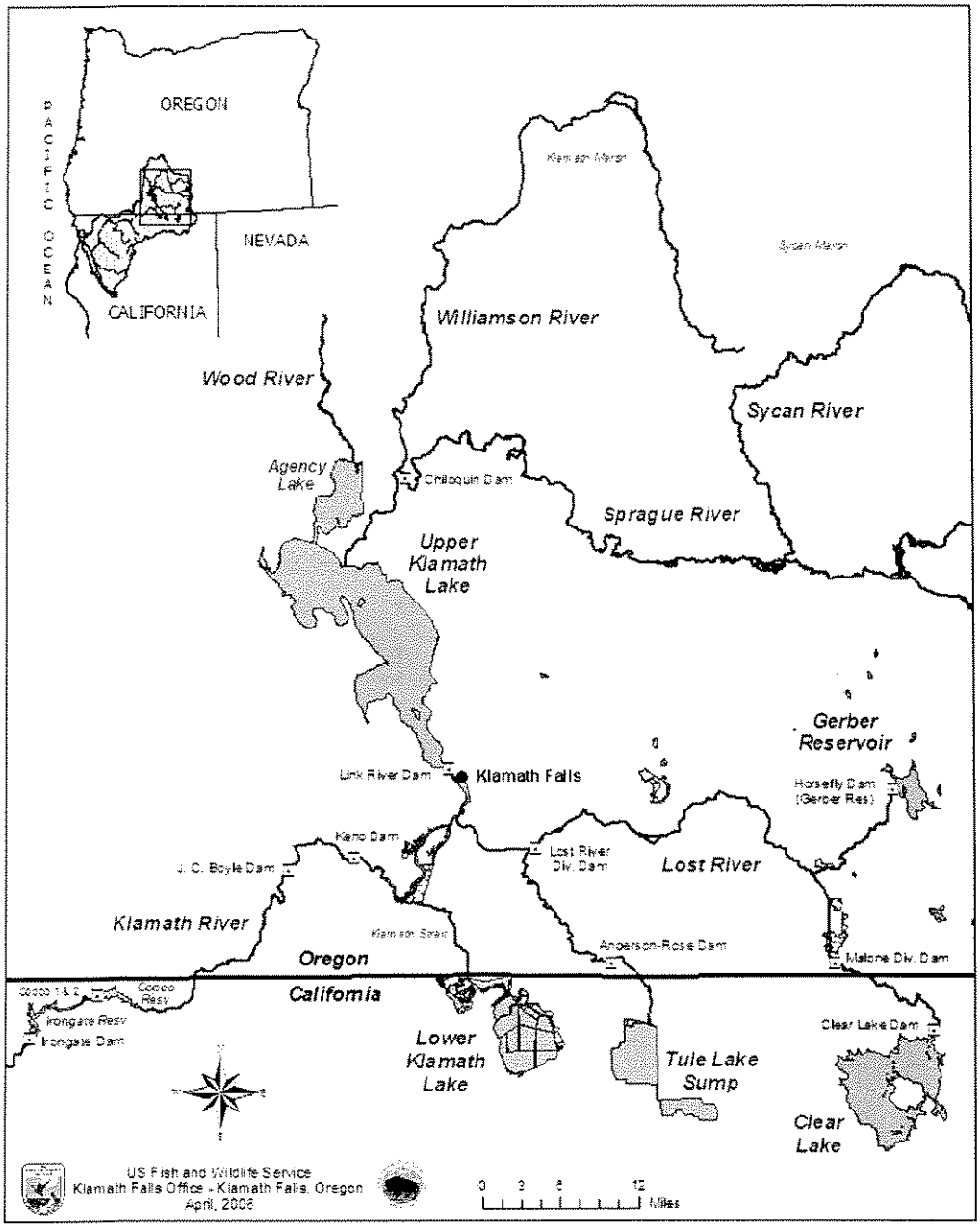

Figure 2. Map of major water bodies in the upper Klamath River Basin.

The known geographic range of LRS and SNS has not substantially changed since listing. Only one previously-unreported LRS population has been found since listing. This population of about one thousand adults occurs in Tule Lake sumps at the terminus of the Lost River (Siskiyou Co., California; J. Hodge, USFWS, pers. comm.). Two previously-unreported SNS populations have been found since listing. A population of about one thousand adult SNS occurs in the Tule Lake sumps and a substantial population (low tens of thousands) of SNS is known to occur in Gerber Reservoir. New genetic information casts some doubt on whether these fish in Gerber

Reservoir and Clear Lake are actually SNS (Tranah and May 2006). Until that information can be further evaluated, we will continue to assume these fish are SNS.

The total area of occupied lake habitat for the LRS and SNS is about 80,000 acres, of which about 80 percent or more is in UKL (which has about 64,000 surface acres). The remainder of occupied habitat occurs primarily in Clear Lake. Some LRS and SNS are found in Keno Reservoir (Piaskowski 2003), and downstream reservoirs (J.C. Boyle, and Copco) (Desjardins and Markle 2000) although these populations are not believed to be self-sustaining (National Research Council 2004).

UKL is a large natural lake located in Klamath County, Oregon, that was modified with a control structure in 1921. The lake's watershed occupies about 3,800 square miles, ranges in elevation from 4,100 to over 9,000 feet, and has an average annual precipitation of 27 inches (Oregon Department of Environmental Quality 2002). The lake surface area averages about 64,000 acres. Its three major tributaries are the Sprague, Williamson, and Wood Rivers.

Clear Lake is a natural lake located in Modoc County, California. It is in the 700-square-mile Lost River watershed, which ranges in elevation from approximately 4,500 to 6,100 feet (USDI Bureau of Reclamation 1970). Annual precipitation is about 13 inches. Upstream stock ponds and diversions reduce inflows somewhat, and over half of the annual inflow is lost to seepage and evaporation (USDI Bureau of Reclamation 1970). The lake has one major tributary, Willow Creek, where suckers spawn (Scoppettone et al. 1995). The size of Clear Lake was increased by construction of a dam completed by Reclamation in 1910. During the 65-year period prior to 1970, annual net inflow has fluctuated from 18,000 to 370,000 acre feet (USDI Bureau of Reclamation 1970).

Gerber Reservoir was constructed in 1924 on a tributary to the Lost River, Klamath County, Oregon. Gerber Dam is 84 feet high and the reservoir has a capacity of 94,000 acre-feet. The reservoir has two tributaries where sucker spawning occurs; Barnes Valley Creek and Ben Hall Creek (Piaskowski and Buettner 2003).

Current Status of Threats Identified at the Time of Listing

1. Habitat Loss and Alteration

Historical Habitat Loss

Loss and alteration of aquatic habitats, including spawning and rearing habitats, and associated wetlands, were major factors leading to the decline and listing of the suckers (53 FR 27130). Historically, habitat loss and alteration were especially pronounced in the Lost River-Tule Lake and Lower Klamath Lake sub-basins, where approximately 150,000 acres (approximately 77 percent) of the sucker spawning and rearing habitat were lost in the draining of Tule Lake and Lower Klamath Lake early in the 20th century (53 FR 27130; (National Research Council 2004)). As well as containing large areas of habitat, these lakes also provided a refuge for larval and juvenile suckers drifting out of UKL during periods of high water in the upper basin. Currently, the Klamath River reservoir populations receive individuals carried downstream from upper

reaches of the river, but they are subsequently isolated from the Upper Klamath Basin by dams and show no evidence of self-sustaining reproduction (Desjardins and Markle 2000).

At UKL, about 79 percent of the original 50,000 acres of wetlands surrounding the lake were diked and drained between 1889 and 1971, leaving about 16,000 acres remaining in 1990 (Snyder and Morace 1997). These wetlands provided a substantial amount of rearing habitat for larval and juvenile suckers (USDI Fish and Wildlife Service 2007b). Also, wetlands are important to the quality of sucker habitat because they play a key role in regulating nutrients, especially phosphorus, which is the primary factor encouraging algae blooms that can cause sucker die-offs (Aquatic Scientific Resources 2005).

Recent Habitat Loss

Currently, most actions that would remove wetland habitat are under jurisdiction of the U.S. Army Corps of Engineers (USACE). When such actions might affect species listed under the ESA, the USACE is required to consult with the Service pursuant to section 7 of the Act. Review of recent USACE section 7 consultations indicates that some relatively minor wetland losses still occur in the upper basin, but effects of these actions on suckers are minimized during Project planning and consultation.

Adverse Water Quality

In general, lake suckers are relatively tolerant of water quality conditions unfavorable for other fishes, tolerating higher pH, temperature, and un-ionized ammonia concentrations, and lower dissolved oxygen concentrations than many fishes (National Research Council 2004; Saiki et al. 1999). Nevertheless, despite their relatively high tolerance for poor water quality, LRS and SNS are adversely affected by poor summer water quality in UKL, Keno Reservoir, and the Lost River (National Research Council 2004).

Many of the water bodies currently occupied by LRS and SNS do not meet water quality standards for nutrients, dissolved oxygen, temperature, and pH set by the States of Oregon and California (North Coast Regional Water Quality Control Board 2006; Oregon Department of Environmental Quality 2002). In particular, summer water quality in UKL presents challenging conditions for LRS and SNS. These conditions have caused several incidents of mass mortality of fish that have included adult suckers. Mortality appears to primarily be a result of inadequate amounts of dissolved oxygen (National Research Council 2004; Perkins et al. 2000a). Loss of substantial portions of young age classes could be expected to limit recruitment. Because all sucker life stages (larvae, juveniles, and adults) in the UKL watershed are almost entirely confined to the lake during summer when water quality is poor, the entire sucker population in the watershed is vulnerable to water quality related die-offs.

Nutrient Loading

UKL was highly productive or "eutrophic" prior to settlement by Europeans in the mid-19th century, but it has since become even more productive or "hypereutrophic" (Bradbury et al. 2004; Eilers et al. 2004; Oregon Department of Environmental Quality 2002). Nutrient loading, from both external (run-off from the watershed including natural and anthropogenic sources like

pumping of diked wetlands and drainage from farms and roads along the tributaries) and internal (lake sediments) sources, in combination with the greatly reduced amount of associated wetlands, is driving the hypereutrophic conditions in UKL (National Research Council 2004; Oregon Department of Environmental Quality 2002; Snyder and Morace 1997). The primary nutrient responsible for the hypereutrophic conditions of the lake is phosphorus, which is bound to and stored in sediment (Graham et al. 2005; Oregon Department of Environmental Quality 2002). Sediment accumulation rates dramatically increased during the 20th century as a result of conversion of wetlands to agricultural lands, grazing, timber harvest, and road construction, and these "modern" sediments are higher in nitrogen and phosphorus than pre-settlement sediments (Bradbury et al. 2004; Eilers et al. 2004), as cited in (Oregon Department of Environmental Quality 2002).

According to the ODEQ, most of the pollutant load entering UKL comes from non-point sources, rather than discrete point sources. The total maximum daily load (TMDL) established for UKL by the ODEQ is based on the premise that reduction in phosphorus-laden sediment reaching the lake is the primary means for improving water quality (Oregon Department of Environmental Quality 2002). An annual average of approximately 60 percent of the phosphorus available to the water column is derived from lake sediments (Oregon Department of Environmental Quality 2002). Therefore, some authors have expressed pessimism regarding prospects for remediation (National Research Council 2004). However, ODEQ (Oregon Department of Environmental Quality 2002) believes that reduction in total phosphorus loading can improve water quality to the point that standards could be eventually attained.

Restoration of wetlands adjacent to UKL could also play a pivotal role in improving water quality, because wetland plants and soils store substantial amounts of phosphorus. If phosphorus is stored in these wetlands, it is logical to assume that those nutrients would not be contributing to the hypereutrophic conditions now present in the lake. It has been well established that wetlands function as a sink for sediment, nitrogen, and phosphorus (Gearheart et al. 1995; Geiger 2001). Wetlands also have a high degree of naturally occurring plant and animal decomposition that creates substances that are known to inhibit algae growth. Restoration of wetlands could help reduce blooms of *Aphanizomenon flos-aquae* (AFA), a blue-green algae that causes further water quality problems in UKL (Aquatic Scientific Resources 2005; Geiger 2001).

Aphanizomenon flos-aquae

The poor water quality in UKL is associated with high abundances of a blue-green alga, *Aphanizomenon flos-aquae* (AFA). Core samples of bottom sediments indicate that AFA was not present in UKL prior to the 1900s (Bradbury et al. 2004; Eilers et al. 2004). Its appearance is believed to be associated with increases in productivity of the lake (Aquatic Scientific Resources 2005; National Research Council 2004).

AFA now dominates the algal community from June to November, and because of the high concentrations of nutrients available, is able to reach seasonally high biomass levels that lead to highly degraded water quality (Oregon Department of Environmental Quality 2002). During the large, temporary "blooms" that occur during favorable summer conditions in UKL, AFA constitutes over 90 percent of the biomass of photosynthetic organisms in the lake (Oregon Department of Environmental Quality 2002). These blooms are subject to massive population

crashes. The rapid decay of large quantities of algae then causes extreme oxygen depletion in the lake, which has caused a number of documented fish die-offs (Independent Multidisciplinary Science Team 2003; National Research Council 2004; Oregon Department of Environmental Quality 2002; Perkins et al. 2000a; Wood et al. 2006). Such events not only kill thousands of suckers, but they can temporarily reduce the reproductive capacity of the populations by eliminating the larger and more fecund females. Adverse water quality is also likely to be impacting young suckers, but information is lacking regarding such effects (S. VanderKooi, USGS, pers. comm.).

2. Prolonged Drought and Low Lake Levels

Clear Lake and Gerber Reservoir

Prolonged drought is the primary threat to endangered suckers in Clear Lake and Gerber Reservoir (Independent Scientific Review Panel (ISRP) 2005). These water bodies are associated with watersheds receiving low precipitation, minimal groundwater input, corresponding low net inflows, and high evaporation rates due to large surface area to reservoir volume ratios (J. Hicks, USBR, pers. comm.). Additionally, water levels are sometimes slow to recover following a drought because of the factors noted above, and thus, low lake levels can persist for several years, as occurred in the 1930s. These low lake levels adversely affect suckers by limiting access to spawning tributaries (Buettner and Scoppettone 1991; Piaskowski and Buettner 2003). Without access to tributaries, there is no available spawning habitat. Suckers concentrated in shallow water are also likely to experience increased incidences of disease, parasitism, and bird predation (USDI Fish and Wildlife Service 2002a). Also, during low water periods the correspondingly higher densities of fish are likely to deplete the food supply, thus adding additional stress.

Upper Klamath Lake

Reclamation has determined the average annual net inflow to UKL to be 1.4 million acre-feet, with a range from 0.6 to 2.4 million acre-feet, with most of the inflow delivered from the three major tributaries: the Sprague, Williamson, and Wood Rivers (USDI Bureau of Reclamation 2005). Net inflows to UKL are affected by many factors including past precipitation levels, amount of snow-pack, groundwater conditions, amount of water withdrawals in the tributaries, and rates of evaporation (USDI Bureau of Reclamation 2005).

Though affected by the same regional droughts that affect Clear Lake and Gerber Reservoir, UKL is less affected by drought because inflows of surface and groundwater from areas of higher precipitation in the Cascade Range are much higher and less variable (USDI Bureau of Reclamation 2005). Droughts affect UKL levels because UKL is shallow and because, during droughts, larger irrigation diversions are needed to offset low soil moisture in agricultural fields and on wildlife refuges (J. Hicks, USBR, pers. comm.). Because UKL has a relatively small storage capacity, if the lake is low one year, it may not fill the next year if it is another dry year. The lowest water level in UKL since Link River Dam was constructed in 1921 was 4,136.8 ft, which was recorded in 1994 (USDI Bureau of Reclamation 2002). At this elevation, the lake has an average depth of only 5 feet.

The potential effects of low UKL levels on suckers have been a key issue in the management of the lake and the Klamath Reclamation Project (National Research Council 2004). When the lake is full (4143.3 ft), about 25,000 acres of adult sucker habitat of preferred depth is present at the north end of the lake where suckers spend the summer, but when water levels fall by 2 ft, the amount of preferred habitat is reduced by about 50 percent (Reiser et al. 2001). Analysis by the National Research Council (National Research Council 2004) did not find evidence of an empirical relationship between UKL elevations and sucker spawning success or adult abundance during the relatively short period (less than 15 years), during which data were available for analysis. However, if severe drought were to result in substantial and prolonged lowering of tributary inflows and lake levels, it is likely that habitat availability would be adversely affected for all sucker life stages, including spawning, larval and juvenile rearing, and adult use of water quality refuge areas (Cooperman and Markle 2004; Helser et al. 2004; Loftus and Reiser 2004).

3. Entrainment and Inadequate Fish Passage

Unscreened diversions were identified as a threat to the suckers at the time of listing (53 FR 27130). Since then private landowners, the ODFW, Reclamation, the Natural Resource Conservation Service (NRCS), the Service, and others have built or funded construction of several new fish screens in the upper basin. As a result, the threat of entrainment (loss of fish as a result of being drawn into water management structures) is now lower than at the time of listing. Recently-installed fish screens in the upper basin include A-Canal (2003); Agency Lake Ranch (2002); Clear Lake (2003); Miller Island on Keno Reservoir (2003); and Wood River Ranch (2004). Reclamation also installed a new fish ladder at Link River Dam in 2005.

4. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

In 1959, suckers were made a game species under Oregon State law, and snagging suckers was extremely popular by both local and out-of-town sportsmen. By 1985, the estimated harvest had dropped by about 95 percent (Markle and Cooperman 2001). Also, unique LRS spawning stocks were extirpated including those that used Barkley Springs, Harriman Springs, Crooked Creek, and a few other spring locations in UKL, probably due to fishing (Markle and Cooperman 2001).

The State of California designated LRS and SNS as fully protected on January 1, 1974, resulting in the prohibition of the take or possession of the fish. The sport fishery for suckers in Oregon was closed prior to Federal listing in 1988, and has not been reopened. The Klamath Tribes, who historically relied on the LRS and SNS for food, no longer harvest the species. Now the only utilization of suckers is for scientific purposes, and the Service and State of Oregon closely monitor take through a carefully managed permit process.

5. Predation/Competition by Non-native Fishes

Non-native fishes were identified as a potential threat at the time of listing. Approximately 20 non-native fish species have been accidentally or deliberately introduced into the upper basin (Desjardins and Markle 2000; Logan and Markle 1993), and they made up about 85 percent of the fish biomass in UKL at about the time the suckers were listed (National Research Council 2004; Scoppettone and Vinyard 1991).

Non-native fish species most likely to affect LRS and SNS are the fathead minnow (*Pimephales promelas)* and yellow perch (*Perca flavescens)*. These non-native fish are suspected to prey on young suckers and compete with them for food or space (Markle and Dunsmoor 2007). Additional non-native, predatory fishes found in sucker habitats include bullheads (*Ictalurus* spp.), largemouth bass (*Micropterus salmonides*), crappie (*Pomoxis* spp.), green sunfish (*Lepomis cyanellus),* and Sacramento perch (*Archoplites interruptus*) (Desjardins and Markle 2000; Koch et al. 1975; Logan and Markle 1993). Their effect on suckers is unknown, and we suggest that the magnitude of the effect would depend on other factors, such as their abundance in sucker habitat and availability of other prey.

6. Hybridization

Hybridization was identified at the time of listing as a threat to LRS and SNS. New data suggest that hybridization among the four Klamath Basin suckers probably does occur (Dowling 2005; Tranah and May 2006). Hybridization can be cause for concern for an imperiled species, even leading to extinction (Rhymer and Simberloff 1996). However, at this time, scientists who have studied Klamath suckers consider any hybridization among them is likely a natural process (Dowling 2005; Tranah and May 2006). The evidence indicates that hybridization has been common throughout the evolutionary history of suckers, in general, and Klamath Basin suckers, in particular (Dowling 2005). Therefore, we do not consider hybridization to be a threat at this time.

New Threats

Disease and Parasites

Since listing, disease and parasites have been identified as new threats. New information indicates that pathogens substantially affect sucker survival, especially during the adverse water quality events in UKL. Although fish die-offs that occurred in UKL in the 1990s were likely a response to low levels of DO, disease outbreaks also probably contributed to mortality during these events (National Research Council 2004; Perkins et al. 2000a).

A number of pathogens have been identified from dying suckers, but Columnaris disease or "gill rot" seems to be the primary disease involved (Foott 1997; Holt 1997). Columnaris disease is caused by the bacterium *Flavobacterium columnare,* which can cause massive damage to the gills and produces lesions elsewhere on the body. This leads to respiratory problems, an imbalance of internal salt concentrations, and provides an entry route for systemic pathogens that can cause death.

Parasites were not identified as a threat at the time of listing, but recent information indicates they could be a threat to the suckers. One of the potential causative factors identified in sucker die-offs was *Lernea* sp., a parasitic copepod or "anchor worm," which feeds on fish tissues by puncturing the skin of their host. *Lernea* was commonly found on sick and dying suckers collected during the 1995 to 1997 fish die-offs. *Lernea* parasitism on age 0 suckers appears to be increasing in UKL (Carlson et al. 2002). From 1994 to 1996, the percent of age 0 suckers parasitized by *Lernea* ranged from 0 to 7 percent, but by 1997 to 2000 it had increased from 9 to

40 percent. *Lernea* now infects about half of age 0 suckers in UKL (D. Markle, OSU, pers. comm.).

While poor water quality, non-native fish predation, and poor quantity/quality of juvenile sucker rearing habitat have been suggested as the primary factors responsible for low juvenile sucker survival rates (Independent Scientific Review Panel (ISRP) 2005), other factors, such as parasite infestation may also affect juvenile sucker survival (K. Russell, USFS, pers. comm.). Several fish parasites (*Ichthyobodo, Ichthyophthirius, Lernea, Neascus,* and *Trochidina)* have been identified in juvenile suckers collected from UKL. Poor water quality combined with high fish densities in sucker rearing areas may provide the necessary conditions for explosive parasite infestation rates.

Consulted-on Effects to Suckers

Consulted-on effects are those effects to the listed species that have been analyzed through section 7 consultation as reported in a BO. These effects are an important component of objectively characterizing the current conditions of the species. To assess consulted-on effects to LRS and SNS, we analyzed all of the BOs addressing the species from the time of listing (1988) through 2007. The most significant action affecting endangered suckers was continued operation of Reclamation's Klamath Irrigation Project. The Klamath Project includes the major habitats for the suckers including UKL, Gerber Reservoir, Clear Lake Reservoir, and Tule Lake. In 2002, the Service concluded that the continued operation of the Project from 2002 to 2012, as proposed, was likely to jeopardize the continued existence of both sucker species and would result in the adverse modification of proposed critical habitat. The Service also identified reasonable and prudent alternatives to the proposed action that allowed the Project to continue operating without jeopardizing the species. These substantive measures included water quality improvement measures, entrainment reduction, fish passage improvements, habitat enhancement, and supporting research and monitoring to evaluate factors limiting recovery. No other federal actions that have undergone consultation were found to appreciably reduce the likelihood of survival and recovery of the LRS and SNS. Furthermore, no actions that have undergone consultation were anticipated to result in the loss of any local populations of LRS or SNS.

Ongoing Conservation Actions

Since the early 1990's, the Service, Reclamation, State of Oregon, Klamath Tribes, other partners, and private landowners have been working to recover the LRS and SNS. The Service and its partners have supported approximately 400 habitat restoration Projects in the Upper Klamath Basin, including 50 wetland and 150 riparian Projects. The cost of these Projects has been shared by many entities, including State and Federal programs such as Partners for Fish and Wildlife, Hatfield Restoration, Jobs in the Woods, and Oregon Resources Conservation Act programs as well as private grant programs and contributions from landowners.

Major habitat restoration Projects focusing on suckers have been completed. These include: (1) screening of the main irrigation diversion on the Klamath Project (A-Canal); (2) screening of the outlet at Clear Lake Dam; (3) construction of a new fish ladder at Link River Dam; (4) restoration of over 25,000 acres of wetlands adjacent to UKL and in the watershed above the lake; (5) 13 fish passage improvement projects, including screening and fish ladders; (6)

restoration of the lower three miles of the Wood River; and (7) fencing along about 200 miles of streams (D. Ross, USFWS pers. comm. 2005). Additionally, Chiloquin Dam, a major impediment to upstream migration of suckers, is planned for removal in 2008 (C. Korson, pers. comm.). Reconnection of the Williamson River Delta (over 4,000 acres) by 2010 will likely provide significant habitat for endangered suckers (David Evans and Associates 2005)

The NRCS has also made substantial commitment to address water quality/water quantity issues in the upper basin. Through authorization and funding for the 2002 Farm Bill, NRCS has restored 2,200 acres of wetland habitat and conserved over 6,700 acre-feet of on-farm water. Conservation systems on over 70,000 acres have been planned, and practices have been applied to over 30,000 acres to manage soil, water, air, plants, and animals on private lands (J. Regan-Vienop, NRCS, pers. comm.).

The Sprague River is listed as water-quality impaired for nutrients, temperature, sediment, and dissolved oxygen under section 303d of the Clean Water Act (Oregon Department of Environmental Quality 2002). The Sprague River is the primary spawning habitat for suckers in UKL, and the largest tributary to the Williamson River, providing 50 percent of the inflow to UKL (National Research Council 2004). The 2002 TMDL and water quality management plan developed by ODEQ provides targets and guidance to improve water quality in the river and UKL (Oregon Department of Environmental Quality 2002). As a result, many wetland and riparian restoration Projects are now designed to improve water quality.

In 2004, the National Academy of Sciences concluded that a lasting resolution of Klamath Basin water issues will require an integrated and comprehensive effort (National Research Council 2004). That type of effort is now being pursued. For example, representatives of the States of California and Oregon, the President's Klamath River Basin Working Group, and the Environmental Protection Agency have signed the Klamath River Watershed Coordination Agreement. They agreed to place a high priority on their Klamath Basin activities; and to coordinate and communicate with one another and with tribal governments, local governments, private groups, and individuals to resolve water quantity/quality problems in the basin (U.S. Department of the Interior et al. 2004). In addition, the Reclamation has initiated a Conservation Implementation Program in the Klamath Basin to restore the Klamath River Basin ecosystem including listed species recovery.

In 2004, the Oregon State University Agricultural Extension Service and the Klamath Watershed Council began a series of monthly meetings with rural landowners in the Sprague River Valley to discuss watershed restoration goals. With the help of the Service, NRCS, the Klamath Basin Ecosystem Foundation (KBEF), and the Klamath Soil and Water Conservation District, this effort has effectively connected landowners with appropriate state and federal resource conservation programs. As a result, more than 70 percent of the private land owners with the Sprague River Valley are partnering with local, state, and federal agencies on land conservation and natural resource actions (D. Ross, USFWS, pers. comm.). The efforts of the watershed council and KBEF have resulted in the addition of fiscal partners (e.g., Oregon Department of Agriculture, Klamath County, and Oregon Watershed Enhancement Board) to the conservation partnership. These partnership forming actions will continue, and will enable more restoration to be done in the future.

The Wood River Valley (WRV) supplies 25 percent of the water to UKL. This valley supports 50 percent of the cattle in the Upper Basin and is the source of 30 percent of the external phosphorus loading to UKL (Oregon Department of Environmental Quality 2002). Because of this, the WRV was identified by ODEQ as a priority water quality impaired area. The Klamath Basin Rangeland Trust (KBRT) has been active in the WRV, encouraging landowners to adopt sustainable land and water management practices. Since 2002, 12,000 acres have been enrolled in a program to reduce water use and it has resulted in a reduction of approximately 1.1 acre-foot of water per acre of land (S. Peterson, KBRT, pers. comm.).

Conservation Needs of the Species

Conservation needs reflect those biological and physical requirements of a species for its long-term survival and recovery. They include:

1) Long-term species survival and recovery requires sufficient numbers of viable, self-sustaining populations of LRS and SNS in as much of their historical range as possible. Multiple populations provide resiliency in response to localized extirpations caused by adverse conditions such as prolonged drought, contaminant spills, disease, and catastrophic water quality declines. Multiple populations also help ensure the genetic diversity of the species and improve its ability to adapt to changing environmental conditions.

Currently, there are three major populations of SNS in the Upper Klamath Basin found in UKL, Clear Lake, and Gerber Reservoir. There are two major populations of LRS in the Upper Klamath Basin found in UKL and Clear Lake, along with a small population in Tule Lake. UKL contains the largest populations of SNS and LRS and these populations are crucial for the long-term survival of both species. However, the populations of LRS and SNS in Clear Lake, Gerber Reservoir, and Tule Lake are also essential to ensure the long-term survival of the species. Maintenance of adult sucker populations in Klamath River reservoirs can provide insurance against loss of subpopulations and could be used for reintroduction should other populations in the Upper Klamath Basin be extirpated.

2) Populations need to be of adequate size and of diverse age structure to withstand stochastic events and remain viable. Populations need to be sufficiently large to withstand stress and mortality associated with droughts, disease, predation, adverse water quality, high flows, and cold temperatures during spawning, and other such random events that affect survival. Populations need to be sufficiently large that they do not lose genetic diversity when significant percentages of individuals die or become non-reproductive. Diverse age structures are needed to ensure survival during events that might be age- or size-specific, such as have been suspected during UKL sucker die-offs. Having sufficient numbers of older and larger fish is crucial because reproductive potential is size dependent.

3) Populations must be interconnected for demographic and genetic support. Populations must have the ability to move about and ensure genetic exchange between populations, to gain access to spawning and rearing habitat, and to allow young fish entrained downstream to return to their parent populations. This is especially important when populations are subject to environmental stress as are the sucker populations in UKL. Currently, most major habitats are isolated from one another due to habitat fragmentation due to past reclamation of wetland habitats.

4) A diversity of adequate spawning, rearing, feeding, and over-wintering and refugial habitats must be present throughout the species' range to support viable populations. These habitats must be available during the period of time they are needed: for example larvae must have adequate emergent marsh, rearing habitat where they can feed and avoid predators. Water quality refugial areas are also crucial for suckers in UKL and Keno Reservoir, so they can avoid adverse water quality conditions. Adequate passage between habitats is needed so that suckers can use all habitats that are necessary for completion of their life cycle.

These needs will be met if: (1) adequate water volumes and depths are maintained in lakes, reservoirs, rivers, and streams to provide habitat for spawning, rearing, feeding, and cover from predators; (2) adequate water depths in lakes and reservoirs are maintained to provide adequate water quality during summer (e.g., pH values of <9; DO concentrations of >4 mg/L; un-ionized ammonia <0.1 mg/L; temperature <27 °C) and during winter ice-cover conditions when DO levels decline due to increased sediment oxygen demand and because re-aeration is halted; (3) adequate water depths in lakes and reservoirs are maintained so that suckers can access water quality refuge areas (e.g., lake/reservoir > 4 feet for adult refuge during adverse water quality conditions); (4) spring and tributary inflows are adequate to improve water quality and to provide physical access for spawning as well as water quality protection; (5) littoral areas have appropriate vegetative cover and substrate structure for larval and juvenile feeding and protection from predators; (6) adequate access to appropriate spawning habitats in tributaries and lakeshore areas is facilitated by providing sufficient lake/reservoir depths; (7) agricultural and forestry practitioners use best management practices to preserve water quality and habitat; (8) adequate fish passage is provided at dams and diversions so suckers can reach critical habitats to complete their life history; and (9) protection from entrainment at the numerous water diversion points is provided throughout their range.

Lost River and Shortnose Sucker Proposed Critical Habitat

This section is part of the Service's conference opinion on the effects of the proposed action on proposed critical habitat for LRS and SNS. Critical habitat for the LRS and the SNS was proposed in 1994, but has not yet been finalized (59 FR 61744). The primary constituent elements identified in the proposal are as follows: (1) water of sufficient quantity and suitable quality; (2) sufficient physical habitat, including water quality refuge areas, and habitat for spawning, feeding, rearing, and travel corridors; and (3) a sufficient biological environment, including adequate food levels, and natural patterns of predation, parasitism, and competition.

Six critical habitat units were identified including: Clear Lake and Watershed, Tule Lake, UKL, Williamson and Sprague Rivers, Gerber Reservoir and Watershed, and Klamath River. The Klamath River unit extends from Link River Dam to Iron Gate Dam and all 100-year floodplain areas.

Environmental Baseline

The Environmental Baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7

consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. [50 CFR § 402.02].

Status of the Species in the Action Area

Prior to major anthropogenic changes to the lakes, river and wetlands in the Upper Klamath Basin beginning in the early 1900s, there were large spawning runs of suckers migrating up the Link River, which were described as "immense congregations" of fish weighing two to six pounds (Klamath Republican 1901). The origin of these runs is not recorded. Presumably, they came up out of Lower Klamath Lake or the Keno Reservoir/Keno reach, as no suitable lake habitat was available below Keno prior to construction of J.C. Boyle Dam. They were headed for tributaries to UKL for spawning. Suckers occupied the Link River even in summer, as evidenced by accounts of stranded suckers when flow to the Link River was cut off by southerly winds producing a seiche (a wind-driven oscillation of the water surface) in UKL that lowered the level at the outlet to below the sill and the river temporarily stopped flowing (Spindor 1996).

There were thousands of acres of open water and emergent wetland habitat in the Lower Klamath Lake and Klamath River area above the basalt reef at Keno before major agricultural development began in the early 1900s (Akins 1970). These areas likely provided good rearing habitat for all sucker life stages. The Klamath River below Keno was generally a high gradient system with shallow swift flowing water. LRS and SNS, a group of fish adapted to lake environments, probably did not occur below Keno. Listed suckers now live in the reservoirs created by dams associated with the Klamath Hydroelectric Project including J.C. Boyle, Copco No. 1, Copco. No. 2, and Iron Gate Reservoirs. These reservoirs support small residual (drift) populations.

The following section provides a review of current condition of the species in the action area and the factors responsible for that condition. Many of the factors impacting sucker status represent Project effects and will be discussed in detail in the Effects Section.

Link River Dam

Link River Dam, which Reclamation owns, is 16 feet high and includes a fish ladder, which was rebuilt in 2005 to improve upstream passage for federally listed sucker species. Intake gates on each side of the dam regulate flow into the canals that lead to PacifiCorp's Eastside and Westside developments.

Fish passage studies were conducted by PacifiCorp in 1988-1991 (PacifiCorp 1997) and Reclamation in 2002-2004 before the new ladder was constructed (Piaskowski 2003; Piaskowski et al. 2004). In the first study, a fish trap was installed and monitored in the original pool and weir fish ladder constructed in 1926. The only year in which suckers were captured was 1989. A total of 18 suckers including 4 LRS, 3 SNS, 9 of other sucker species, and 2 unidentified juveniles were captured during mid-April to mid-June. The small numbers of suckers using the ladder was due in part to inadequate passage conditions. The ladder did not meet Service and ODFW criteria for sucker passage (Oregon Department of Fish and Wildlife 2006b; USDI Fish and Wildlife Service 2005b). From 2002-2004, Reclamation radio tagged adult suckers captured in Keno Reservoir and tracked their movements in Link River and Keno Reservoir. Although

several suckers moved up Link River to the base of the dam, none passed through the ladder. In 2004, 12 and 13 LRS from Sprague River fish ladder and Sucker Springs (UKL) were radio-tagged and relocated in Keno Reservoir (Reclamation, unpublished data). Five of the LRS from Sucker Springs and one from the Sprague River fish ladder passed through the Link River fish ladder in 2005 and were detected in UKL.

Reclamation installed PIT tag readers in the new ladder which was first operational in 2005. Over the last three years Reclamation has detected several adult suckers that were PIT tagged in the Keno Reservoir moving through the ladder during the springtime (Reclamation, unpublished data).

Link River

The 1.2 mile-long segment of the Klamath River that extends from Link River Dam to Keno Reservoir is commonly known as the Link River. The streambed in this section is mostly bedrock, and at lower flows the river breaks into smaller braided channels. The "Klamath Falls" which is a long steep cascade rather than a waterfall, occurs in the Link River and may constrain upstream fish passage (Oregon Department of Fish and Wildlife 1997). PacifiCorp, as directed by Reclamation, manages flows that are released from UKL into the Link River to meet flow requirements downstream of Iron Gate Dam as specified in the NMFS 2002 BO. This BO addresses the effects of Reclamation's irrigation project on the threatened coho salmon and the flow requirements are designed to protect coho salmon in the lower Klamath River. PacifiCorp's Eastside and Westside Powerhouses also divert water from UKL. Historically, up to 1,450 cfs of flow that was released to Link River passed through Eastside and Westside Powerhouses, rather than being released at Link River Dam. The amount of water that must be released into the Link River to meet the NMFS BO required flows below Iron Gate Dam is affected by irrigation diversions and return flows and accretions from springs and tributaries between the Link River and Iron Gate Dam. These accretion flows typically amount to about 300 to 500 cfs during low precipitation periods in the summer and fall.

In addition to the flow releases that are required to meet minimum flows downstream of Iron Gate Dam, PacifiCorp has an agreement with ODFW to maintain a minimum flow of 90 cfs downstream of Link River Dam. This minimum flow is increased to 250 cfs from mid-July through mid-October to comply with a requirement of the Service 2002 BO to provide this flow when water quality conditions are adverse. Ramping rates below Link River Dam that were developed in consultation with ODFW during the 1980s limit downramping rate 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.

Water quality conditions in Link River are similar to those that occur in UKL, and include periods of high water temperatures, low DO levels, and high pH levels.

All life stages of listed suckers have been found in Link River in recent years based on monitoring below UKL and the Link River Dam. This habitat is primarily a migration corridor for large numbers of larval and juvenile suckers dispersing downstream from UKL to Keno Reservoir (Gutermuth et al. 2000b; USDI Bureau of Reclamation 2006). Juvenile suckers were consistently caught during salvage operations conducted in the upper Link River during

maintenance operations and spill termination for Link River Dam, which occurs in most seasons except the January-March period (USDI Bureau of Reclamation 2000). PacifiCorp conducted fish surveys in Link River during 2001 and 2002 to determine fish distribution and seasonal patterns (PacifiCorp 2004e). They captured one SNS in upper Link River by near-shore backpack electrofishing in spring 2002 but did not collect any suckers during summer and fall. This information suggests that very few suckers are rearing in upper Link River.

Small numbers of adult LRS and SNS were found attempting to utilize the old fish ladder at Link River Dam in 1988 through 1991 (PacifiCorp 1997). From 2002 to 2004, Reclamation conducted radio telemetry studies of adult suckers from Keno Reservoir (Piaskowski et al. 2004). Many of these fish migrated up the Link River during April and May, attempting to reach tributaries of UKL for spawning. In 2005, the year the new Link River fish ladder became operational, 6 radio-tagged LRS passed the ladder into UKL.

Fifteen SNS were captured by boat electrofishing in the lower Link River below Eastside power discharge during fall 2001 (PacifiCorp 2004e). During spring 2002, 12 SNS, 1 LRS, and 2 KLS were captured in the same area. In the springtime the fish were probably staging before migrating upstream to spawn. Based on the number of SNS and LRS adults sampled in Keno Reservoir (see next section), up to about 200 suckers migrate up the Link River during the spring spawning season attempting to access tributaries to UKL for spawning.

While juvenile suckers occupy habitat throughout the Link River in low numbers, the lower Link River is an important water quality refuge area for juvenile and adult suckers during periods of low dissolved oxygen (DO) in Keno Reservoir. Summer water quality in Link River and Keno Reservoir is frequently very poor and the better water quality in the Link River may allow fish from Keno Reservoir to survive (Deas and Vaughan 2006; Piaskowski 2003). In 2002 through 2004, radio-tagged adult suckers in the Keno Reservoir moved into the Link River during the summer when water quality in the reservoir degraded to particularly low DO concentrations (Piaskowski 2003; Piaskowski and Simon 2005). Link River, because of its high gradient and numerous cascades, has a significant potential for oxygenation of water prior to entry into Keno Reservoir, where there is a high biochemical oxygen demand (BOD). Furthermore, a number of small springs along and in the channel add fresh, high-quality water to the river.

Keno Reservoir

Keno Reservoir is more appropriately described as a widened part of the head of the Klamath River. It is narrow and riverine in character, and is confined within a diked channel that was once connected to Lower Klamath Lake. The reservoir is 20 miles long, has a surface area of 2,475 acres, an average depth of 7.5 feet and a maximum depth of 20 feet, and a total storage capacity of 18,500 acre-feet. Water levels in Keno Reservoir are normally maintained within a 0.5 foot range. Summer water quality is generally poor, with heavy algae growth, high temperatures and pH, and low DO.

Fish sampling conducted by PacifiCorp in 2001 and 2002 indicates that fish populations in Keno Reservoir are very similar in species composition to those in Link River, and are dominated by the same pollution-tolerant species: blue chub, tui chub, and fathead minnows (PacifiCorp 2004e). Several other fish distribution studies have been conducted in Keno Reservoir including

Hummel (Hummel 1993), ODFW (Oregon Department of Fish and Wildlife 1996), Piaskowski (Piaskowski 2003), and Terwilliger et al. (Terwilliger et al. 2004). Hummel (Hummel 1993) and ODFW (Oregon Department of Fish and Wildlife 1996) only captured a few juvenile and adult LRS and SNS during their limited sampling activities. PacifiCorp (PacifiCorp 2004e) conducted boat electrofishing surveys in Keno Reservoir during fall 2001 and spring, summer, and fall 2002. Twenty-five SNS and 2 LRS were captured during 6 hours of effort. Most suckers were captured in the fall. Other suckers captured included 30 KLS, 3 KSS, 6 unidentified/hybrid suckers. Oregon State University (OSU) conducted a more rigorous sampling effort in 2002 through 2003 monitoring all life stages and multiple locations throughout Keno Reservoir (Terwilliger et al. 2004). Larvae and age-0 suckers were most abundant in Keno Reservoir and decreased downstream. Juvenile and adult suckers were rare. It is likely that most of the larvae and age-0 suckers captured by OSU were fish entrained from UKL according to entrainment studies at Eastside and Westside Diversion Canals at Link River Dam in 1998 and 1999 (Gutermuth et al. 2000a; Gutermuth et al. 2000b), and below Link River Dam in 2005 and 2006 (McCall et al. 2006; Tyler 2007; USDI Bureau of Reclamation 2006).

During 2002, Reclamation fished trammel nets to collect adult suckers for a radio-tagging study (Piaskowski 2003). A total of 172 adult suckers were caught between March 28 and May 3 mostly in the upper end of Keno Reservoir. They included 84 SNS, 28 LRS, 53 KLS and 7 unidentified suckers. Twenty-two and five adult suckers were captured from upper Keno Reservoir during spring 2003 and 2004, respectively, as a continuation of Reclamation's radio-tagging study to assess adult sucker migration and habitat use in Link River and Keno Reservoir ((Piaskowski et al. 2004), Reclamation, unpublished data). In 2005, 35 adult suckers were captured in Keno Reservoir and Link River fish ladder, PIT tagged and released (Reclamation, unpublished data). The adult suckers present in Keno Reservoir probably represent fish entrained from UKL, since water quality conditions in Keno Reservoir likely prevent year-round rearing except in the upper portion of the reservoir near Link River. In 2005 and 2006, catch per unit effort for adult suckers in Keno Reservoir was much lower than 2002-2004 (D. Bennetts, BOR, pers. comm.). This may indicate that suckers were able to migrate back to UKL with completion by Reclamation of a new fishway at Link River Dam by Reclamation in 2005, but the actual reason for the lower trapping success is unknown.

The low numbers of suckers in Keno Reservoir appear to be related primarily to poor summertime water quality (Piaskowski 2003). DO levels reach stressful and lethal levels for suckers every summer particularly during July and August (Piaskowski 2003). Also, due to past diking and draining of wetlands for agricultural purposes along the Klamath River above Keno Dam and water management operations resulting in stable water levels, there is very little wetland habitat available for larval and juvenile sucker rearing. Loss of larval and juvenile suckers also occurs through entrainment at irrigation diversions that occur in this reservoir (C. Korson, USBR, pers. comm.). The major diversions include the Lost River Diversion Channel, North Canal, and Ady Canal. There are dozens of smaller irrigation diversions in Keno Reservoir (USDI Bureau of Reclamation 2001).

Large numbers of non-native fish, particularly fathead minnows, compete and prey on larval and juvenile suckers in Keno Reservoir. Turbine mortality associated with the operation of Eastside and Westside facilities also affects the number of suckers entering the reservoir. Larval and

juvenile suckers dispersing downstream into Keno Reservoir are also impacted by stranding associated with downramping and low flows in Link River.

Keno Dam

The current requirement is to operate Keno Dam as a re-regulating project, which serves a number of purposes. These include the control of water levels to maintain steady reservoir elevations in the 20-mile-long Keno Reservoir, flow to and from Reclamation's Klamath Irrigation Project, inflows to J.C. Boyle Reservoir, and minimum stream flow requirements of 200 cfs at Keno Dam (USDI Bureau of Reclamation 2006).

Keno Dam is equipped with a 24-pool weir and orifice type fish ladder, which rises 19 feet over a distance of 350 feet, designed to pass trout and other resident fish species. PacifiCorp has an agreement with ODFW to release a minimum flow of 200 cfs at the dam per article 58 of its existing license. Similar to Link River Dam, the average daily flow released from Keno Dam generally follows the license instream flow requirements downstream of Iron Gate Dam, less anticipated accretion flows. Hourly flows released from Keno Dam can be affected by the rate of winter and spring run-off and irrigation return flows delivered via the Klamath Straits Drain and the Lost River Diversion Channel, which can vary by 775 cfs over a 24-hour period. PacifiCorp has a voluntary down-ramping rate below Keno Dam of 500 cfs or 9 inches per hour ((Federal Energy Regulatory Commission 2006) page 3-168).

From 1988 to 1991, a total of 136 suckers were captured in the fish ladder at Keno Dam, including 6 LRS, 3 SNS, 6 KLS, 99 KSS, and 22 unidentified juvenile suckers (PacifiCorp 1997). Two LRS were captured in May 1988 and 4 LRS in April and May 1989. Individual SNS were caught in April and July 1990 and September 1991. The KSS were caught mostly from April-June of 1989 and 1990, but others were captured during August-October. No recent fish passage monitoring has been conducted at Keno Dam fish ladder. Based on the low numbers of suckers documented using the fish ladder, and since the ladder does not meet Service sucker passage criteria (USDI Fish and Wildlife Service 2005b), Keno Dam may be an impediment to sucker migration and may restrict migration of LRS and SNS from J.C. Boyle Reservoir to spawning areas in tributaries of UKL (see U.S. Department of the Interior (2007) for further information).

Keno Reach

Downstream of Keno Dam, the Klamath River flows freely for 4.7 miles until it enters J.C. Boyle Reservoir. The Keno reach runs through a canyon area with a relatively high gradient of 50 feet/mile or about 1 percent. The river channel is generally broad with habitat consisting of rapids, riffles, and pocket water among rubble and boulders (Oregon Department of Fish and Wildlife 1997). Water quality in the Keno reach is influenced by water quality in Keno Reservoir, which is influenced by water quality in UKL. Summer water quality in Keno Reservoir is generally poor because of heavy algae growth, high water temperatures and pH, low DO, and elevated nutrients. This combination of warm water, abundant nutrients, and organic materials from upstream sources, and adequate dissolved oxygen resulting from the river's turbulence, create a productive aquatic environment in the Keno reach (Oregon Department of Fish and Wildlife 1997).

Fisheries sampling conducted by PacifiCorp in 2001 and 2002 indicates that the fish population in the Keno reach is dominated by marbled sculpin, fathead minnows, blue chub, speckled dace, and tui chub (PacifiCorp 2004e). Rainbow trout were consistently collected, but in relatively small numbers. One sub-adult LRS was captured in June 2002 in the upper segment of the Keno reach, probably dispersing downstream from UKL. No listed suckers were captured in 2001 and 2002 in the lower segment of the Keno reach. The possible presence of the lake-dwelling, endangered SNS and LRS in the Keno reach may reflect the downstream emigration of larvae, juvenile and adults from upstream basin habitat, a behavior suggested for those two species when present in the Klamath River below J.C. Boyle Dam (Henriksen et al. 2002). It is unlikely that LRS and SNS spawning occurs in the Keno reach because of the high gradient and lack of spawning gravel (Fortune et al. 1966).

Based on the estimated number of adult listed suckers in J.C. Boyle Reservoir (several hundred individuals; USDI Fish and Wildlife 2005), it is estimated that about 20 percent of the populations will migrate up to Keno Dam during the spring spawning period each year (Perkins et al. 2000b).

J.C. Boyle Reservoir

The upstream half of the J.C. Boyle Reservoir is shallow and is surrounded by a low-gradient, gently sloping shoreline, while the reservoir deepens in the lower half, where the canyon narrows again. The upper end of the reservoir contains a large amount of macrophytes during the summer and several fairly large shoreline wetland areas. The reservoir is 3.6 miles long, has a surface area of 420 acres, an average depth of 8.3 feet, a maximum depth of 53 feet, and a total storage capacity of 3,495 acre-feet. Water levels in J.C. Boyle Reservoir are normally maintained within 5.5 feet of full pool, and daily fluctuations due to peaking operation of the J.C. Boyle development are typically between 1 and 2 feet. Like the upstream Keno Reservoir, water quality is often degraded, particularly during the summer

The most extensive fish abundance and distribution studies in J.C. Boyle Reservoir were conducted during 1998 and 1999 by OSU (Desjardins and Markle 2000). Additional sucker population monitoring was conducted by ODFW in 1987 (Ziller and Buettner 1987) and Reclamation in 1993 (USDI Bureau of Reclamation 1993). The fish community is dominated by chub species, fathead minnows, and bullheads.

All four Klamath Basin sucker species have been captured in J.C. Boyle Reservoir (Desjardins and Markle 2000; Piaskowski et al. 2004; Ziller and Buettner 1987). SNS and KSS were fairly common, KLS uncommon, and LRS rare in these studies. Desjardins and Markle (2000) captured 44 SNS and 2 LRS sub-adult/adult suckers during 1998 and 1999. The endangered SNS and LRS suckers accounted for about 1.5 percent of the native fish captured in J.C. Boyle Reservoir, and may represent individuals or their progeny that originated in UKL. Desjardins and Markle (2000) collected substantial numbers of larval and juvenile suckers during 1998 and 1999 in J.C. Boyle Reservoir, but their species identity and source are unknown. The observed recruitment of larval and juvenile suckers in J.C. Boyle Reservoir could be due to export out of UKL (Desjardins and Markle 2000).

Spencer Creek is the only tributary of significance to J.C. Boyle Reservoir and provides spawning habitat for rainbow trout from the Keno reach and to a lesser extent, the J.C. Boyle bypassed and peaking reaches. KSS are known to spawn in Spencer Creek (M. Buettner, USFWS, pers. comm.). However, no LRS or SNS have been documented spawning there.

Since most of the LRS and SNS in J.C. Boyle Reservoir probably originated from UKL, we would expect them to try to migrate back to UKL and its tributaries when they reach maturity. This assumption is based on radio tagging studies conducted by Reclamation where adult LRS and SNS suckers from UKL were transported to Keno Reservoir and most attempted to migrate up Link River (Piaskowski 2003). In 2005, 5 Lost River suckers that were captured at Sucker Springs in UKL, radio-tagged and released in Keno Reservoir in spring 2004 were located back in UKL during spring 2005 (Reclamation, unpublished data). However, few listed suckers were captured in fish passage studies conducted at Keno Dam fish ladder from 1988-1991 (PacifiCorp 1997). Because the ladder does not meet Service and ODFW sucker passage criteria (Oregon Department of Fish and Wildlife 2006b; USDI Fish and Wildlife Service 2005b), we cannot conclude that the few numbers captured correlates to low numbers of fish attempting to migrate upstream to spawn.

Populations of suckers in J.C. Boyle Reservoir are primarily limited by the amount of rearing habitat in the impoundment and competition and predation with non-native fish including fathead minnows, yellow perch, bullheads, and largemouth bass (National Research Council 2004). However, J.C. Boyle Reservoir contains fewer non-native fish predators than the lower two reservoirs, Copco and Iron Gate (Desjardins and Markle 2000).

Water level fluctuations in J.C. Boyle Reservoir, resulting from daily peaking operations at J.C. Boyle Powerhouse, may further complicate the interactions of predation and habitat availability. If water level fluctuations force larval and juvenile suckers to abandon refuge littoral areas, they can be more vulnerable to predators.

J.C. Boyle Dam

PacifiCorp constructed J.C. Boyle Dam, which is 68 feet high, in 1958. The dam is equipped with a 569-foot long pool and weir fishway, with 63 pools, which operates over a gross head range of 55 to 60 feet. The dam diverts flow into a 2.56-mile-long flow line to a powerhouse, creating a 4.3 mile-long bypassed reach. The intake to the flow line at J.C. Boyle Dam is equipped with vertical traveling screens and a fish bypass pipe that delivers screened fish and debris along with a 20 cfs bypass flow to the base of the dam. The existing fish screens do not meet current agency velocity criteria.

No suckers were captured in the J.C. Boyle fish ladder during the 1988-1991 fish passage study (PacifiCorp 1997). However, in 1959 shortly after the dam was constructed, ODFW conducted a fish passage study and caught 2,456 suckers from May 10 to December 12. Peak catches occurred in June and July. The suckers ranged from 100 to 535 mm and were identified as KSS and KLS (PacifiCorp 1997). No LRS or SNS were documented. Beak (Beak Consultants Inc. 1987) conducted a radio telemetry study on adult SNS from Copco Reservoir. During the spring several tagged fish migrated a short distance upstream, presumably to spawn. None migrated upstream to J.C. Boyle Dam.

Because J.C. Boyle Dam fish ladder does not meet Service sucker criteria (USDI Fish and Wildlife Service 2005b), suckers residing in downstream habitats or dropping below the dam do not have access to upstream spawning habitats.

J.C. Boyle Bypassed Reach

The J.C. Boyle Bypassed Reach is 4.3 miles long, extending from the dam to the J.C. Boyle Powerhouse. This reach of the Klamath River has a relatively steep gradient of about 2 percent. The river channel is approximately 100 feet wide, and consists primarily of rapids, runs, and pools among large boulders with some large cobble interspersed. Gravel is scarce, in part because recruitment from upstream areas is blocked by the presence of J.C. Boyle Dam. When spill from the dam is substantial, habitat in the bypassed reach consists of a series of rapids and fast runs.

PacifiCorp releases a 100 cfs minimum flow at the dam into the J.C. Boyle Bypassed Reach under the existing annual license. An additional 220 to 250 cfs of spring flow accrues in the bypassed reach, beginning about 0.5 mile downstream from the dam. The existing license limits the rate of upramping and downramping in the bypassed reach to 9 inches per hour.

Water discharged from J.C. Boyle Dam to the bypass reach during summer is typically quite warm, highly productive, and often degraded, similar to upstream water quality on the Klamath during summer (Oregon Department of Fish and Wildlife 1997). Because of contributions from springs, flows at the end of the bypass reach during the summer are relative constant at about 350 cfs and water temperature about 13 °C.

Fisheries sampling conducted by PacifiCorp in 2001 and 2002 indicates that the fish populations in the J.C. Boyle Bypassed Reach is dominated by rainbow trout, speckled dace, and marbled sculpin. One juvenile SNS was captured in the fall of 2001 in the J.C. Boyle Bypassed Reach, while no suckers were captured during the spring, summer, and fall of 2002 (PacifiCorp 2004e). No LRS were collected in either year. This reach is primarily a migration corridor for suckers dispersing downstream (Henriksen et al. 2002).

J.C. Boyle Peaking Reach

The J.C. Boyle Peaking Reach is 17.3 miles long, extending from the J.C. Boyle Powerhouse to the upper end of Copco Reservoir. The upstream 11.1 miles of this reach are in Oregon, and this segment has been federally designated as a Wild and Scenic River. The downstream 6.2 miles are in California, and the segment is designated by CDFG as a Wild Trout Area (PacifiCorp 2004b). In the Oregon portion of the reach, habitat includes cascades, deep and shallow rapids, runs, riffles, and occasional deep pools. Substrate is heavily armored and consists primarily of boulders and large cobbles, with a few small pockets of gravel behind boulders. The California segment of the peaking reach is wider and lower in gradient, and contains more riffles and runs, and infrequently exhibits pools and quiet water. Substrate is primarily bedrock, boulders, and cobbles, with a few gravel pockets behind boulders. The California portion exhibits good riparian and instream cover including boulders, rooted aquatic plants, and undercut banks.

Stream flows in the reach are affected by peaking operations of the J.C. Boyle development. Under current operations, water is typically stored at night and flows during the day ramp up to either one unit (up to 1,500 cfs) or two unit operations (up to 3,000 cfs, but typically 2,750 cfs). When generation ceases at night, flow at the powerhouse consists of the flow that is released from J.C.Boyle Dam into the bypassed reach (with the exception of spill periods, this is normally 100 cfs minimum flow), plus the 220 to 250 cfs of spring flow that accrues in the bypassed reach. The current licensed ramping rate is 9 inches per hour for both up-ramping and down-ramping.

Fisheries sampling conducted by PacifiCorp in 2001 and 2002 indicates that the fish populations in the J.C. Boyle Peaking Reach were comprised primarily of speckled dace, marbled sculpin, and rainbow trout (PacifiCorp 2004e). A small number of SNS were captured in the fall of 2001 and 2002 by near-shore backpack electrofishing. In the fall of 2002, boat electrofishing surveys failed to capture any SNS or LRS in the Oregon and California sections of the J.C. Boyle Peaking Reach (PacifiCorp 2004e). KLS and KSS suckers were captured in both of these sections and they were common in the California section. Henricksen et al. (Henriksen et al. 2002) reported that the use of the Klamath River between J.C. Boyle Dam and Copco Reservoir by the endangered LRS and SNS likely is limited to downstream emigration of juveniles and adults from upstream basin habitat. SNS from Copco Reservoir spawn in the lower section of this reach (Beak Consultants Inc. 1987).

A key tributary to the peaking reach is Shovel Creek at RM 206.5. California Department of Fish and Game (2000), as cited in Federal Energy Regulatory Commission (Federal Energy Regulatory Commission 2006), considers lower Shovel Creek an important spawning tributary for rainbow trout in the J.C. Boyle Peaking Reach. However, it is not used by LRS and SNS for spawning or rearing (Dennis Maria, California Department of Fish and Game, pers. comm.).

Stranding of sucker eggs, larvae and juveniles occurs as a result of hydroelectric peaking operations and associated daily river flow fluctuations (Beak Consultants Inc. 1987; Dunsmoor 2006; PacifiCorp 2004e).

Copco Reservoir

Copco Reservoir was formed when Copco No. 1 Dam was constructed in 1918. The dam is 126-feet high, and does not include any fish passage facilities. The reservoir is 4.5 miles long, has a surface area of 1,000 acres, an average depth of 34 feet, a maximum depth of 108 feet, and a total capacity of 33,724 acre-feet. Water levels in Copco Reservoir are normally maintained within 6.5 feet of full pool, and daily fluctuations due to peaking of the J.C. Boyle and Copco No. 1 developments are typically 0.5 feet.

The reservoir is located in a canyon area, and is quite large and deep compared to the Keno and J.C. Boyle Reservoirs. It contains several coves with more gradual slopes, and large areas of thick aquatic vegetation are common in shallow areas. Nearshore riparian habitat is generally lacking, due to the cliff-like nature of the shorelines, and only very small isolated pockets of wetland vegetation exist. Water quality in the reservoir is generally degraded during the summer months, and a predictable sequence of algae blooms occur as temperatures warm, including large blooms of the nitrogen-fixing blue-green alga, *Aphanizomenon flos-aquae.*

Fish collections by OSU in Copco Reservoir during 1998 and 1999 surveys were dominated by yellow perch, unidentified larval suckers, and golden shiners (Desjardins and Markle 2000). Substantial numbers of adult SNS were captured from Copco Reservoir over the last two decades (Beak Consultants Inc. 1987; Buettner 1993; Buettner and Scoppettone 1991; Desjardins and Markle 2000). Approximately 13 percent of the adult fish collected in the OSU study were SNS. In 1998 and 1999 only three juvenile suckers (unknown species) were collected (Desjardins and Markle 2000). Thousands of sucker larvae were sampled; however, species identity was not known. Since 1976, only five LRS have been captured in Copco Reservoir (Desjardins and Markle 2000; U.S. Department of the Interior 2007). KSS were relatively abundant and KLS were rare. SNS spawn in the Klamath River just upstream of the reservoir.

Poor summertime water quality, lack of larval and juvenile rearing habitat, and large populations of non-native fish predators likely limit listed sucker populations in Copco Reservoir (National Research Council 2004).

Copco No. 2 Reservoir and Bypassed Reach

The Copco No. 1 Powerhouse discharges up to 3,560 cfs into Copco No. 2 Reservoir, which is approximately 0.25 mile in length, and was formed by the construction of the 33-foot high Copco No. 2 Dam in 1925. There are no fish passage facilities at the Copco No. 2 development, and due to its small size, PacifiCorp did not conduct any fishery sampling in Copco No. 2 Reservoir.

Copco No. 2 Dam diverts up to 3,250 cfs into a flow line, leading to a powerhouse at the head of Iron Gate Reservoir. Due to the small size of its reservoir, Copco No. 2 development operates in tandem with Copco No. 1 development. Although the existing license does not specify a ramping rate or minimum flow for the bypassed reach, PacifiCorp currently releases 5 to 10 cfs from the dam into the Copco No. 2 Bypassed Reach which is 1.5 miles in length. The bypassed reach is in a deep, narrow canyon with a steep gradient similar to that of the upstream Klamath River reaches. The channel consists of bedrock, boulders, large rocks, and occasional pool habitat.

Fisheries sampling conducted by PacifiCorp in 2001 and 2002 indicate that the fish population in the Copco No. 2 bypassed reach is comprised primarily of marbled sculpin and speckled dace, with much smaller numbers of tui chub, rainbow trout, yellow perch, black crappie, largemouth bass, and blue chubs (PacifiCorp 2004e). No suckers of any kind were collected during sampling conducted in this reach. There has not been any fish monitoring in Copco No. 2 Reservoir. Because of its small size and high rate of water exchange, it probably does not support listed suckers.

Iron Gate Reservoir

Iron Gate Reservoir was formed when Iron Gate Dam was constructed in 1962. The dam is 173 feet high and does not include any fish passage facilities. The reservoir is 6.8 miles long, has a surface area of 944 acres, an average depth of 62 feet, a maximum depth of 167 feet, and a total storage capacity of 50,941 acre-feet. Water levels in Iron Gate Reservoir are normally

maintained within 4 feet of full pool, and daily fluctuations due to peaking operation of the upstream J.C. Boyle and Copco developments are typically 0.5 feet.

Iron Gate Reservoir is similar to Copco Reservoir in that it is located in a canyon area, and is large and deep with generally steep shorelines except for a few coves with more gradual slopes. Large areas of thick aquatic vegetation are common in shallow areas. Nearshore riparian habitat is generally lacking. Due to the cliff-like nature of the shorelines, only very small isolated pockets of wetland vegetation exist around the perimeter of the reservoir. Water quality in the reservoir during the summer is generally quite poor, large blooms of the *Aphanizomenon flos-aquae* occur annually, and surface water temperatures are warm.

Fish collected in Iron Gate Reservoir during OSU's 1998 and 1999 surveys were dominated by golden shiners, tui chub, pumpkinseed, unidentified chub, yellow perch, unidentified sucker larvae, and largemouth bass, which collectively comprised 95 percent of all fish collected (Desjardins and Markle 2000). Based on fish monitoring data since 1976, no LRS and relatively few SNS were captured in Iron Gate Reservoir, (Buettner and Scoppettone 1991; California Department of Fish and Game 1976; Desjardins and Markle 2000). Adult SNS accounted for 1 percent of the adult fish catch in 1998 and 1999 (Desjardins and Markle 2000). Most of the adult SNS appeared to be older individuals. During 1998 and 1999 no juvenile suckers were captured (Desjardins and Markle 2000). Over a thousand sucker larvae were captured in this study but it is not known what species they are or their origin.

Klamath River Downstream of Iron Gate Dam

Iron Gate Dam re-regulates flow fluctuations caused by peaking operation of the upstream J.C. Boyle and Copco Nos. 1 and 2 developments to provide stable flows downstream of Iron Gate Dam. The powerhouse is located at the dam and has a maximum hydraulic capacity of 1,735 cfs. The current license stipulates a minimum flow release of 1,300 cfs from September through April; 1,000 cfs in May and August; and 710 cfs in June and July. However, since 1997, PacifiCorp had operated the project to provide flow releases dictated by Reclamation's annual operations plans. Reclamation develops these annual plans in consultation with the Service and NMFS to comply with recent BOs for protecting the federally listed coho salmon (National Marine Fisheries Service 2002) and LRS and SNS (USDI Fish and Wildlife Service 2002a). Ramping rates downstream of Iron Gate Dam are limited to 50 cfs per 2 hours not to exceed 150 cfs in 24 hours when flows are 1,750 cfs or less, and 135 cfs per hour not to exceed 300 cfs in 24 hours when flows exceed 1,750 cfs.

Downstream of Iron Gate Dam, the Klamath River flows unobstructed for 190 miles before entering the Pacific Ocean. The river basin downstream of Iron Gate Dam supports a variety of species of anadromous fish including fall and spring Chinook salmon, coho salmon, steelhead, green sturgeon, and Pacific lamprey. Although information on the non-anadromous species downstream of Iron Gate Dam is limited, Klamath smallscale sucker, speckled dace, and sculpin are common. LRS and SNS which are typically lake-dwelling species have not been documented below Iron Gate Dam (M. Buettner, USFWS, pers. comm.).

Summary

Information on the status of LRS and SNS in the action area from Link River Dam to Iron Gate Dam is less extensive than that known for sucker populations upstream of the project in UKL, Clear Lake, and Gerber Reservoir. However, investigations have been adequate to determine relative abundance and distribution of fish populations and condition of habitat. The range of listed suckers, which prefer lacustrine habitats, was expanded by the construction of J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate Reservoirs. Adult populations of SNS number up to several hundred individuals in Keno, J.C. Boyle, and Copco Reservoirs. SNS are uncommon in Iron Gate Reservoir. LRS are very uncommon except in Keno Reservoir where there appears to be up to about 100 individuals that are restricted to the upper portion of Keno Reservoir. Based on entrainment studies at Link River Dam and fish distribution studies in the project reservoirs, it appears that substantial numbers of larval and juvenile suckers disperse downstream from UKL and these expatriates reside in the Klamath River reservoirs. There is no evidence that self-reproducing populations exist in any of the reservoirs. SNS spawning and larval production occurs in Copco Reservoir, but poor summertime water quality and large populations of non-native fish predators prevent recruitment into the adult population. The National Research Council (2004) concluded that sucker populations in Klamath River reservoirs do not have a high priority for recovery because they are not part of the original habitat complex of the suckers and probably are inherently unsuitable for completion of life cycles of suckers. Maintenance of adult suckers in these reservoirs does provide insurance against loss of other subpopulations as long as the reservoirs are present. These reservoirs can provide for long-term storage of a small number of adult suckers for potential conservation use in the future, if needed.

Factors Affecting the Species Environment in the Action Area

The main factors affecting the species environment in the action area include: Klamath Hydroelectric Project facilities and operations, agricultural activities, non-native fish interactions, and poor water quality. In their comments on the draft BO, both FERC and PacifiCorp commented that the BO failed to properly distinguish between effects included in the baseline and the effects of the action (FERC comments at 3, PC comments at 4). In this revised BO, we have reconsidered our analysis, to include discussion of current and past effects of the Project and of Reclamation's activities in the Environmental Baseline section, and continuing and new effects of the proposed action in the Effects of the Action section.

1. Klamath Hydroelectric Project

The current and past effects of the Klamath Hydroelectric Project are part of the Environmental Baseline for the analysis of effects for this formal consultation. In our descriptions of past effects of the Project, below, we consistently refer to the power company as PacifiCorp. However, prior to 1961, the power company was called California Oregon Power Company (COPCO). In 1961, COPCO merged with and became part of PacifiCorp. Our references herein to PacifiCorp include its predecessor, COPCO.

a. Injury/Mortality

Entrainment at Hydropower Facilities and Spillways

Project Entrainment Studies - Entrainment is defined as the downstream movement of fish into power or irrigation diversions or spillways by drift, dispersion, and volitional migration. PacifiCorp has hydroelectric facilities at Eastside and Westside Powerhouses, J.C. Boyle Dam, Copco No. 1 Dam, Copco No. 2 Dam, and Iron Gate Dam. There are no downstream fishways (screen and bypass facilities) at any of these facilities to prevent entrainment, except for J.C. Boyle Dam where existing fishways are ineffective (see below).

The only turbine entrainment studies completed for the Klamath Hydroelectric Project were at the Eastside and Westside Power Diversions from 1997 to 1999 (Gutermuth et al. 2000b). Based on similar fish entrainment studies at A-Canal and Link River Dam, larval and juvenile (mostly age 0) suckers are likely the most vulnerable life stage to entrainment at downstream dams and hydropower developments (Gutermuth et al. 1997; Gutermuth et al. 1998; Gutermuth et al. 2000a; Gutermuth et al. 2000b). Adult suckers were uncommon in these entrainment studies except during die-off events. Although Gutermuth et al. (2000a; 2000b) did not identify sucker larvae by species, it is likely that most larvae were endangered LRS and SNS. Of the four Klamath sucker species (LRS, SNS, KLS, and KSS) only one specimen of KSS has been reported from UKL (Markle et al. 2000). KLS are common in the tributaries to UKL but rare in UKL (Markle et al. 2007; U.S. Geological Survey 2007). Thus, based on the best available evidence, it is reasonable to conclude that larval suckers being entrained at the Eastside and Westside Power Diversions and Link River spillways are federally listed suckers. Although non-listed sucker larvae exist in some Project reservoirs and riverine reaches below UKL, we are not including them in our entrainment analysis.

Entrainment studies at other facilities were not conducted for the Klamath Hydroelectric Project, even though requested by the Services (National Marine Fisheries Service 2003 DLA, 2004 FLA; U. S. Department of the Interior 2004; U.S. Department of the Interior 2003; USDI Fish and Wildlife Service 2001a). Neither turbine or spillway entrainment studies have been conducted at Keno, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate Dams.

Estimation of Project Entrainment Mortality - While fish injury and mortality rates associated with the Eastside and Westside power diversion entrainment studies were not estimated, other studies have determined that substantial turbine entrainment mortality can take place caused by pressure changes, shear stress, cavitation, turbulence, strike, and grinding (Cada 2001). The Electric Power Research Institute (EPRI) (Electric Power Research Institute 1987) reported that Francis turbines, which are used at all of the Klamath mainstem developments, caused mortality of 20 to 26 percent of juvenile salmonids (average 25 percent). For projects with Francis turbines, the EPRI study found a high correlation ($r = 0.77$) between head and fish mortality. Four hydroelectric developments with turbines that had a greater than 335 feet of head had mortality ranging from 33 to 48 percent (Electric Power Research Institute 1987). Head at the Klamath facilities ranges from 123 feet at Copco No. 1 Dam to 463 feet at J.C. Boyle Dam. The Applicant acknowledges, based on its initial review of other studies, about 10 to 20 percent of the fish entrained annually at each of the unscreened mainstem Klamath River developments are killed passing through each powerhouse ((PacifiCorp 2004c), Exhibit E 4-112). Based on these findings, we estimate turbine mortality of all life stages of suckers at all Project dams at 25 percent based on the average mortality of juvenile salmonids through Francis turbines (Electric Power Research Institute 1987). Although other studies have documented that turbine mortality is directly proportional to the length of fish passing through the turbine runner (Ruggles and

Collins 1982; Headrick 2001) as cited by PacifiCorp (PacifiCorp 2004d), we use 25 percent mortality for all life stages and sizes of suckers because there is no turbine entrainment mortality information available specifically for suckers and literature values are highly variable for other fish species. Also, this mortality rate is justified because most juvenile and adult sucker entrainment occurs during the summer and early fall months (Gutermuth et al. 2000a; Gutermuth et al. 2000b) when water quality is poor and many fish are stressed. Based on all these factors and the best scientific evidence available to us, we have selected a 25 percent mortality rate due to turbine entrainment as a reasonable estimate of turbine mortality.

Injury and mortality associated with spillway passage at Project dams is unknown. Spill mortality estimates for juvenile salmonids are numerous and range from 0-30 percent depending on species, life stage, amount or proportion of water spilled, spillway configuration, tailwater hydraulics, the methodology of estimating mortality, and predator conditions (U.S. Department of the Interior 2007). Fish passing down a spillway may experience physical, chemical and biological effects. Fish passing over spillways can be injured by strikes or impacts with solid objects (e.g. baffles, rocks, or walls in the plunge zone), rapid pressure changes, abrasion with the rough side of the spillway, and the shearing effects of turbulent water (Clay 1995). Mortality of all life stages of suckers at all Project dams without spillway improvements is estimated at 2 percent based on spillway mortality estimates for anadromous salmonids from Whitney et al. (1997) as cited in NMFS (2000). Whitney reviewed 13 estimates of spill mortality for salmonids (3 steelhead and 10 salmon) published through 1995 and concluded that 0 to 2 percent is the most likely mortality range for standard spillbays. Scoppettone et al. (1986) conducted a spillway mortality study with sucker larvae and documented very low losses of fish passing over a 40 foot high dam.

Eastside and Westside Power Diversions and Link River Dam Spillways – While turbine entrainment studies were completed for the Klamath Hydroelectric Project were at the Eastside and Westside Power Diversions, these did not include larval entrainment estimates. However, since the A-Canal is nearby and larvae drift as particles in the water column, we use the A-Canal larval entrainment numbers (Gutermuth et al. 2000b) to estimate the Eastside and Westside development entrainment numbers since it is located nearby and diversion rates are similar during the April through July larval dispersal period. Also, with the screening of the A-Canal in 2003 and based on larval sucker exclusion estimates at the A-canal (See Appendix 1), approximately 50 percent of the larval suckers that enter the A-Canal are bypassed to UKL in the vicinity of Link River Dam and approximately 75 percent of these pass downstream of Link River Dam (see Appendix 1 for description of entrainment estimate and mortality calculations). Based on these calculations, as explained in Appendix 1, we estimate the current larval entrainment mortality at the Eastside and Westside Power Diversions at up to 25 percent or 1,011,000 per year (Table 2).

Based on entrainment indices calculated from the number of fish collected, percent of canal flow sampled and sampling efficiency, an estimated 792,000 juvenile and sub-adult/adult fish passed through the Eastside Powerhouse from July 1997 through October 1999. Similarly, an estimated 528,000 fish passed through the Westside Powerhouse. The study concluded that large numbers of fish were diverted, generally proportional to the volume of flow diverted. No fish entrainment studies were conducted at other Project facilities. However, PacifiCorp estimated a median annual entrainment of 75,655 fish for reservoirs the size of J.C. Boyle, and 115,979 fish for

reservoirs the size of Copco and Iron Gate ((PacifiCorp 2004c), Exhibit E 4-112). Several fish entrainment studies were conducted at A-Canal, the major irrigation diversion for the Klamath Irrigation Project located just upstream of Link River Dam (Gutermuth et al. 1997; Gutermuth et al. 1998; Harris and Markle 1991; Markle and Simon 1993).

The effect of spillway passage on sucker larvae survival at Link River Dam is unknown. Based on larval sucker entrainment over a dam of similar height on the Truckee River (Scoppettone et al. 1986) and estimates for anadromous salmonids from Whitney et al. (1997) as cited in NMFS (2000) we estimate 2 percent mortality of larvae entrained through the spillway release gates, fishway, and auxiliary water supply (53,900).

Table 2. Sucker entrainment mortality under current operations

Facility	Eastside/Westside	Keno	J.C. Boyle	Copco No. 1	Copco No. 2	Iron Gate	Total
Current operation – Turbine Mortality							
Larvae	1,011,000	0	12,700	12,200	9,500	700	1,04,6100
Juvenile	21,258	0	324	25	19	1	21,627
Adult	21	0	0	0	0	0	21
Current operation - Spillway Mortality							
Larvae	-	11,400	100	100	100	0	11,700
Juvenile	-	294	3	0	0	0	297
Adult	-	0	0	0	0	0	0
Current operation – Total Mortality							
Larvae	1,064,900	11,400	12,800	12,300	9,600	700	1,111,700
Juveniles	22,959	294	327	25	19	1	23,625
Sub-adult/adult	23	0	0	0	0	0	23

Thousands of age 0 and age 1 juvenile suckers were entrained at both the A-Canal and Eastside and Westside Power Diversions, and in 1997 and 1998 about 45,000 and 246,000 juvenile suckers were entrained at A-Canal, mostly during the months of August and September (Gutermuth et al. 1997; Gutermuth et al. 1998; Gutermuth et al. 2000a; Gutermuth et al. 2000b). Prior to construction of the A-Canal fish screen facility, the estimated annual entrainment of suckers for the Eastside and Westside Power Diversions combined was 21,182 (1997), 82,817 (1998) and 41,405 (1999); most of these were age 0 suckers. In 2006, a large sucker production year in UKL, it appears that juvenile sucker entrainment at Link River Dam including Eastside and Westside Power Diversions was much larger than the previous high year (1998;(Tyler 2007)).

Juvenile sucker entrainment at Eastside and Westside Power Diversions and Link River Dam has increased since the A-Canal was screened in 2003, resulting in the bypass of fish excluded from A-Canal to a location near Link River Dam. Using the highest estimated juvenile sucker entrainment into A-Canal (246,000) before the screen was installed (Gutermuth et al. 2000a), it is reasonable to assume that 50 percent of these fish swim back to UKL after passing through the screen and bypass facility and 50 percent move downstream towards Link River Dam (see Appendix 1). Further, PacifiCorp operates Eastside and Westside Power Diversions differently during the peak juvenile sucker entrainment period (July to October) to reduce entrainment.

During this period, PacifiCorp shuts down Westside Powerhouse and operates Eastside Powerhouse at full capacity (1200 cfs) only during the daylight hours when sucker entrainment is low, and the diversion rate is about 200 cfs at night. We estimate that this operation results in 25 percent of the juvenile and sub-adult/adult suckers approaching Link River Dam returning to UKL (see Appendix 1). Therefore, we estimate that up to 170,062 juvenile suckers are entrained here each year including 50 percent through the Eastside and Westside Power Diversions (85,031) and 50 percent through the Link River Dam spill gates. Currently, juvenile sucker turbine mortality at the Eastside and Westside Power Diversions is estimated at up to 21,258 fish per year (Table 2). Spillway mortality at Link River Dam is estimated at 2 percent ((Whitney et al. 1997) as cited in NMFS (2000)) or 1,701 juvenile suckers.

The largest measured annual entrainment of federally listed sub-adult/adult suckers at the Eastside and Westside Power Diversions during a non fish die-off year was 14 in 1998 (Gutermuth et al. 2000b). Before the A-Canal was screened, 411 federally listed sub-adult/adult suckers were entrained into the canal (Gutermuth et al. 2000a). Presently, adult suckers entering the A-Canal are bypassed back to UKL and we estimate that 50 percent of these fish disperse downstream to Link River Dam (see Appendix 1). We estimate that about 84 sub-adult/adult suckers are entrained at Eastside and Westside Power Diversions and 84 through Link River Dam release gates, fish ladder, and auxiliary water supply yearly (Appendix 1). Turbine and spillway mortality under current operations is estimated at 21 and 2 sub-adult/adult suckers (Table 2). Less than two percent of the total estimated sucker mortality at Link River Dam occurs among juvenile and sub-adult/adult suckers.

Keno Development - Most larval suckers in Keno Reservoir were captured in the upper portion of the reservoir in close proximity to the major source of downstream dispersing fish from UKL, and few at sampling locations downstream near Keno Dam (Terwilliger et al. 2004). It is likely that some of the larval suckers entering Keno Reservoir from UKL continue to move downstream of Keno Dam due to the lack of emergent vegetation habitat in Keno Reservoir (Cooperman and Markle 2004). Water quality conditions in Keno Reservoir are generally good during the larval sucker life stage (April-June), allowing them to survive. We estimate 10 percent of the larval suckers dispersing into Keno Reservoir survive and reside in the reservoir. Further, Desjardins and Markle (Desjardins and Markle 2000) documented many larval suckers in J.C. Boyle Reservoir, which they suggested serves as a downstream sink for larval suckers dispersed from UKL. Based on the estimated number of sucker larvae dispersing downstream of Link River Dam and the numbers sampled in the lower sections of Keno Reservoir (Terwilliger et al. 2004), larval sucker downstream passage at Keno Dam is estimated at about 10 percent of the fish entering Keno Reservoir from UKL (up to 567,500 larvae). Because water exits Keno spillways via undershot gates with small openings and high pressure, and plunges into a wide, shallow bedrock sill that is an area known for predatory fish (Oregon Department of Fish and Wildlife 2006a) , we estimate that about 2 percent mortality occurs under current operations (i.e., about 11,400 larval suckers). This estimate is consistent with Whitney et al. (1997), as cited in NMFS (2000).

Up to 85,031 juvenile suckers are entrained at Eastside and Westside Power Diversions and a similar amount pass through the spillway release gates each year (Gutermuth et al. 2000b) (Table 2), and they are common in Keno Reservoir (PacifiCorp 2004e; Terwilliger et al. 2004). We estimate that 10 percent of the juvenile suckers survive and reside in Keno Reservoir. However,

juvenile suckers are rare in the lower portion of Keno Reservoir during the summer (Hummel 1993; Terwilliger et al. 2004) and below Keno Dam (PacifiCorp 2004e). Poor summertime water quality conditions in Keno Reservoir may cause suckers to disperse downstream, and of those remaining, few survive (PacifiCorp 2004e; Piaskowski 2003). Desjardins and Markle (Desjardins and Markle 2000) documented many juvenile suckers in J.C. Boyle Reservoir, a portion of which were probably expatriates from upstream habitats. Thus, based on this information, we estimate that currently about 10 percent of the juvenile suckers dispersing downstream from UKL pass through Keno Dam spill release gates, sluiceway, auxiliary water supply system, and fish ladder annually (up to 14,710 juvenile suckers). We estimate that approximately 294 juvenile suckers (2 percent) die annually as a result of inadequate passage facilities at Keno Dam (see Appendix 1).

Based on the small number of sub-adult/adult suckers entrained at Eastside and Westside Power Diversions (Gutermuth et al. 2000b) and Link River Dam annually (up to 168 fish; Appendix 1) and the small numbers of adults sampled in Keno Reservoir (Terwilliger et al. 2004), we estimate that 10 percent (15) of those fish entering Keno Reservoir move downstream and pass Keno Dam, of which 0 dies as a result of inadequate downstream fishway facilities.

J.C. Boyle Development – The J.C. Boyle development has a fish screen and bypass facility. These facilities are partially functional, but do not conform to current State or Federal criteria (Oregon Department of Fish and Wildlife 2006b; USDI Fish and Wildlife Service 2005b). Screen approach velocity is nearly six times the current criteria of 0.4 feet per second. The ineffectiveness of the screen is demonstrated by the large number of unidentified suckers and trout that pass downstream through or around fish screens. ODFW counted numerous trout and unidentified suckers in the power canal during fish salvage operations (Oregon Department of Fish and Wildlife 2006a). PacifiCorp (PacifiCorp 1997) also reported tagging a high number of fish as a result of a salvage operation in the canal below the dam. Finally, radio-tracking results showed a 14-inch trout passed upstream through the J.C. Boyle ladder, and the same fish also migrated downstream through the power canal and turbines. It was not excluded by screens (PacifiCorp 2004e).

This information indicates both small and large fish are passing through or around downstream screens at J.C. Boyle Dam, and are subject to turbine mortality and injury. Larval suckers are also likely impinged on the screens because of the high approach velocity. Entrainment of endangered suckers at J.C. Boyle development is unknown, but based on our estimate that 10 percent entering the reservoir disperse downstream (Terwilliger et al. 2004), we estimate that up to 56,400 larvae; 1,442 juveniles; and 1 sub-adult/adult suckers pass downstream at the dam under current operations (Appendix 1).

Turbine mortality for high head facilities with Francis turbines like J.C. Boyle development ranged from 33 to 48 percent (Electric Power Research Institute 1987). However, since the current screen and bypass facility is partially functional we estimate 25 percent mortality of fish entering the facility. The Service estimates current entrainment mortality of 12,700; 324; and 0 larval, juvenile, and sub-adult/adult suckers through the turbines, respectively (Table 2 and Appendix 1). Spillway mortality is estimated at 100 larvae, 3 juveniles, and 0 sub-adult/adult suckers.

Copco No. 1 Development - Many larval suckers were collected in Copco Reservoir (8,729) in 1998 and 1999 (Desjardins and Markle 2000). However, the source and identity of these suckers was unknown. In Copco Reservoir, they probably represent a combination of SNS and KSS because there are relatively large adult populations in that reservoir (several thousand individuals) and SNS have been documented spawning in the Klamath River upstream of the reservoir (Beak Consultants Inc. 1987; Buettner and Scoppettone 1991; Desjardins and Markle 2000). We estimate the current turbine mortality of endangered larval suckers to be 12,200 larvae at Copco No. 1 based on the relative number of SNS larvae produced in the Klamath River (Beak Consultants Inc. 1987), number sampled in the Copco Reservoir (Desjardins and Markle 2000) and dispersal from J.C. Boyle Reservoir. Juvenile and sub-adult/adult turbine mortality is estimated at 25 and 0 fish, respectively (25 percent; Table 2). With 10 percent of the fish entrained through the spillway and 2 percent mortality (see Appendix 1), 100 larvae, 0 juveniles, and 0 sub-adult/adult suckers are killed.

Copco No. 2 Development - Because of the small size of Copco No. 2 Reservoir and short water residence times, all suckers surviving downstream passage through Copco No. 1 Dam likely move downstream through Copco No. 2 development. Estimated turbine mortality under current operations is 9,500 larvae, 19 juveniles, and 0 sub-adult/adults (Table 2). Spillway mortality is estimated at 100 larvae, 0 juveniles, and 0 sub-adult/adults.

Iron Gate Development - Desjardins and Markle (2000) collected over 1,100 sucker larvae during their fisheries studies on Iron Gate Reservoir in 1998 and 1999. Due to the rarity of LRS and SNS in Iron Gate Reservoir, low numbers of endangered suckers dispersing downstream from UKL and poor survival of larval suckers produced in the Klamath River above Copco Reservoir, the collected sucker larvae were probably mostly KSS with few endangered LRS and SNS. No juvenile suckers and only 13 SNS adults were captured in Iron Gate Reservoir were captured in Copco Reservoir in 1998 and 1999 (Desjardins and Markle 2000).

At Iron Gate Dam, based on the relative number of suckers captured in Iron Gate Reservoir (Desjardins and Markle 2000) and dispersal rates used upstream, we estimate that approximately 10 percent of the larval and juvenile suckers entering the reservoir from Copco No. 2 are entrained through the turbines (90 percent) and spillway (10 percent). Estimated turbine mortality under current conditions includes 700 larvae, 1 juvenile, and 0 sub-adult/adults. There is no spillway mortality.

False Attraction and Harm at Tailrace Barriers

The Klamath Hydroelectric project has powerhouses and associated turbine discharge structures at Eastside and Westside Power Diversions, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate developments. None of these facilities have tailrace barriers to exclude fish from being falsely attracted to their discharges and injured or killed by contacting powerhouse structures.

Water discharging from the Eastside and Westside Power Diversions frequently represents a significant portion of the total river flow of the Link River (Federal Energy Regulatory Commission 2006). The natural tendency for fish attracted to such an area is to hold and wait for passage conditions to improve, or to attempt to move past the obstacle either by swimming or leaping. Depending on powerhouse operations, draft tube discharge velocities at Project

facilities are between 3.4 and 10.4 feet per second (CH2MHill 2006); these velocities easily fall within the swimming abilities of suckers (Bell 1986; Koch and Contreras 1972; USDI Bureau of Reclamation 2002). The types of injury sustained by some fish entering draft tubes or contacting turbines vary from site to site, as do immediate and delayed mortality rates. Several studies, however, attribute injuries in migrating salmonids to powerhouse structures associated with tailrace structures (Department of Fisheries Canada 1958; International Pacific Salmon Fisheries Commission 1976; Schadt et al. 1985); Williams 1985 as cited in (U.S. Department of the Interior 2006) Section C-66).

While it is known that adult anadromous fish are attracted into oncoming flows (National Marine Fisheries Service 2004 FLA), there have been no studies to evaluate the effects of turbine discharges on suckers in the Klamath Hydroelectric Project. Reclamation conducted adult sucker radio telemetry studies in Link River from 2002 to 2004 but did not discuss migration delays associated with false attraction to hydropower canal discharges as a potential problem (Piaskowski 2003; Piaskowski et al. 2004). However, it is likely that false attraction to hydropower discharges occurs during dry years when most of the flow passing Link River Dam is diverted through the Eastside and Westside Power Diversions.

Migration upstream may be delayed when tailrace flows from the powerhouse exceed river bypass reach flows. A migration delay, or combined delays at several facilities, may prevent fish from reaching suitable spawning habitat when they are ready to spawn or conditions are optimal for survival. Migration delays caused by tailrace effects may have a greater impact on fish populations than injury and mortality from turbine impacts (Federal Energy Regulatory Commission 1994). Migration delays may occur to a greater percentage of migrating fish than the percentage of fish impacted by turbine mortality.

The impacts of unscreened turbine discharges on adult sucker injury or mortality are unknown but because draft tube discharges are within the swimming abilities of adult suckers, some injury and mortality is likely under current operations. Based on the number of adult suckers Reclamation sampled in Keno Reservoir in 2002-2005, we estimate up to 200 listed suckers migrate up the Link River during the spring spawning season. Up to 2 fish may be injured annually in the Eastside and Westside Power Diversions. Adult sucker spawning migration delays are a more serious impact particularly during dry years when most of the Link River flow is directed through the Eastside and Westside Power Diversions and river bypass reach flows are low. We estimated that up to 20 adult suckers may be falsely attracted to turbine discharges each year and unable to reach suitable spawning habitat when they are ready to spawn or conditions are optimal for survival.

Stranding and Ramp Rate Effects

Hydroelectric facilities typically have the capacity of increasing or decreasing flow levels downstream of the facilities. In general, the rate at which these changes occur is called the "ramp rate" or "ramping." Project ramping occurs when power generation operations require an increase or decrease in flow through the turbines for shifts in power demand, or to adjust for other reasons. Ramping occurs during Project drawdown and when outflow is reduced to facilitate reservoir refill. Ramping can also occur when maintenance activities require lower

reservoir levels to provide access to structures. Unplanned outages are an uncontrollable cause of Project ramping. Project start-up after planned and unplanned outages also involves ramping.

Sudden flow changes in stream reaches due to Project ramping can adversely impact fish and aquatic resources. Significant rapid flow reduction in bypassed, peaking, and regulated reaches affects a fish population by dewatering spawning, rearing, or foraging habitat and strands fish. Rapid flow increases in bypassed, peaking, and regulated reaches can wash out existing spawning areas, displace fry, and displace macro-invertebrates which are food for fish in these reaches. One very significant ramping event at a very unusual time can cause a significant limiting condition for one or more age classes of fish or a section of habitat to be impacted for a long period (Hunter 1992). Cushman (Cushman 1985) reviewed effects on rapidly varying flows downstream of hydroelectric facilities and found flow fluctuations reduce fish and invertebrate density.

Large flow fluctuations can also result in increased erosion of important small substrates such as gravel or small cobble, which can reduce available habitat for spawning fish and macro-invertebrate species. Daily and hourly flow fluctuations may increase the rate of erosion of shallow shoreline habitats, and with the cumulative effect of sediment recruitment blocked by dams, magnifying the effect on aquatic, terrestrial, riparian, botanical, and recreational resources.

Current ramp rates at Link River Dam were established in 1987 through collaboration with ODFW. 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 2004d). Prior to the 1996 BO, at which time endangered sucker salvages were first required in the Link River (USDI Fish and Wildlife Service 1996), numerous fish die offs associated with stranding were documented in Link River when flows dropped below 300 to 500 cfs (Oregon Department of Fish and Wildlife 2006a).

PacifiCorp was required by the 1996 BO to inspect the shoreline areas and side channels of the Link River for any suckers that might become stranded or trapped as flows are ramped down to less than 300 cfs (USDI Fish and Wildlife Service 1996). Substantial numbers (up to 138) of stranded juvenile suckers (age 0 and age 1) were salvaged and returned to the Link River in 1995-1997, 1999, and 2000, as required, when flows were reduced to below 300 cfs at Link River Dam (USDI Bureau of Reclamation 2000). Overall, based on salvage operations conducted from 1995 to 2003, the number of stranded and subsequently salvaged suckers was generally higher following high spill events during the spring than at lower flows and other seasons (USDI Bureau of Reclamation 2000). Fish salvages are only moderately effective, capture the fish that are obviously stranded, are limited by available manpower, and require immediate action following drawdown. Fish salvages are not effective for fish that have already died, been removed by predators, or not visible due to channel or vegetative conditions that block detection.

There is no ramp rate restriction for discharges at Eastside Powerhouse, which influences about 800 feet of stream. Standard operating procedure is to drop flows 100 cfs per 15 minutes (400 cfs/hour). This equates to a stage drop of 4 to 5 inches per hour (at the USGS gauge). Numerous observations in this reach indicated that fish stranding does not occur at this down ramp rate; however, some entrapment occasionally occurs at a single small location on the left bank as

flows drop to less than 450 cfs (PacifiCorp 2004e). Because of this, in the 1996 BO the Service required PacifiCorp to monitor this location and salvage any trapped fish whenever flows are reduced to less than 450 cfs (USDI Fish and Wildlife Service 1996).

Our review of USGS Link River gage data provided to us by PacifiCorp revealed four instances of abrupt flow reductions exceeding the standard down ramp rate of 100 cfs per hour in recent years. On May 28, 2005, flows dropped from 2,700 cfs to 1,150 cfs; April 26, 2006 from 1,900 cfs to 1,250 cfs; May 23, 2006 from 2,800 cfs to 1,700 cfs; and April 17, 2007 from 1,390 cfs to 580 cfs, each over about 15 minutes (USGS Link River gage data). These flow reductions occurred during the migration period for spawning suckers and may have delayed or disrupted migration.

The lower Link River is an important staging area for adult suckers during their spawning migration and critical water quality refuge habitat for juvenile and adult suckers during summer when water quality conditions are poor in Keno Reservoir (Piaskowski 2003). Large flow reductions and low flows crowd suckers into a smaller area, or force them to occupy lower quality habitat in Keno Reservoir where they are more vulnerable to stress and mortality from poor water quality (Piaskowski 2003). Lower flows and reduced water depths in the lower Link River may also lead to higher predation rates by fish and fish-eating birds. Current operation of Eastside and Westside Power Diversions with existing Link River minimum flow requirements and ramp rates, may strand hundreds of juvenile suckers in the Link River annually, delay or disrupt the LRS and SNS spawning migration, and may force fish out of the water quality refuge area during the summer leading to stress and mortality at flows less than about 500 cfs (R. Piaskowski, Geoengineers pers. comm.).

Up to 2.7 million sucker larvae pass downstream through Link River Dam release gates each year and are vulnerable to stranding because of their poor swimming ability, small size, and shoreline orientation. However, there is no information on larval stranding in the Link River. Based on the large number of larvae dispersing through this reach, stranding mortality is estimated at up to 5,000 sucker larvae each year during down ramping. With up to 85,000 juvenile suckers dispersing downstream through Link River Dam spillway we estimate up to 500 could be stranded per year (Mark Buettner, USFWS, pers. comm.). We do not believe that sub-adult/adult suckers are stranded because they have not been reported in previous spillway termination salvage efforts (USDI Bureau of Reclamation 2000) and they tend to occupy deeper areas that are not prone to dewatering.

PacifiCorp has implemented a voluntary ramp rate below Keno Dam of 500 cfs or 9 inches per hour (PacifiCorp 2004e). Many fish die-offs have occurred in the Keno Reach since ODFW staff began to keep records in their monthly reports (Oregon Department of Fish and Wildlife 2006a). Project impacts result from periodic low flows in combination with a high down ramp rate (Tinniswood 2006). Impacts are greatest during very warm or very cold water temperatures and often lead to fish die-offs. For example, the June 2003 rapid declines in flow from 1,390 cfs to 273 cfs and high water temperatures led to a large fish die-off due to stranding and stressful conditions. In December 2005, a flow reduction of 1,140 cfs to 333 cfs in about 15 minutes occurred resulting in a die-off of thousands of blue chubs and fathead minnows, and several redband trout (Mark Buettner, USFWS, pers. comm.). No endangered suckers have been documented in die-offs related to down ramping in the Keno reach. However, current operation

of Keno Dam with existing ramp rates may strand an unknown number of sucker larvae dispersing downstream during the spring and summer, and juvenile suckers dispersing downstream throughout the year. Under current conditions, the Service estimates that up to 2,000 larvae and 100 juveniles may be killed due to stranding, based on estimates of suckers passing through the Keno Reach identified in the previous section on entrainment.

The Commission license, as continued through current annual licenses, requires PacifiCorp to ramp up and ramp down flow changes in the J.C. Boyle Bypassed Reach at a rate of less than 9 inches per hour (about 700 cfs). While fish stranding and mortality events due to down ramping are less common in the J.C. Boyle Bypassed Reach due to the relatively constant flow of 100 cfs below J.C. Boyle Dam, with an additional 220 to 250 cfs of spring flow accruing in the upper mile of the bypassed reach and to the rarity of down ramping events (mostly during February through May), occasional fish die-offs occur due to high down ramp rates (Oregon Department of Fish and Wildlife 2006a). No endangered suckers have been reported from these events; however, fish die-offs are also less obvious at this location since river reaches below J.C. Boyle Dam have more remote access. We estimate that under current operations stranding of up to 200 larvae and 10 juvenile suckers occurs in the bypassed reach each year based on estimates of suckers passing through the J.C. Boyle identified in the previous section on entrainment.

The current Commission ramp rate requirement for the J.C. Boyle Peaking Reach is 9 inches per hour. Current rates of stage decline are generally between 4.8 and 9 inches per hour (PacifiCorp 2004e). PacifiCorp conducted fish stranding observations in 2002 and 2003 in the J.C. Boyle Peaking Reach (10 study sites) and observed 0 fish stranded in 2002, and 6 fish stranded in 2003 (including one juvenile sucker) (PacifiCorp 2004e). However, examination of isolated pools and side channels found trapped trout fry, larval suckers, and dace. Dunsmoor (Dunsmoor 2006) observed thousands of stranded larval and juvenile fish including several larval suckers in the peaking reach during the first major peaking cycle of the year on July 5. Observations during subsequent peaking cycles noted fewer stranded fish (Dunsmoor 2006). Stranding potential appears to be highest at the upper end of the peaking reach. Stranding is reduced downstream because of ramp rate attenuation. For example, PacifiCorp (PacifiCorp 2004e) quantified dominant ramp rates (for single turbine down ramps to low flows near 350 cfs) of 9.36 in/hour over 3.5 hrs at the USGS gage below J.C. Boyle Powerhouse; 5.22 in/hr over 4.25 hrs at Frain Ranch; and 2.90 in/hr over 6.0 hrs at sites downstream of Shovel Creek.

There are also ramp rate impacts to SNS that ascend from Copco Reservoir to spawn in the lower portion of the peaking reach (Beak Consultants Inc. 1987). Stream flows in this reach that are affected by peaking operations result in wide daily fluctuations ranging from about 350 to 3,000 cfs. Beak (Beak Consultants Inc. 1987) identified that approximately 9.5 percent of the Klamath River between Copco Reservoir and the Oregon/California border was composed of areas subject to stranding of larvae at low flows. The Service estimates that current ramp rate operations result in dewatering of up to 100,000 sucker eggs and stranding and mortality of up 10,000 SNS larvae in the Boyle peaking reach each year (Mark Buettner, USFWS, pers. comm.).

Ramp rate effects on listed suckers below Copco No. 1, Copco No. 2, and Iron Gate Dams are unknown. However, because there is no riverine habitat between Copco No. 1 and Copco No. 2 and water levels rarely fluctuate more than a few inches, stranding potential below Copco No. 1 is minimal. However, since sucker larvae are fairly common in Copco No. 1 Reservoir, some

downstream dispersal and stranding likely occurs below Copco No. 2 in the bypassed reach. 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. We estimate current larval and juvenile sucker stranding mortality at 100 and 1 fish per year respectively in the Copco No. 2 Bypassed Reach based on the estimated number of suckers dispersing through this area (Appendix 1). The current Commission license required ramp rate for Copco No. 2 Bypassed Reach is 9 inches per hour.

Since endangered suckers in Iron Gate Reservoir are rare and few suckers disperse below the dam (see previous section), current operation of the Iron Gate development results in no stranding and mortality of larval, juvenile, and sub-adult/adult suckers.

Rapid flow increases or up-ramping can have negative impacts on fish and their habitats (Hunter 1992). Since most of the riverine reaches below Project dams are primarily migration corridors for downstream dispersing suckers and upstream migrating adult suckers, rapid up-ramping under current conditions most likely effects sucker spawning. It likely results in increased erosion of sucker spawning substrate and egg scouring in the lower J.C. Boyle Peaking Reach. Also, the listed sucker migrations up the Klamath River above Copco Reservoir and Link River may be delayed or disrupted, reducing spawning success for up to a few hundred suckers in the lower Boyle peaking reach and up to about 200 suckers from Keno Reservoir.

Summary – Operation of Project developments and associated ramp rates has in the past and currently strands suckers, but because these habitats are not part of the original habitat complex of the suckers and probably are inherently unsuitable for completion of life cycles of suckers, there are minimal impacts within the context of the overall population size and geographic range of LRS and SNS.

Reservoir Fluctuations and Stranding Potential

An agreement between PacifiCorp and Reclamation specifies that the maximum water surface elevation of Keno Reservoir should be at 4,086.5 feet and the minimum water surface elevation should be at 4085 feet. However, at the request of irrigators, PacifiCorp generally operates Keno Dam to maintain the reservoir at elevation 4085.4 +/-0.1 feet from October 1 to May 15 and at elevation 4085.5 +/-0.1 feet from May 16 to September 30 to allow consistent operation of irrigation canals and pumps. Because Keno Dam is operated to maintain a nearly constant reservoir level, there is little potential for fish stranding. However, once a year, at the request of irrigators, PacifiCorp draws the reservoir down about 2 feet over a period of 24 hours (drawdown rate of less than 1 inch per hour) for 1-4 days in March or April, so that irrigators can conduct maintenance on their pumps and clean out their water withdrawal systems before the irrigation season. The Service anticipates that up to 1,000 sucker larvae are stranded as a result of this operation annually. Because juvenile and adult suckers occupy deeper water, we do not anticipate any stranding of these life stages.

While the J.C. Boyle Reservoir can operate within a range of 5.5 feet (Federal Energy Regulatory Commission 2006), the reservoir generally fluctuates 1-2 feet per day and up to 2 inches per hour. At these rates there is little opportunity for fish stranding except for larval suckers that are poor swimmers. We estimate that based on the relative number of sucker larvae

collected by Desjardins and Markle (Desjardins and Markle 2000) and number of estimated sucker larvae dispersing through J.C. Boyle Reservoir (Appendix 1), that up to 5,000 larvae could be stranded each year. More importantly, larval and juvenile suckers using the shallow shoreline habitats may be temporarily displaced on a daily basis. The impact of this displacement on fish behavior, predation, and rearing is unknown. Predation by non-native fish has been identified as an important factor limiting the recovery of other sucker populations (Scoppettone and Vinyard 1991). The reservoir is well known for its largemouth bass fishery and has populations of yellow perch and brown bullheads (Oregon Department of Fish and Wildlife 1996). Predation by these non-native fish species on larval and juvenile suckers undoubtedly occurs as a result of reservoir fluctuations that displace fish from shoreline cover habitat, making them more vulnerable to predation. We estimate that up to 5,000 larvae and 1,000 juveniles may be killed by predation associated with daily reservoir fluctuations.

Copco and Iron Gate Reservoir water levels are normally maintained within 6.5 feet and 4 feet of full pool, respectively, and average daily fluctuations are less than 0.5 feet (less than 1 inch per hour; Federal Energy Regulatory Commission 2006). However, maximum daily fluctuations up to 3.0 feet occur on rare occasions. Although thousands of sucker larvae were collected in Copco No. 1 Reservoir (Desjardins and Markle 2000), because of the small daily water level fluctuations and the lack of shallow shoreline habitat with gradual slopes, the Service estimates that up to 1,000 larval suckers are stranded per year in Copco No. 1 Reservoir. Catches of larval suckers in Iron Gate Reservoir in 1998 and 1999 were about 15 percent lower than catches in Copco Reservoir. Therefore, based on the relative numbers of larval suckers collected by Desjardins and Markle (2000), the generally steep shorelines and the small daily water level fluctuations, we estimate annual larval sucker stranding at up to 100 fish in Iron Gate Reservoir. No juvenile and sub-adult/adult suckers are likely stranded because they are generally located in deeper water and have better swimming ability to escape shallow water. Because of the small daily reservoir fluctuations and lack of emergent vegetation habitat providing cover for larval and juvenile suckers in Copco and Iron Gate Reservoirs, we do not believe there are increased predation impacts due to habitat displacement.

b. Migration Barriers

Historically, larval and juvenile suckers dispersing from UKL to the Klamath River above Keno Dam and Lower Klamath Lake probably reared in this shallow productive environment with extensive emergent wetlands and returned to UKL and its tributaries to spawn as adults (Gutermuth et al. 2000a; USDI Fish and Wildlife Service 2002a). Now most fish moving out of UKL likely perish due to the lack of rearing habitat and poor water quality in Keno Reservoir or disperse downstream beyond Keno Dam. Before the development of PacifiCorp's Klamath Hydroelectric Project, some suckers dispersing into the Klamath River below Keno Dam probably moved back upstream into lacustrine habitat. Suckers that did not return upstream over the reef at Keno Dam were lost downstream. Currently, because of the presence of lake habitats available in J.C. Boyle, Copco, and Iron Gate Reservoirs, refuge populations exist, consisting of mostly adult suckers that probably dispersed from upstream habitats as larvae and juveniles (Desjardins and Markle 2000; National Research Council 2004).

In 2005, the Reclamation, owners of Link River Dam, built a new fishway at the dam that meets recommended design criteria and guidelines for upstream fish passage of federally listed suckers

(Oregon Department of Fish and Wildlife 2006b; USDI Fish and Wildlife Service 2005b). Reclamation installed a PIT tag detection system in 2005, and a fish trap at the top end of the fishway in 2007, to monitor fish passage at the facility. Preliminary monitoring results indicate both LRS and SNS are passing upstream through this fish ladder (T. Tyler, Reclamation, pers. comm.). In 2005, 6 radio-tagged LRS that originated from UKL and were released in Lake Ewauna successfully negotiated the fish ladder (Reclamation, unpublished data).

The Link River contains a series of cascading drops consisting of bedrock and large alluvial material. The main cascade provides a drop of about 15 feet in elevation over a length of about 450 feet. Nearly 10 feet of the drop is concentrated in a single cascade that is about 100 feet long. The main cascade starts about 320 feet downstream of the dam with the steepest section starting about 500 ft downstream of the dam. Adult sucker passage may be restricted at low flows during the springtime spawning migration when the drop at the cascade is greatest (PacifiCorp 1997; USDI Bureau of Reclamation 2000)

From high-water marks, it appears during high flows that the drop at the falls is much less, making it easier for fish to pass the falls. A release of 2,500 cfs was observed to completely inundate the falls (USDI Bureau of Reclamation 2000). Better passage at higher flows is supported by data obtained in the fish trapping study in 1988-1991 at the Link River Dam fish ladder (PacifiCorp 1997). During the low flow years of 1988, 1990, and 1991 (flows generally less than 500 cfs), no suckers were trapped in the old Link River Dam fish ladder. However, during the high flow year of 1989 (flows ranged from 1,500 to 3,900 cfs), 18 suckers were sampled from the fish trap in the ladder.

However, more recent sucker passage data does not corroborate earlier observations that passage at the cascade may be restricted at lower flows. In 2002, 10 radio-tagged suckers migrated up the Link River during May and 4 moved above the falls to the base of the Link River Dam during spills ranging from 1,010 to 1,475 cfs (Piaskowski 2003). In 2003, 6 of 8 adult suckers migrated above the falls during May at flows ranging from 233 cfs to 831 cfs. In August 2002 and 2003, one adult SNS moved above the falls at dam releases of 282 cfs and 252 cfs, respectively.

To address fish passage conditions in the cascade reach of Link River, Reclamation conducted a hydraulic modeling study (USDI Bureau of Reclamation 2005). Based on modeling flow velocity simulations at flows ranging from 1,000 to 4,000 cfs, conditions supporting fish passage through the cascade become progressively worse at higher flows (USDI Bureau of Reclamation 2005). Therefore, during wet years when releases are several thousand cfs, sucker migration past the cascade may be restricted due to high velocities. Current operation of Eastside and Westside Power Diversions at Link River Dam likely restricts adult sucker migration at flows less than about 300 cfs in the Link River Bypassed Reach because of the location of turbine outlets and at flows greater than 3,000 cfs because of the flow hydraulics in the cascade reach. With fewer adults able to migrate to spawning habitat in the Sprague and Williamson Rivers, production and recruitment to the LRS and SNS populations will be negatively impacted.

Although Keno Dam has a fish ladder, it does not meet Service and ODFW criteria for sucker passage. The fishway slope is too steep for suckers, and automated weirs 25 through 28 lack adequate orifice passage so that fish using the ladder have to jump over the last four weirs to pass

into the reservoir (Oregon Department of Fish and Wildlife 2006a; USDI Fish and Wildlife Service 2005b). Suckers will pass through orifices but apparently do not jump over weirs. The Keno Dam fishway and auxiliary water supply system have attraction hydraulics and flow regulation problems (USDI Fish and Wildlife Service 2005b).

Based on previous fish population monitoring in J.C. Boyle Reservoir (Desjardins and Markle 2000; USDI Bureau of Reclamation 1993), the adult listed sucker populations are likely up to several hundred individuals. Some of these fish may migrate up to Keno Dam each year during the springtime spawning migration. Some suckers may be successfully using the existing ladder at Keno Dam to go upstream of the dam; monitoring of fish passage at Keno Dam fish ladder from 1988 to 1991 documented only 6 LRS and 3 SNS (PacifiCorp 1997). Thus, the current operation of the existing upstream fishway at Keno Dam may restrict upstream migration of endangered suckers from J.C. Boyle Reservoir and those entrained from UKL and Keno Reservoir. Based on the estimated number of adult federally listed suckers in J.C. Boyle Reservoir we estimate that approximately 20 percent migrate upstream each year to spawn (Mark Buettner, USFWS, pers. comm.) and are blocked at Keno Dam (up to 100 fish per year). Based on the estimated number of suckers entrained at Keno Dam (Appendix 1), 14,795 juveniles and 207 sub-adults/adults may be lost to the populations upstream since they cannot return upstream. Because of the lack of information on sucker population status in J.C. Boyle Reservoir and the numbers of suckers successfully migrating through the Keno ladder are unknown, the current need for a new ladder is unclear. The Service considers the amount of information available to be inadequate to assess either the existing degree of impact on the sucker populations or the potential utility of modifying this ladder for sucker use. The Service has recommended additional studies to evaluate the need for a ladder built to sucker criteria at Keno Dam under its Section 10(j) authority.

No endangered suckers were documented using the J.C. Boyle Dam ladder in 1988-1991 (PacifiCorp 1997). ODFW identified numerous problems with this ladder that restrict fish passage including lack of attraction flow, steep slope, high turbulence, small pool volume, poor entrance location, and flow fluctuations. Since this ladder is inadequate and does not meet design criteria for suckers, the fish passage study results may not accurately represent the number of fish attempting to migrate upstream. However, fish surveys conducted in the J.C. Boyle Bypassed Reach and J.C. Boyle Peaking Reach by PacifiCorp in 2001 and 2002 documented no adult endangered suckers (PacifiCorp 2004d). There is a population of hundreds of adult SNS in Copco Reservoir that spawn in the lower section of the J.C. Boyle Peaking Reach but do not migrate up through the high gradient J.C. Boyle Peaking Reach to get to J.C. Boyle Dam (Beak Consultants Inc. 1987). Therefore, current operation of J.C. Boyle fish ladder has no impact to adult LRS and SNS because none appear to be attempting to migrate upstream of the dam to spawn or return to upstream rearing areas.

There are no upstream fishways at Copco No. 1, Copco No. 2, and Iron Gate Dams. However, since adult endangered suckers are rare or absent in Copco No. 2, uncommon in Iron Gate Reservoir, and absent in the Klamath River below Iron Gate Dam (because of the lack of lake or reservoir habitat), there are currently no effects on upstream sucker spawning migrations at these facilities.

c. Degradation and Loss of Habitat

Instream Flows

The ecological structure and functioning of aquatic, wetland, and riparian ecosystems depends largely on the hydrologic regime, or pattern and quantity of water flowing through the system (U.S. Department of the Interior 2006). Intra-annual variation in hydrologic conditions plays an essential role in the dynamics among species within such communities through influences on reproductive success, natural disturbance, and biotic interactions (Poff and Ward 1989). Modifications of hydrologic regimes can indirectly alter the composition, structure, and functioning of aquatic, riparian, and wetland ecosystems. The literature consistently illustrates the adverse effect of inadequate flow on aquatic organisms (Annear et al. 2004). Adequate minimum flows in project-affected reaches are essential to restore the physical and ecological processes that support fish, aquatic, and riparian habitat conditions in the Klamath River. Research also indicates that beyond prescribing a minimum flow, managers should determine an appropriate flow regime based on season and water year type (Richter et al. 1997; Stanford et al. 1996). The artificial manipulation of flow without reference to a baseline hydrograph can profoundly impact habitat and fish communities (Poff and Allan 1995).

The Link River, which is approximately 1.2 miles long, is primarily used as a migration corridor for suckers moving between Keno Reservoir and UKL (USDI Bureau of Reclamation 1996; USDI Fish and Wildlife Service 2002a). Adult suckers from Keno Reservoir migrate upstream through the Link River during springtime on their way to tributaries of UKL for spawning (Piaskowski 2003). Juvenile and adult suckers also hold in the lower portion of the river and upper end of Keno Reservoir during summer, when water quality is poor in downstream Keno Reservoir (Piaskowski 2003; Piaskowski et al. 2004). Large numbers of larval suckers disperse downstream through Link River during April through July. Age 0 and age 1 juvenile suckers move downstream mostly during July through October (Gutermuth et al. 2000b). Sub-adult and adult suckers disperse downstream throughout the year. Juvenile suckers have been sampled in Link River throughout the year, suggesting that this area may provide some rearing habitat (USDI Bureau of Reclamation 1996, 2000).

Minimum instream flows downstream of Link River Dam are 90 cfs pursuant to a cooperative agreement with ODFW and PacifiCorp (PacifiCorp 2000a). The minimum flow below Link River Dam is increased to 250 cfs from mid-July through mid-October, per the 2002 Klamath Irrigation Project BO (USDI Fish and Wildlife Service 2002a). The 2002 BO also requires shutdown of the Westside development during the same time period, and that flows passed through the Eastside diversion be reduced to 200 cfs at night from mid-July though mid-October to limit sucker entrainment. Although the minimum instream flow requirements below Link River Dam are 90 cfs, minimum flows fell below this level during 16 different months between October 1996 and October 2006 (PacifiCorp 1998, 1999, 2000b, 2001, 2002, 2003, 2004f, 2005, 2006a). These minimum instream flows provide very limited rearing, holding, and passage habitat for endangered suckers. Larval and juvenile suckers are particularly vulnerable to predation by large number of fish-eating birds that reside in the area. Full inundation of the complex structure and side channel habitat in the upper and middle sections of the Link River does not occur until flows reach at least 300 cfs (PacifiCorp 2000a).

The minimum flow in the lower Link River below the Eastside Powerhouse is 450 cfs per cooperative agreement between PacifiCorp and ODFW (PacifiCorp 2004d). This minimum flow avoids significant losses of habitat that would result at lower flows, as indicated by wetted perimeter versus discharge plots for individual habitat transects of Link River that show substantial reduction in habitat at flows less than 450 cfs (PacifiCorp 2004e). The effects of current operation of the Eastside and Westside Power Diversions, combined with implementation of existing minimum Link River Dam release (90 cfs and 250 cfs during the summer months) and minimum instream flow of 450 cfs in the lower Link River below Eastside Powerhouse, result in reduced rearing, holding, and passage habitat; increased predation rates by fish-eating birds; and reduced water quality refugial habitat during the summer. Larval, juvenile, and sub-adult/adult sucker mortality associated with current minimum flow operations in Link River are estimated at 5,000 larvae, 500 juveniles, and 10 sub-adults/adults based on the number of fish dispersing or inhabiting this area. These numbers are based on a rough percentage of Link River Dam spillway sucker entrainment estimates (Appendix 1).

The minimum flow requirement below Keno Dam, per existing FERC license article 58 and ODFW agreement is 200 cfs (PacifiCorp 2004d). In 2002, the NMFS (NOAA Fisheries) established minimum flow requirements at Iron Gate Dam for threatened coho salmon (National Marine Fisheries Service 2002). Because of these requirements, minimum flows below Keno Dam have generally been considerably higher than 200 cfs since 2002 (U.S. Geological Survey 2006). From May 2002 through August 2007, the lowest minimum daily flow recorded was 239 cfs and lowest mean monthly flow was 348 cfs.

The Keno Reach, a canyon area with a relatively high gradient, is primarily a migration corridor for endangered suckers dispersing downstream from UKL and Keno Reservoir, and a few adult suckers migrating upstream from J.C. Boyle Reservoir to spawn. Fish sampling by PacifiCorp in 2001 and 2002 collected only one juvenile LRS in the upper portion of the Keno Reach (PacifiCorp 2004e). Fish monitoring in the Keno Dam fish ladder documented 9 adult listed suckers migrating upstream during the spring spawning season during 1988 through 1991 (PacifiCorp 1997). However, the fishway does not meet Service or ODFW criteria for sucker passage and there may have been more fish attempting to pass than documented in the fish ladder trap (Oregon Department of Fish and Wildlife 2006b; USDI Fish and Wildlife Service 2005b). Current operation of Keno Dam with the existing minimum flow requirement of 200 cfs increases the risk of predation on larval, juvenile, and sub-adult/adult suckers dispersing downstream by fish and fish eating birds. Based on estimates of suckers dispersing through this reach each year (Appendix 1), predation mortality during low flow conditions is estimated at 2,000 larvae, 100 juveniles, and no sub-adults/adults per year under current operations. These numbers are based on a rough percentage of Keno Dam sucker entrainment estimates in Appendix 1.

There are no minimum flow requirements in the current Commission license for J.C Boyle, Copco No. 1, and Copco No. 2 Dams. However, PacifiCorp releases a minimum flow of 100 cfs, 320 cfs, and 5-10 cfs in the J.C. Boyle Bypassed, J.C. Boyle Peaking, and Copco No. 2 Bypassed Reaches, respectively. A few juvenile SNS were captured in the J.C. Boyle Bypassed and Peaking Reaches during fall 2001 (PacifiCorp 2004d). Endangered suckers in these riverine reaches are probably fish moving down from upstream lake or reservoir habitat. No suckers were sampled by PacifiCorp in the Copco No. 2 Bypassed Reach. Current operation of J.C.

Boyle Bypassed Reach, J.C. Boyle Peaking Reach, and Copco No. 2 Bypassed Reach under existing minimum flows may result in increased risk to predation by fish and fish eating birds at low flows, based on estimated numbers of larval, juvenile and sub-adult/adult suckers dispersing through these reaches that originated from UKL (Appendix 1). We estimate larval and juvenile sucker predation mortality associated with current minimum flow operations at 200 larvae and 10 juveniles in the J.C. Boyle Bypassed Reach; 10,000 larvae in the J.C. Boyle Peaking Reach; and 100 larvae and 1 juvenile sucker in the Copco No. 2 Bypassed Reach. These numbers are based on a rough percentage of sucker entrainment estimates in Appendix 1.

In summary, current operation of project developments and associated minimum instream flow requirements may impact individual sucker survival in the Project area but because these habitats are not part of the original habitat complex of the suckers and probably are inherently unsuitable for completion of life cycles of suckers, there are minimal impacts within the context of the overall population size and geographic range of LRS and SNS.

Wetlands Loss

Keno Reservoir

Historically, the Klamath River above Keno Reef (at the present location of Keno Dam) and Lower Klamath Lake were part of a large marshland and open water system whose water levels were controlled by the basalt reef near the town of Keno. There were large areas of emergent marsh along the shoreline that provided habitat for larval and juvenile suckers (Gutermuth et al. 2000a; USDI Fish and Wildlife Service 2002a). Before construction of Keno Dam in 1931 by PacifiCorp, water levels fluctuated 2-3 feet per year (Weddell 2000). They were generally highest during late winter and spring and gradually lowered during the summer and fall. This type of hydrograph supported an emergent wetland fringe along the shorelines of the Klamath River by dewatering shoreline areas during the late spring and early summer, resulting in good conditions for germination of emergent plant seeds.

There were approximately 30,000 acres of open water and 55,000 acres of emergent wetland habitat in the Lower Klamath Lake and Klamath River area between Keno Reef and Link River before anthropogenic changes started in earnest around 1900 (USDI Bureau of Reclamation 2005). This large area was interconnected exposing Klamath River waters to a great deal of wetlands, promoting greater nutrient cycling, improved water quality, and greater amounts of habitats for sucker larvae and juveniles. Approximately 15,000 acres of these wetlands and open water habitats existed along the Klamath River from Link River to Keno Reef before development (Boyle 1964). Except for about 1,500 acres located near the Klamath Straits Drain, about 2,400 acres at Miller Island Wildlife Area, and about 125 acres of fringe wetlands scattered along the shoreline of Keno Reservoir, all the wetlands were reclaimed for private agricultural development through construction of dikes along the river in the early 1900s. Water levels at Miller Island Wildlife Area are actively managed behind levees to maintain the diverse and productive wetland communities (2,400 acres) by ODFW.

Southern Pacific Railroad constructed a crossing of the Klamath Straits including a concrete gate control structure required by Reclamation in 1906 and 1907 (Boyle 1964). The closing of the gates of this structure prevented the Klamath River from flowing into the Lower Klamath Lake

area, as had occurred naturally (Boyle 1964), which isolated about 65,000 acres of aquatic habitat. This action was led by private and Reclamation sponsored agricultural development in this area. Another 10,000 acres were diked and converted to agricultural lands along the Klamath River in the early 1900's (Boyle 1964). A dike break in 1927 along the Klamath River resulted in the inundation of about 5,000 acres of farm lands and was blamed on PacifiCorp's operation of the Klamath River flows at Link River Dam. This, and other damage claims arising out of PacifiCorp's partial control of the fluctuations in the river, led to PacifiCorp's construction of Keno Dam in 1931 (Boyle 1964). The flood control provided by Keno Dam enabled and perpetuated the wetland loss associated with agricultural conversion of some portion of the 85,000 acres of wetland loss estimated for this region.

In winter 1964-1965, flooding occurred in the region that led to extensive damage to agricultural lands along the Klamath River and the original regulating dam (Keno Dam). PacifiCorp dredged a channel about 200 feet wide and 15-20 feet deep between 1966 and 1971 upstream of the dam between river miles 235 and 249 to fulfill the power contract with Reclamation to provide a channel capacity of 13,300 cfs to accommodate inflow from Reclamation canals (Federal Energy Regulatory Commission 2006). Up to 3.75 million cubic yards of material was placed upon adjacent farm fields and shoreline areas. In March 2002, dredging was conducted in Keno Reservoir in front of the fish ladder exit to remove debris and sediment that were partially blocking the exit/water intake. About 17,000 cubic yards of material were removed via suction dredge and the spoils were pumped to an adjacent upland area. While it is possible that these dredging activities damaged or destroyed an unknown quantity of emergent wetlands in Keno Reservoir, the extent of these impacts is unknown.

In addition to the loss of wetlands associated with agricultural conversion and dredging, the relatively constant water levels in Keno Reservoir caused by PacifiCorp's active water management and additional management directed by Reclamation have led to a loss and degradation of emergent wetlands that would provide habitat for larval and juvenile suckers in peripheral areas of Keno Reservoir. We estimate that emergent wetlands occupied all shoreline areas less than 3 feet deep based on annual historical water level fluctuations and depth distribution of emergent vegetation in local wetlands. Based on 38 miles of shoreline with an average of 50 feet of shoreline less than 3 feet deep, an estimated 230 acres of wetlands have been lost. Also, constant water levels have led to the degradation of 1,625 acres of remnant wetland along the east side of Keno Reservoir near the Klamath Straits Drain. Emergent vegetation, particularly bulrush, prefers bare mudflats as a seedbed, a condition not met in stable water systems; fluctuation during the spring and summer provides conditions for the germination of seeds (Cooke et al. 1993).

Currently, most of the shallow shoreline areas in Keno Reservoir are vegetated with seasonal grasses and submerged aquatic plants, except the remnant wetlands (dense stands of bulrush). Although such habitats are occupied by sucker larvae and juveniles, they are of lower quality than diverse, emergent vegetation wetlands that provide abundant food, cover from predation, and protection from wind and wave action that physically harms or stresses fish (Klamath Tribes 1996). Emergent wetland vegetation supported significantly more, larger, and better-fed sucker larvae than submergent macrophytes, woody vegetation, or open water in UKL and the Williamson River (Cooperman and Markle 2004).

There is strong evidence that larval sucker access to shoreline wetland habitat is related to retention time in UKL (Markle et al. 2007). Larvae entering wetland areas were retained longer in these habitats than in habitat in the Williamson River that lacked emergent habitat. Larvae not finding suitable rearing habitat are more likely to disperse and be entrained out of the lake. Since there is a lack of emergent vegetation habitat in Keno Reservoir, many sucker larvae entering from UKL likely disperse downstream past Keno Dam. Therefore, the loss of about 230 acres of fringe wetlands, and the degradation of approximately 1,625 acres of existing emergent wetlands, are expected to lower larval sucker survival rates and cause higher downstream dispersion of sucker larvae and juveniles out of Keno Reservoir.

Based on larval sucker densities in UKL for emergent fringe wetlands (5 larvae per m^2, (Klamath Tribes 1996); 0.1 juveniles per m^2, (Hendrixson 2007)), the total of 230 acres of wetlands loss represents rearing habitat for about 4.65 million larval and 93,000 juvenile suckers per year.

In addition to habitat values that wetlands provide to sucker larvae and juveniles, exposure to emergent wetlands improves the quality of water that is high in nutrient content or BOD. Emergent wetlands sequester nutrients through plant uptake during the growing season as well as remove some of the nutrient load by filtering and settling of particulate matter (Gearheart et al. 1995). The vegetation also provides a substrate for the attachment of decomposer microorganisms that break down the organic matter. Wetland plants also produce wetland decomposition products (humic substances) that may have an inhibitory effect on blue-green algae growth (Aquatic Scientific Resources 2005). Wetlands may influence blue-green algae growth through other mechanisms including lower pH, lower water transparency, and production of wetland decomposition products. Impacts of reduced water quality on suckers are discussed in Section 1d, Water Quality, under Factors Affecting the Species' Environment in the Action Area.

The loss of approximately 85,000 acres of connected wetlands in the Lower Klamath Lake and Klamath River areas above the Keno Reef (at the present location of Keno Dam) has greatly reduced the values of wetlands to suckers as habitat for larvae and juveniles and as a means to improve habitat conditions (i.e., water quality). The role of the Klamath Hydroelectric Project in the losses of these wetland values includes an unknown amount of wetlands loss from facilitation of agricultural conversion of lands, an unknown amount of wetlands loss due to continued dredging for maintenance, about 230 acres of wetlands lost or degraded due to reduced water surface elevation fluctuations at Keno Reservoir, and degradation of approximately 1,625 acres of existing emergent wetlands along the east side of Keno Reservoir near the Straits Drain.

Upper Klamath Lake

Upper Klamath Lake, which is the largest freshwater lake in Oregon, is very shallow and has extensive wetlands within and immediately adjacent to the natural lake area. Historically, there were up to 52,000 acres of marshland associated with UKL and up to 65,000 acres of open water at maximum capacity (Aquatic Scientific Resources 2005; USDI Bureau of Reclamation 2005). Lake levels were controlled by a basalt reef near the town of Klamath Falls and fluctuated up to 3 feet annually between 4140 feet and 4143 feet.

Management of the water surface elevation of the lake by regulating the outflow did not occur until 1919 when a temporary dam was built. PacifiCorp constructed Link River Dam and began regulation of water levels in UKL in 1921 under agreement with Reclamation. In addition to construction of the dam, the reef was cut to allow water levels to be lowered below elevation 4140 feet. The agreement with Reclamation required management of water levels between 4143.3 feet and 4137 feet. PacifiCorp sought and obtained releases from damage related to lake regulation for all the private interests who had riparian and other legal rights associated with UKL including lumber mills, railroad, navigation companies, timber owners, owners of resorts and recreational properties, farmers, and government agencies. These releases and easements were obtained by purchase of complete releases, purchase of property, performing work to prevent claims for damages, executing agreements to protect the property if damage should occur, and leasing property pending proof of damages (Boyle 1964). Some cases of flooding of agricultural lands were settled by litigation and compensation was provided by PacifiCorp (Boyle 1964). The rights obtained by PacifiCorp became property rights running with the land. These actions by PacifiCorp have facilitated the continued agricultural operations and have prevented restoration of wetlands in some of these areas.

About 10,000 acres of marshland had already been diked and drained for agricultural uses by private interests before Link River Dam was constructed and PacifiCorp began regulation of UKL levels. Substantial diking and draining of emergent wetlands around UKL continued through 1968 by private interests (Snyder and Morace 1997). Overall, approximately 35,000 acres had been reclaimed and converted to agricultural lands around UKL (Aquatic Scientific Resources 2005). The loss of approximately 35,000 acres of wetlands has greatly reduced wetland nutrient reduction potential and production of wetland decomposition products that influence algae growth and water quality. Also, this conversion from wetland to agricultural land resulted in a substantial loss in habitat for larval and juvenile suckers (National Research Council 2004).

In an attempt to compensate for wetland losses, both the federal government and privately funded organizations, including PacifiCorp, have supported the purchase of former farmed and ranched wetlands and are reclaiming these areas as wetland. The present total of this intended reclaimed wetland area is approximately 18,000 acres around UKL including the Williamson River Delta Preserve (The Nature Conservancy, 4,500 acres), Wood River Ranch (Bureau of Land Management, 3,200 acres), Agency Lake Ranch (Bureau of Reclamation, 7,100 acres), Barnes Ranch (Bureau of Reclamation and U.S. Fish and Wildlife Service, 2,600 acres), Caledonia Ranch (Jeld-Wen, 240 acres), and Hanks Marsh (Lakeside Farms, 90 acres). The total investment to acquire these former wetland areas is about $25 million. The cost of reclaiming and developing these wetlands is additional.

In 1920, PacifiCorp entered into a contract with the Bureau of Indian Affairs to reclaim the Williamson River Marsh by diking and draining the wetland and leasing the allotted lands. PacifiCorp purchased most of the allotted lands from 1920 to 1930 and later sold the entire property in 1948 to Tulana Farms. In recent years, this site has become targeted for wetland restoration and PacifiCorp contributed $1.5 million towards the restoration costs estimated at about $20 million for land purchases and restoration actions. The Nature Conservancy purchased this property in the 1990s and has been restoring it to wetland. Reconnection of the

restored wetlands to UKL (5,500 acres) is planned for 2008 and 2009, and they plan to restore the entire site.

In 1920, PacifiCorp entered into a stipulation agreement with private landowners for maintenance of the lakeshore dike protecting from flooding 2,500 acres of former wetlands that were diked and drained for agricultural uses in 1914-1915 (Boyle 1964). PacifiCorp has continued responsibility for protecting these 2,500 acres of former wetlands (Caledonia Marsh). Jeld-Wen, owners of the property, have already converted 400 acres of this property to permanent wetlands. PacifiCorp's continued maintenance responsibility for protection of these lands from flooding represents facilitation of the agricultural conversion and loss of 2,100 acres of wetlands.

Overall, PacifiCorp's actions have facilitated the agricultural conversion and loss of 35,000 acres of wetlands through regulation of UKL water levels and flooding risk. The loss of 6,400 acres at the mouth of the Williamson River (Williamson River Delta), a part of the estimated 35,000 acres, has been partially compensated through the provision of an estimated 7.5 percent of the cost of its restoration and is expected to be completely restored. Another approximately 12,000 acres adjacent to UKL has been purchased by federal government and private organizations for conversion to wetlands but has not been fully restored. Wetland loss of 2,100 acres at Caledonia Ranch has not been compensated.

d. Water Quality

Most of the sources providing water to the Project area (UKL, Lost River, Straits Drain) are subject to poor water quality (Federal Energy Regulatory Commission 2006). The storage and release of water at the Project reservoirs imposes additional effects on water quality in the Klamath River by increasing retention time, exposure to sunlight, and thermal stratification. Reservoir stratification also alters other water quality parameters including DO, BOD, pH, and production of toxic ammonia. Aquatic plants and algae in the reservoirs and river have a significant effect on fluctuations in DO and pH, which in combination with temperature-induced effects can cause acute and chronic health problems in fish. Reservoirs also modify nutrients by acting as a sink or source for nutrients and temperature, metabolism or organic compounds, and nutrient uptake by phytoplankton.

All reaches of the Klamath River including Project reservoirs and riverine reaches were listed in 2002 for Clean Water Act 303(d) violations for temperature. Also, all hydroelectric Project reservoirs were listed for other water quality violations in addition to temperature. These included but were not limited to DO, toxic ammonia, pH and chlorophyll *a*. Removal of nutrients by assimilation in plants and decomposition occurs in free-flowing reaches of the Klamath River. Because of the water quality impacts caused by Project reservoirs, nutrient assimilation and decomposition of UKL releases occurs many miles further downstream of the hydroelectric project than would normally have occurred in the absence of the Project reservoirs. Isolating the nutrient loading and the effect of Project reservoirs on water quality from other impacts has yet to be completed; however, TMDL analyses, currently underway in California and Oregon, will identify these loads.

Kann and Asarian (2005) and Campbell (1999) (both in Federal Energy Regulatory Commission 2007) concluded that the project reservoirs act as both nutrient sinks and sources. Campbell concluded that there is a general increase in phosphorus loading longitudinally from Keno to below Iron Gate dam which is not completely explained by increases in flow between the two sites and may be caused by internal nutrient cycling in the project reservoirs. Campbell further notes that although internal nutrient cycling in the project reservoirs was not quantified, the reservoirs in series do not seem to be functioning as a substantial nutrient sink between Keno and Iron Gate dam. Absent reservoirs, nutrient assimilation would likely be greater than under existing conditions, resulting in an upstream shift in the portions of the Klamath River that currently experience excessive nutrients (Federal Energy Regulatory Commission 2007).

The water quality impacts of Project facilities are described below.

Keno Reservoir

Water quality in the Link River flowing into Lake Ewauna/Keno Reservoir is the same as its source, UKL, and it does not change as it passes through its short (1.2 mile) high gradient turbulent river section (J. Cameron, Reclamation, pers. comm.). Water quality parameters (including temperature, pH, DO, and conductivity) were similar at both the upper and lower ends of the river throughout the year in 2002 (Piaskowski 2003).

The quality of water entering, within, and leaving Keno Reservoir is degraded, especially during summer months. During summer, conditions in Keno Reservoir are conducive for blue-green algae blooms and crashes because of elevated water temperature and high nutrient levels from enriched inflow from UKL and to a lesser extent from Klamath Straits Drain and other non-point sources (National Research Council 2004). The resultant algal blooms exacerbate water quality problems by affecting pH and DO, and may potentially include blooms of *Microcystis aeruginosa,* which produce a toxin that may impact fish survival.

Poor water quality in Keno Reservoir is hypothesized to result from large quantities of organic matter (primarily in the form of blue-green algae) originating in UKL and exceeding the assimilative capacity of the Link River and Lake Ewuana/Keno Reservoir reaches, resulting in a considerable oxygen-demanding load on the system in the summer. High pH and un-ionized ammonia are also associated with the heavy transfer of blue green algae from UKL. In addition to the UKL water releases, there are municipal, industrial, and agricultural return flows to this reach.

The operations of PacifiCorp's Keno Dam prevent adequate nutrient cycling that would improve water quality in Keno Reservoir. The dam and its impoundment affect water quality primarily by increasing surface area, hydraulic retention time, and solar exposure. This increases water temperature and facilitates photosynthetic and microbial processes that can degrade water quality, by causing DO and pH fluctuations.

Maximum water levels in the natural lake controlled by Keno Reef were similar to the currently managed reservoir elevation (Weddell 2000), yet water quality problems were probably not as severe. Historically, the Klamath River and Lower Klamath Lake above Keno Reef fluctuated in elevation more than they do now (up to 3 feet). As described in the wetlands habitat loss section

above, the lake fluctuation produced a large wetland fringe to Lake Ewauna/Klamath River that is absent today. In addition, the Klamath River was connected to thousands of acres of wetlands in Lower Klamath Lake. The absence of wetland fringe and the disconnection to Lower Klamath Lake wetlands greatly reduces the potential for nutrient cycling in Keno Reservoir.

Poor water quality conditions, especially low DO levels, occur during the summer, restricting endangered suckers to the upper end of Keno Reservoir, and fish die-offs, including endangered suckers, occur frequently (Piaskowski 2003; Tinniswood 2006). Poor water quality in Keno Reservoir is largely responsible for the mortality of thousands of juvenile suckers dispersing downstream into the reservoir from UKL. Therefore, LRS and SNS populations are diminished by poor water quality in Keno Reservoir.

J. C. Boyle Reservoir

Water quality conditions in J.C. Boyle Reservoir, including temperature, pH, and DO, as documented by PacifiCorp 2000-2004, were generally adequate for endangered sucker survival (PacifiCorp 2004d). Desjardins and Markle documented temperatures ranging from 5 to 27 °C, pH from 7.7 to 9.0, and DO from 5.3 to 14.1 mg/L (Desjardins and Markle 2000). At no point did water quality parameters reach levels that resulted in sucker mortality in laboratory bioassays (Saiki et al. 1999). However, a small sucker die-off was documented during July and August 2003 at J.C. Boyle Reservoir during a period of hot weather that also resulted in fish die-offs in other locations including the Lost River, Keno Reservoir, and UKL (Tinniswood 2006). This die-off was related to warm water temperatures and low DO (M. Buettner, USFWS, pers. comm.). Water quality is relatively good in J.C. Boyle Reservoir because water leaving Keno Reservoir is aerated as it passes through the highly turbulent Keno Reach. Also, due to the small size of the reservoir, residence time is very short (1-2 days) and there is not sufficient time for substantial change in DO to occur. The effects of current Project operations on water quality in J.C. Boyle Reservoir are small and water quality conditions are acceptable for endangered suckers.

Keno and Boyle River Reaches

Endangered sucker use (primarily in the Keno Reach, and to a much lesser extent in J.C. Boyle Bypassed and Peaking Reaches) includes downstream dispersal of larval suckers during the spring and early summer and of juveniles and sub-adult/adults throughout the year, and upstream migrating adult suckers during the springtime spawning season. Water quality in these reaches, as monitored by PacifiCorp from 2000 to 2004, was adequate for survival of individual listed suckers (PacifiCorp 2004d). Current operation of Keno Dam and the J.C. Boyle developments do not result in water quality conditions that are adverse to sucker survival in the Keno, J.C. Boyle Bypassed, and J.C. Boyle Peaking Reaches.

Copco and Iron Gate Reservoirs

Water quality processes in Copco and Iron Gate Reservoirs are dominated by the thermal stratification that occurs annually in both reservoirs (PacifiCorp 2004d). Reservoir stratification alters water quality parameters including temperature, DO, pH, BOD, and production of toxic ammonia. Water quality conditions in Copco and Iron Gate Reservoirs are generally adequate

for suckers during fall, winter, and spring. However, during the summer, blue-green algae blooms are prevalent and influence key water quality parameters including pH, DO, and ammonia. Thermal stratification in Copco and Iron Gate Reservoirs isolates the bottom waters from the rest of the water column. DO levels stressful to endangered suckers are common near the bottom due to decomposition of organic matter. Poor summertime water quality may contribute to the lack of survival of larval and juvenile suckers in Copco and Iron Gate Reservoirs. Current operation of Copco and Iron Gate facilities will result in thermal stratification and low DO in the bottom waters that are stressful to suckers. However, water quality conditions in the surface waters are acceptable for suckers.

Large blooms of *Microcystis aeroginosa* have been documented in recent years in Copco and Iron Gate Reservoirs ((Federal Energy Regulatory Commission 2006), 3-117). This blue-green alga species produces a potent liver toxin, microcystin, which can harm fish and other organisms. Although major fish die-offs have not been reported in these reservoirs, it is possible that microcystin levels may reach levels that are stressful to endangered suckers and other fish.

2. Agricultural Development

Reclamation's Klamath Irrigation Project developed substantial water storage and distribution systems, and drainage of lakes and wetlands. It currently includes about 240,000 acres of irrigable lands. In an average year, the Project provides water to about 200,000 acres of agricultural land (USDI Bureau of Reclamation 2002). Reclamation states that, during a normal year, the net use of irrigation Project water is 2.0 acre-feet per acre including water used by the Service in the Tule Lake and Lower Klamath National Wildlife Refuges (USDI Bureau of Reclamation 2002). The main sources of water for this system are UKL via the A-Canal, the Klamath River from Keno Reservoir, and the naturally closed Lost River Basin.

Before the connection between Lower Klamath Lake and the Klamath River was diked by Southern Pacific Railroad in 1906 and 1907, the surface area of Lower Klamath Lake was often larger than UKL. Flows from the Klamath River, supplemented by springs around the lake, supported a complex of wetlands and open water covering about 80,000 to 94,000 acres in the spring, during high water, and 30,000 to 40,000 acres during late summer (USDI Bureau of Reclamation 2002). A water control structure installed in the Southern Pacific crossing of the Klamath Straits that supplied water to Lower Klamath Lake was closed in 1917 as directed by Reclamation to allow agricultural development (Boyle 1964). By 1924, more than 90 percent of Lower Klamath Lake's open water and marsh was converted to agricultural lands. About 28,000 acres of open water and wetland remain. Connections between the Klamath River and Lower Klamath Lake were severed by development, which changed the hydrology of both the lake and the river. Currently, connectivity between Lower Klamath Lake and the rest of the basin is limited to water pumped from Tule Lake and water from irrigation structures that lead to and from the present Keno Reservoir.

Before the Klamath Irrigation Project, Tule Lake varied in surface area from 55,000 to more than 100,000 acres, at times larger than the former expanse of UKL (Akins 1970). Lost River was the main source of water for Tule Lake. Similar to Lower Klamath Lake, Tule Lake was connected seasonally to the Klamath River. During periods of high runoff, water from the Klamath River flowed into the Lost River Slough and down the Lost River to Tule Lake; there was no outlet

from Tule Lake. The direction of the river's flow is now determined by operators of the Klamath Irrigation Project depending on water needs. Most of the former bed of Tule Lake has been drained for agriculture, leaving about up to 13,000 acres of shallow lake and marshland.

The Klamath Irrigation Project, a facility operated by Reclamation, provides benefit to the power generation of the Klamath Hydroelectric Project. However, it is not interrelated or interdependent; i.e., the Klamath Irrigation Project can operate independently of the Klamath Hydroelectric Project. In determining interrelatedness and interdependency, the Service applies the "but for" test that asks whether the other activity (the irrigation project) would occur "but for" the proposed action. Since the irrigation project would occur regardless of the hydroelectric project, the activities are not interrelated or interdependent, and the effects of the irrigation project are not included in the analysis of the effects of the action. The effects of the Klamath Irrigation Project on listed species are addressed in a separate BO (USDI Fish and Wildlife Service 2002a). The major effects of the Klamath Irrigation Project as described in the 2002 BO include sucker entrainment at project dams and diversions, degraded water quality in UKL related to shallow water depths during dry inflow year types, and reduced adult sucker habitat during summer and fall of dry years. New information has been obtained since 2002 that is currently being addressed in a reinitiation of consultation on the effects of the Klamath Irrigation Project.

PacifiCorp, in commenting on the draft BO, stated that the draft was inconsistent with the finding in the Biological Assessment (BA) prepared by Reclamation in connection with the referenced reinitiation of consultation, because the Reclamation BA included impacts of the historical wetland loss in the Environmental Baseline (PacifiCorp comment at 12-13). As noted in this discussion, this BO also considers the impact resulting from construction and operation of the Reclamation Klamath Irrigation Project to be in the Environmental Baseline, including those impacts due to the historical wetland loss. Further, the Service has considered past and current impacts of the hydropower Project as part of the Environmental Baseline, not as the effects of the proposed action (PacifiCorp comments at 13).

Private agricultural development also occurred along the Klamath River between Link River and Keno Reservoir. Thousands of acres of wetlands in this reach were diked and drained for agriculture during the early 1900s. This contributed to the loss of sucker habitat in this reach.

3. Non-native Fish Interactions

In the last century, the upper Klamath Basin has been invaded by about 20 non-native fish species (Logan and Markle 1993; National Research Council 2004). Most of these species are not particularly common in the basin, but some are abundant and widespread and their effects on listed suckers are poorly understood. One of the most recent invaders is the fathead minnow, which is now the most abundant fish in UKL and Keno Reservoir (Simon and Markle 1997; Terwilliger et al. 2004). Fathead minnows prey on sucker larvae in laboratory settings, and there is a negative relationship between fathead minnow abundance and annual larval sucker survival in UKL (Markle and Dunsmoor 2007).

The percentage of non-native fish captured in trammel nets was high in the three downstream reservoirs, ranging from 40 percent to 78 percent, and increased downstream with the highest

percentage in Iron Gate Reservoir (Desjardins and Markle 2000). A large percentage of the non-native species were potential predators including yellow perch, brown bullhead, crappie, Sacramento perch, and largemouth bass. J.C. Boyle Reservoir contained fewer non-native predators than the lower two reservoirs, Copco and Iron Gate.

4. Water Quality

Under section 303(d) of the Clean Water Act, States are required to develop lists of impaired waters. The Oregon 2004/2006 section 303(d) list reported that portions of the Klamath River from Link River to the state line are impaired because pH, DO, ammonia toxicity, and temperature levels do not meet applicable standards (Oregon Department of Environmental Quality 2006). The California 2002 303(d) list reported that the entire length of the Klamath River was impaired from the state line to the river's confluence with the Pacific Ocean because nutrients, organic enrichment, DO, and temperatures do not meet applicable numerical or narrative water quality objectives (North Coast Regional Water Quality Control Board 2002).

Water quality in the Project area (i.e., downstream of Link River Dam) is strongly influenced by the quality of water entering the Klamath River from UKL, and to a lesser extent by the Lost River and Klamath Straits Drain, in addition to its residence time within Project impoundments (PacifiCorp 2004d). The storage in Project reservoirs is being utilized by PacifiCorp to provide flow fluctuations in support of hydroelectric peaking operations, increasing residence time. During wet months, sources other than the Link River provide about one-third of the total flow reaching the lower end of the Project (Iron Gate Dam), particularly discharge from the Lost River Diversion Channel and Klamath Straits Drain; these sources may account for up to half of the total water entering the Project area ((Federal Energy Regulatory Commission 2006) page 3-93). As such, source water of diverse quality influences the quality of the water within the Project-affected reaches (National Research Council 2004).

Temperature

Oregon and California listed the Klamath River from UKL to the Pacific Ocean and Klamath Straits Drain on their respective 303(d) lists as temperature impaired (North Coast Regional Water Quality Control Board 2002; Oregon Department of Environmental Quality 2006). Monthly sampling results from March through November compiled by PacifiCorp indicate that water temperatures below Keno Reservoir are typically below 10 °C in March (PacifiCorp 2004d). Average summer temperatures over 20 °C were observed along the Klamath River at almost all sampling sites, particularly during July and August. Water temperatures in UKL and Link River are at or above 20 °C from June through September. Water temperatures increase slightly in Keno Reservoir due, in part, to the relatively shallow nature of the reservoir which enhances solar warming, and to a minor extent by warm agriculturally influenced water inputs from the Klamath Straits Drain. Average water temperatures below Keno Dam were slightly cooler as the reach becomes steep, free flowing, and receives groundwater inputs

Dissolved Oxygen

Generally, average DO concentrations from samples near the surface are in compliance with applicable criteria; however, seasonal DO concentrations are quite variable. DO concentrations

in UKL respond to the primary production and respiration needs of algal blooms and the BOD from the aerobic decomposition of organic material in the water, and to a lesser extent, the bottom substrate. Low DO levels in UKL have been associated with the period of declining algal blooms, typically in late summer and fall (Perkins et al. 2000a).

PacifiCorp's and Reclamation's DO sampling results from Keno Reservoir show persistently low DO levels throughout much of the impoundment during the summer (Deas and Vaughan 2006; PacifiCorp 2004c). However, there is a great deal of spatial and temporal variability in DO concentrations in the reservoir. Overall, DO levels in Keno Reservoir from June through September are below 6 mg/L, and some sites average below 4 mg/L in July and August.

Except for a localized area at J.C. Boyle Reservoir log boom where DO levels average less than 5.0 mg/L in July and August, DO levels were recorded near saturation in the free-flowing reach downstream of Keno Dam to Copco Reservoir (PacifiCorp 2004d). The operation of J.C. Boyle Dam in peaking mode seems to have negligible effect on DO concentrations in the peaking reach because the free-flowing river upstream of J.C. Boyle Reservoir provides ample opportunity for aeration.

The thermal stratification in Copco and Iron Gate Reservoirs isolates the bottom waters from the rest of the water column (PacifiCorp 2004d). Biological and sediment oxygen demand in Copco (and to a lesser extent in Iron Gate) Reservoir in the summer (most likely resulting from aerobic decomposition of dead algae and other organic matter) cause the hypolimnion to lose oxygen.

DO concentrations are high and near saturation at corresponding water temperature during spring at Copco and Iron Gate Reservoirs (PacifiCorp 2004d). However, as the summer progresses, the DO gradient between top and bottom becomes greater until the lake mixes in November. DO concentrations are similar throughout the water column as the water remains isothermal until around March when stratification begins to isolate the bottom waters.

Nutrients

Water quality in the Klamath River is strongly influenced by the amount of nutrients (particularly the various forms of nitrogen and phosphorus) and algae entering Project waters from UKL. Sediment core studies performed by Eilers et al. (Eilers et al. 2004) concluded that UKL has historically been a very productive lake with high nutrient concentrations and blue-green algae for the last 1,000 years. Walker (Walker Jr 2001) concludes, based on sediment core analysis, that over the last 100 years the water quality of UKL has changed substantially as consumptive water use practices (e.g., irrigation, municipal uses) and accompanying changes in land use practices throughout the upper Klamath and Lost River watersheds have increased. Mobilization of phosphorus from agriculture and other non-point sources (Walker Jr 2001) appears to have pushed the lake into its current hypereutrophic state, which includes algal blooms reaching or approaching theoretical maximum abundance. In addition, algal populations now are strongly dominated by a single blue-green algal cyanobacteria species, *Aphanizomenon flos-aquae*, rather than the diatom taxa that dominated blooms before nutrient enrichment (Eilers et al. 2004; Kann 1997). Blooms of toxic blue-green algae *Microcystis aeruginosa* have also been documented in UKL and Copco and Iron Gate Reservoirs.

The TMDL for Upper Klamath and Agency Lakes developed in 2002 by ODEQ and approved by Environmental Protection Agency identified these interconnected lakes as hypereutrophic (Oregon Department of Environmental Quality 2002). They have high nutrient loading which promotes correspondingly high production of algae, which in turn, modifies physical and chemical water quality characteristics that can directly diminish the survival and production of fish populations. The TMDL identifies phosphorus loading targets as the primary strategy in improving water quality.

Water quality in the Project-affected reaches of the Klamath River exhibits the characteristics of its source waters (i.e., UKL and agricultural returns into Keno Reservoir) (Federal Energy Regulatory Commission 2006). Agricultural returns have substantial amounts of sediments, nutrients, and higher temperatures resulting from its course through agricultural fields and canals. Municipal and industrial inflows to Keno Reservoir, which represent about 1 percent of the inflow, are additional sources of nutrients.

Downstream of Keno Dam, including J.C. Boyle development, the Klamath River generally becomes steep and free flowing, providing good mixing and aeration (Federal Energy Regulatory Commission 2006). PacifiCorp sampling results from the top and bottom of J.C. Boyle Reservoir near the dam show no substantial differences in total phosphorus, orthophosphate, nitrate, and ammonia concentrations (PacifiCorp 2004d).

Results of nutrient sampling of both Copco and Iron Gate Reservoirs exhibit the characteristics of productive, stratified lakes (PacifiCorp 2004d). PacifiCorp's data show that Copco Reservoir has a much higher annual concentration of ammonia, orthophosphate, total phosphorus, and nitrate in the hypolimnion than in the epilimnion. Concentrations of total phosphorus are at their greatest in August and September (0.5 and 0.7 mg/L, respectively); however, by November, when the water column is isothermal, the concentration drops to 0.1 mg/L throughout the entire water column (PacifiCorp 2004d). In Iron Gate Reservoir, total phosphorus concentrations are the same in both epilimnion and hypolimnion, or even lower in the hypoliminion than the epilimnion and at concentrations well below those seen in Copco Reservoir in the summer (PacifiCorp 2004d).

The amount of oxygen present in the water also affects nutrient chemistry. Extended periods of anoxia (low or zero oxygen) promote conditions that result in the reduction of nitrate to ammonia and can lower the oxidation-reduction potential (redox potential — a measure of the electrical potential of ions in the water) to the point that phosphorus is released from the sediment. Such conditions occur regularly in Copco Reservoir, especially in August and September, but rarely in Iron Gate Reservoir (PacifiCorp 2004d). The differences in redox potential in the reservoirs are reflected in nutrient concentrations in the hypolimnion. Orthophosphate and ammonia are noticeably more abundant in the hypolimnion of Copco Reservoir than in Iron Gate Reservoir.

Seasonal changes in water quality constituents below Iron Gate Dam are not large. Orthophosphate and total phosphorus concentrations are highest in March with little variability throughout the rest of the year and little difference between the Copco and Iron Gate Reservoirs (PacifiCorp 2004d). Ammonia concentrations remain fairly constant throughout the year, with occasional high values in May, September, and October.

Sediment Oxygen Demand

PacifiCorp commissioned a sediment oxygen demand (SOD) study to analyze sediment core samples from Keno, J.C. Boyle, Copco, and Iron Gate Reservoirs in 2003 (Eilers and Gaubala 2003). More recently, Eilers and Raymond ((Eilers and Raymond 2005), as cited in Federal Energy Regulatory Commission 2006) performed a similar study in Lost River and Keno Reservoir to enhance current TMDL model development. USGS also commissioned SOD sampling in Keno Reservoir in 2003 (Doyle and Lynch 2005).

PacifiCorp's study showed that SOD in Project reservoirs ranged from 1.5 to 4.7 $g/m^2/day$ (PacifiCorp 2004d). SOD measurements in reservoirs above J.C. Boyle Dam were all above 2.0 $g/m^2/day$. Results from Eilers and Raymond (Eilers and Raymond 2005), as cited in Federal Energy Regulatory Commission 2006) are consistent with PacifiCorp's work where SOD in the Lost River and Keno Reservoir ranged from 1.32 to 3.61 $g/m^2/day$. The results indicate that the oxygen dynamics of the upper study area, especially Keno Reservoir, are controlled to a large extent by the nature of the water entering the system rather than sediment/water interactions in the impounded areas. Where anaerobic conditions exist for extended periods, nutrients and other constituents can be released from the sediment, and such effects may play a larger role in water quality dynamics in the hypolimnion in Copco and Iron Gate Reservoirs.

SOD rates measured by USGS in June 2003 (U.S. Geological Survey 2003) at 16 sites in Keno Reservoir ranged from 0.6 to 3.11 $g/m^2/day$. Results from Eilers and Raymond 2005 study are consistent with results of the USGS study. PacifiCorp concludes that, although sediments exert an oxygen demand, the SOD in the water column is less than the biological demand in Keno and J.C. Boyle Reservoirs.

Water enters Keno Reservoir with a substantial BOD present, presumably derived from decomposition of the entrained cyanobacteria (Eilers and Gaubala 2003). Eilers and Gaubala (Eilers and Gaubala 2003) conclude that BOD in the waters of the upper portion of Keno Reservoir overshadows the effects of the sediment in the lower portion of Keno Reservoir and J.C. Boyle Reservoir to a considerable degree. In Copco and Iron Gate Reservoirs, BOD is lower and sediment effects become a more important influence on the quality of the overlying water.

Algae

Algae within Klamath River are an important component to the overall water quality and water chemistry processes affecting water quality within the system ((Federal Energy Regulatory Commission 2006). The seasonal blooms and die offs of algae in response to conditions within the water at various locations throughout UKL and the Project waters have consequences throughout the entire system. In UKL, algae productivity is associated with DO that shows extreme daily variation (high during the day and low at night). Elevated pH and free ammonia concentrations that do not meet Oregon's water quality standards (Kann and Walker Jr 1999; Walker Jr 2001), and chlorophyll *a* concentrations (a surrogate measure of planktonic algae abundance) exceeding 200 $\mu l/L$ are frequently observed during the summer months (Kann and Walker Jr 1999). Carlson Trophic State Index (TSI) values calculated from PacifiCorp

monitoring data (based on chlorophyll *a* concentrations) for UKL at the Fremont St. Bridge range from 55 in May to 77 in June, indicating high algal productivity.

As expected, chlorophyll *a* concentrations are higher in reservoirs than the river sections directly upstream, except for Link River (PacifiCorp 2004d). The average chlorophyll *a* concentration entering Keno Reservoir from Link River is 57 μg/L with a peak concentration of 257 μg/L in July. Peak algal abundance (chlorophyll *a* concentrations near 300 μg/L) in Keno Reservoir occurs in June. TSI index values based on monthly chlorophyll *a* in Keno in July, August, and September ranged from 64 to 70.

Water entering J.C. Boyle Reservoir has an average chlorophyll *a* concentration of 14.5 μg/L with a peak concentration of 58 μg/L (PacifiCorp 2004d). Chlorophyll *a* concentrations steadily decrease downstream of the J.C. Boyle Powerhouse. The average and peak chlorophyll *a* concentration in the peaking reach is 7.8 μg/L and 23 μg/L, respectively. Sampling results near the Copco and Iron Gate Dams show that both reservoirs are highly productive. The average and peak chlorophyll *a* values at Copco Reservoir were 10.7 μg/L and 44 μg/L, respectively; and at Iron Gate Reservoir, 10.3 μg/L and 58.0 μg/L, respectively. The chlorophyll *a* concentrations in both reservoirs vary seasonally. Generally, monthly Carlson TSI values for chlorophyll *a* decrease from upstream to downstream in Keno, J.C. Boyle, and Copco Reservoirs, with all values in Copco Reservoir in the 40 to 50 range (PacifiCorp 2004d). TSI values in Iron Gate Reservoir are slightly higher than those calculated for Copco Reservoir, but within the same range. There is a predictable sequence of algal taxa in both reservoirs. During March there is typically a bloom of diatoms, followed by a period of relatively low chlorophyll abundance. Chlorophyll usually peaks in August and September when dense blooms of the nitrogen-fixing cyanophyte (blue-green alga) *Aphanizomenon flos-aquae* occur.

On January 30, 2005, the Quartz Valley Indian Community filed a letter with the Commission documenting the presence of *Microcystis aeruginosa* and the liver toxin microcystin at Copco Reservoir in 2004 (Federal Energy Regulatory Commission 2006). *Microcystis aeruginosa* blooms historically have been observed in UKL and throughout the Klamath River Basin. Shoreline and open water locations within Copco and Iron Gate Reservoirs sampled by Kann and Corum (Kann and Corum 2006) exhibited the presence of the cyanobacteria *Microcystis aeroginosa* which, in previous samples collected in September 2004 and July 2005, produced the potent hepatotoxin (liver toxin), microcystin.

Cell densities of *Microcystis aeruginosa* exceeded World Heath Organization and Environmental Protection Agency (EPA) moderate risk levels at all sampled stations on August 10 and 11, 2005, including at the open-water stations in front of Iron Gate (916,548 cells/mL) and Copco (151,004 cells/mL) Dams (Federal Energy Regulatory Commission 2006). Several of the shoreline stations exceeded the moderate risk cell count level by more than 20 times.

PacifiCorp also performed phytoplankton sampling from 2001 to 2004 at 21 sites along the Klamath River in the vicinity of the Klamath Hydroelectric Project including UKL and its tributaries (PacifiCorp 2004d). Results show that the highest mean algal abundance (measured at over 7,500 units/mL), was observed in the Klamath River at Keno Bridge, Link River, and UKL. Results also show that the blue-green algae *Microcystis aeruginosa* was found in about 12 percent of the 462 samples taken throughout the Project vicinity.

Attached algae and rooted vegetation within the Klamath River also play an important role in nutrient dynamics, as well as general river ecology. Because attached algae are in continuous contact with the river, the growth and distribution of the algal communities can affect nutrient fluxes and result in short-term changes in water quality parameters such as DO and pH. The UKL TMDL recognized that aquatic plants are abundant in portions of the upper Klamath River and in areas dominated by nuisance filamentous green algae species such as *Cladophora,* an algae common in nutrient enriched waters. Field work contracted by EPA sampled 10 sites in the Klamath River below Iron Gate Dam to characterize the benthic (periphyton) community. Results suggest that there are some major changes in the periphyton community that appear to be controlled to some degree by differences in nutrient availability (Federal Energy Regulatory Commission 2006).

pH

The high concentration of algae in UKL and Keno Reservoir influences pH levels because photosynthesis and associated uptake of carbon dioxide results in high pH (basic condition) during the day and respiration by algae and other organisms at night decreases pH to more neutral conditions. Monthly average alkalinity (measured as $CaCO_3$) levels in UKL, Link River, and Keno Reservoir are fairly similar ranging between 40 and 50 mg/L, with little variability throughout the sampling period (PacifiCorp 2004d). Values of 20 to 200 mg/L are typical of freshwater systems, however, at lower levels freshwater systems have less buffering capacity, increasing their susceptibility to changes in pH. As expected, Link River water is more alkaline with strong seasonal trends. Concentrations ranged between 141 and 259 mg/L with the lowest levels recorded during the summer. PacifiCorp sampled pH as part of its water quality sampling program and collected almost 3,800 readings between March and November from 2000 to 2004. Average pH values from all PacifiCorp sampling stations on the Klamath River and Project reservoirs collected during the 2000 to 2003 study were between 7 and 10 standard units with the higher values coinciding with high algal densities, which typically occur spring through fall. Annual mean pH values show little variability between Keno Reservoir and the bottom of the peaking reach. Water in Keno Reservoir has an average pH of 8.2 with a peak pH of 9.4. Average pH in J.C. Boyle Reservoir is 7.8 with a peak of 9.3 (PacifiCorp 2004d). Downstream of the J.C. Boyle development in the peaking reach the average pH was 8.1 with a peak of 8.9.

The pH values in Copco and Iron Gate Reservoirs are similar to each other in that the average pH at the surface was 8.2 and 8.1, respectively, while below 20 meters the average pH was 7.3 in Copco and 7.2 in Iron Gate with very little difference during June through September (range in Copco epilimnion was 0.7 units and 0.5 in Iron Gate). The range in the hypolimnion of both Copco and Iron Gate Reservoirs during the summer was 0.2, indicating that there is little variability in pH at depth within these reservoirs during the summer. Monthly average alkalinity levels within Copco and Iron Gate Reservoirs is slightly higher than those recorded in Keno Reservoir, however none is above 75 mg/L.

Relationship of the Action Area to Conservation of the Suckers

Conservation of the LRS and SNS is dependent on preserving several viable self-sustaining populations of suckers in as much of their historic range as possible: 1) populations must be of

adequate size and of diverse age structure to withstand stochastic events and remain viable; 2) populations must be interconnected for demographic and genetic support; and 3) adequate spawning, rearing, feeding, and overwintering habitat must be present throughout the species' range to support viable populations.

Currently, the largest populations of SNS and LRS are found in UKL and its tributaries. Larvae, juvenile, and adult suckers drift downstream into the hydroelectric project via Link River and diversions. Some adult suckers return upstream to UKL via Link River during spawning migration. The Link River also provides refugial habitat when water quality conditions degrade in Keno Reservoir during the summer and a migration corridor for adult suckers migrating upstream to spawn. Keno Reservoir has the potential to support suckers if water quality conditions can be improved in the summer.

Historically, there was no LRS and SNS habitat below Keno Dam because of the lack of lacustrine areas needed by these lake suckers. However, with the construction of J.C. Boyle, Copco, and Iron Gate Dams, the range of these species was expanded by the construction of additional lake environments. However, these additional reservoir populations are not believed to be self-sustaining due to the lack of spawning habitat and shallow shoreline rearing habitat for larvae and juvenile suckers, poor water quality conditions, and high density of non-native predators. The National Research Council (National Research Council 2004) stated that the sucker populations in the Klamath River reservoirs do not have a high priority for recovery because they are not part of the original habitat complex of suckers and probably are inherently unsuitable for completion of life cycles by suckers. Maintenance of adult suckers in these reservoirs does provide insurance against loss of other subpopulations as long as the reservoirs are present. These reservoirs can provide for long-term storage of a small number of adult suckers for potential conservation use in the future.

Proposed Sucker Critical Habitat

Status of Proposed Critical Habitat Within the Action Area

Critical habitat for the suckers was proposed in 1994, but has not been finalized (59 FR 61744). The primary constituent elements identified in the proposal are as follows: (1) water of sufficient quantity and suitable quality; (2) sufficient physical habitat, including water quality refuge areas, and habitat for spawning, feeding, rearing, and travel corridors; and (3) a sufficient biological environment, including adequate food levels, and patterns of predation, parasitism, and competition that are compatible with recovery.

The Action Area is within proposed critical habitat units #3 — Klamath River. None of the water bodies currently occupied by LRS and SNS in the Action Area meet various water quality standards for nutrients, dissolved oxygen, temperature, and pH set by the States of Oregon and California (North Coast Regional Water Quality Control Board 2006; Oregon Department of Environmental Quality 2002). Water quality in the Klamath River reservoirs is stressful to suckers during the summer when large blue-green algae blooms and crashes occur (National Research Council 2004). Fish die-offs are common in Keno Reservoir (Tinniswood 2006).

Emergent wetlands and shallow shoreline habitat are extremely limited in the Klamath River reservoirs with the exception of J.C. Boyle Reservoir. Spawning habitat is also lacking or limited in the Klamath River above each impoundment due to high gradient and velocity of the river and absence of gravel spawning substrate. Non-native fish populations are also very large in all of the Klamath River reservoirs in the Action Area. Competition and predation by species including fathead minnows, yellow perch, bullheads, crappie, and largemouth bass likely impact sucker populations in the Action Area (Desjardins and Markle 2000).

In summary, the status of the primary constituent elements in this proposed critical habitat unit is less than optimum. This condition exists in part because of anthropogenic factors such as degraded water quality and dams with inadequate passage, but also in part due to factors such as high stream gradients that existed prior to the project.

Effects of the Proposed Action on Federally Listed Suckers

"Effects of the proposed action" refers to the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action that will be added to the environmental baseline. Regulations implementing section 7(a)(2) of the Act require the Service to consider the effects of activities that are interrelated or interdependent with the proposed Federal action (50 CFR 402.02). Interrelated actions are those that are part of the larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consultation. Both interrelated and interdependent activities are assessed by applying the "but for" test which asks whether any action and its resulting impact would occur "but for" the proposed action.

Under the FPA, as amended by the Electric Consumers Protection Act of 1986, the Commission may issue new licenses for existing hydropower projects as the original licenses expire. The Commission has determined that these new licenses represent a new commitment of resources. Therefore, an ESA section 7 analysis of the project's effects on listed species is done in the same way as the analysis for new projects. When analyzing these projects, we use the same approach as for other types of section 7 analyses:

- The total effects of all past activities, including effects of the past operation of the project, current non-Federal activities, and Federal projects with completed section 7 consultations, form the environmental baseline;
- To this baseline, future direct and indirect impacts of the operation over the new license or contract period, including effects of any interrelated and interdependent activities, and any reasonably certain future non-Federal activities (cumulative effects), are added to determine the total effect on listed species and their habitat.

Therefore, the effects of the action encompass the effects of the continued operation of the project resulting from the new license, some of which are the same as the current effects but which under the proposed action will continue in the future. The effects of the original construction and past operation of the Klamath Hydroelectric Project are part of the environmental baseline. For example, blocked fish passage caused by the construction and operation of a dam up to the present time is within the baseline, while ongoing blocked fish

passage resulting from the continued presence and operation of the dam into the future is considered an effect of the proposed action. There also may be an interim period when the proposed action contemplates the continuation of the current effect (blocked fish passage) before the construction of fishways. This analysis considers both the interim, continuing impacts, and the future impacts resulting from full implementation of the proposed action.

Direct and Indirect Effects of the Proposed Action

Below is a description of the direct and indirect effects of the proposed action on listed sucker species. To the extent available, we have based the extent of these effects on documentation available to the Service, as cited below. Where data are lacking, we have based our analysis on the extent of the effects of the proposed action on the best data available to us.

1. Injury/Mortality

a. Entrainment at Hydropower Facilities and Spillways

During the interim prior to construction of fishways, the current level of effects is expected to continue. Following installation of downstream fishways and spillway improvements, we estimate that mortality of suckers entrained into the power diversions will be reduced to approximately 2 percent, except for larval suckers which cannot be effectively screened, and 1 percent of suckers entrained into spillways. A detailed description of the Klamath Hydroelectric Project entrainment and take analysis is provided in Appendix 1.

Eastside and Westside Power Diversions

After license issuance, the effects referred to in the Environmental Baseline would continue on an annual basis until fishways for anadromous fish are installed (Table 2). Accordingly, during this interim period, we anticipate annual turbine entrainment mortality of 1,011,000; 21,258; and 21 for larval, juvenile, and sub adult/adult suckers, respectively. Although we estimate impacts of spillway operation of Link River Dam in the Environmental Baseline section of this document, those impacts are not part of the effects of the proposed action because they are the responsibility of Reclamation.

With installation of downstream fishways as prescribed in the Service's mandatory Section 18 fishway prescriptions, continued operation of Eastside and Westside Power Diversions would screen and divert downstream dispersing fish from turbine intakes and minimize mortality of juvenile and adult federally listed suckers. The fishways are expected to exclude all juvenile and sub-adult/adult suckers from the Eastside and Westside Power Diversions. However, the screens would not be effective in screening larval suckers because of their small size and poor swimming ability. Based on larval sucker monitoring conducted at the A-Canal fish screen facility (D. Bennetts, Reclamation, pers. comm.) and the Tehama-Colusa and Corning Canals near Red Bluff, California (USDI Bureau of Reclamation 2001) up to about 50 percent of larval suckers entering the downstream fishways pass through the screens and enter the turbines and the other 50 percent would be bypassed back to Link River. With fishways, up to approximately 4,044,000 larvae would be entrained at Eastside and Westside Power Diversions annually with turbine mortality of 505,500 (Appendix 1; Table 3). A small percentage of larval fish are expected to be injured or killed in the turbine bypass (2 percent; 40,400). With fishways, annual

total downstream mortality at PacifiCorp's Eastside and Westside Power Diversions (turbine and turbine bypass) for larvae, juvenile and sub-adult/adult suckers is estimated to be 545,900, 340, and 1 fish, respectively (Table 3).

Table 3. Sucker entrainment mortality under new license operations with fishways and spillway improvements

Facility	Eastside/Westside	Keno	J.C. Boyle	Copco No. 1	Copco No. 2	Iron Gate	Total
New License – Fishway and Turbine Mortality							
Larvae	505,500	0	6,800	6,200	5,500	500	524,500
Juveniles	340	0	18	2	2	0	362
Sub-adult/adult	1	0	0	0	0	0	1
New License – Spillway Mortality							
Larvae	-	6,100	100	100	0	0	6,300
Juvenile	-	100	1	0	0	0	101
Adult	-	0	0	0	0	0	0
New License – Total Fishway and Spillway Mortality							
Larvae	505,500	6,100	7,400	6,800	5,900	500	532,200
Juveniles	340	100	19	2	2	0	463
Sub-adult/adult	1	0	0	0	0	0	1

The proposed action for operation of the Eastside and Westside downstream fishways calls for trapping and hauling lamprey, juvenile salmonids and federally listed suckers during periods of poor water quality (mid-June to mid-November) (U.S. Department of the Interior 2007). Suckers in the trap would be sorted from the salmon and other fish and hauled back to UKL. There would not likely be much overlap between salmon and sucker presence in the trap, because most salmon would move downstream from March-June and suckers from July-October. Based on past Link River and A-Canal entrainment studies (Gutermuth et al. 2000a; Gutermuth et al. 2000b), tens of thousands of juvenile suckers are entrained during the late summer (August and September). In 1997, many of the juvenile suckers collected were debilitated or dying from stressful water quality conditions and resultant outbreaks of *Columnaris* disease, while in 1998 most juvenile suckers appeared to be in good condition (Gutermuth et al. 2000a).

Since most entrainment occurs during the late summer when water quality is poor and fish may stressed in some years, additional handling associated with the trapping and hauling operation will increase the risk of mortality of suckers in the downstream fishway. Handling mortality associated with trap and haul operations is estimated to be about 15 percent of the fish trapped based on juvenile sucker trapping studies on the Sprague River during periods of poor water quality (J. Hodge, USFWS, pers. comm.). However, survival of fish from the trap and haul operation would be much higher than if the fish were allowed to pass downstream into Keno Reservoir where many perish under current water quality conditions.

Keno Development
After license issuance, the effects referred to in the Environmental Baseline would continue on an annual basis until spillways are installed[3]. Accordingly, during this interim period, we anticipate annual spillway entrainment mortality of 11,400; 294; and 0 for larval, juvenile, and sub adult/adult suckers (Table 2). With spillway modifications that result in lower passage mortality (1 percent compared to 2 percent), annual passage mortality of larvae, juvenile, and sub-adult/adult suckers are estimated at 6,100, 100, and 0 fish, respectively (Table 3).

J.C. Boyle Development
After license issuance, the effects referred to in the Environmental Baseline would continue on an annual basis until fishways for anadromous fish are installed (Table 2). Accordingly, during this interim period, we anticipate annual entrainment mortality of 12,700; 324; and 0 for larval, juvenile, and sub adult/adult suckers. We estimate annual spillway mortality of 100, 3, and 0 for larval, juvenile, and sub-adult/adult suckers, respectively, during this interim period (Table 2).

We anticipate continued operation of the Klamath Hydroelectric facilities following installation of prescribed downstream fishways and spillway modifications will result in no turbine mortality of juvenile and sub-adult/adult suckers. Because the new downstream fishway screens to be installed at J.C. Boyle Dam will not totally exclude sucker larvae, annual turbine mortality is estimated at 6,800 larval fish (Table 3; see Appendix 1). Annual turbine bypass mortality (2 percent) is estimated at 500 larvae, 18 juveniles, and 0 sub-adult/adults. Annual spillway mortality (1 percent) is estimated at 100, 1, and 0 larvae, juveniles, and sub-adult/adults, respectively (Table 3).

Copco No. 1 Development
After license issuance, the effects referred to in the Environmental Baseline would continue on an annual basis until fishways for anadromous fish are installed (Table 2). Accordingly, during this interim period, we anticipate annual entrainment mortality of 12,200; 25; and 0 for larval, juvenile, and sub adult/adult suckers. We estimate annual spillway mortality of 100, 0, and 0 for larval, juvenile, and sub adult/adult suckers, respectively, during this interim period (Table 2).

With continued operation of Copco No. 1 Dam including the prescribed downstream fishways and spillway improvements, total annual mortality is estimated to be reduced to 6,800 larvae, 2 juvenile, and 0 sub-adult/adult suckers (Table 3; Appendix 1).

Copco No. 2 Development
After license issuance, the effects referred to in the Environmental Baseline would continue on an annual basis until fishways for anadromous fish are installed (Table 2). Accordingly, during this interim period, we anticipate annual entrainment mortality of 9,500; 19; and 0 for larval, juvenile, and sub adult/adult suckers. We estimate annual spillway mortality of 100, 0, and 0 for larval, juvenile, and sub adult/adult suckers, respectively, during this interim period (Table 2).

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[3] In accordance with a stipulation with the Applicant, the U.S. Fish and Wildlife Service and National Marine Fisheries Service have revised the prescriptions for spillway modifications and tailrace barriers in the Modified Prescriptions to allow the Applicant to conduct site-specific studies on the need for and design of spillway modifications.

Continued operation of Copco No. 2 following installation of prescribed downstream fishways and spillway improvements will result in lower entrainment mortality. Downstream fishway mortality after construction of downstream fishways and spillways is estimated at 5,900 larvae, 2 juvenile and 0 sub-adult/adult annually (Table 3). Similarly, spillway mortality under the proposed action is estimated at 100 larvae, 0 juveniles, and 0 sub-adult/adult suckers (Table 3).

Iron Gate Development
After license issuance, the effects referred to in the Environmental Baseline would continue on an annual basis until fishways for anadromous fish are installed (Table 2). Accordingly, during this interim period, we anticipate annual entrainment mortality of 700, 1, and 0 for larval, juvenile, and sub adult/adult suckers. We anticipate no annual spillway mortality during this interim period (Table 2)

Continued operation of Iron Gate Dam following installation of downstream fishways and spillway improvements will reduce turbine mortality to about 500 larvae, 0 juveniles, and 0 sub-adult/adult suckers annually (Table 3). There is no spillway mortality anticipated.

Summary
After license issuance, the effects referred to in the Environmental Baseline would continue on an annual basis until fishways for anadromous fish are installed. Continued operation of the Klamath hydroelectric facilities under the proposed action with installation of prescribed screens, bypass systems and spillway improvements to anadromous fish criteria would substantially reduce mortality and harm of downstream dispersing suckers, primarily at Eastside and Westside Power Diversions. The downstream fishways will exclude all juvenile and sub-adult/adult suckers and about 50 percent of the larvae from turbine entrainment. Downstream anadromous fishways and spillway improvements to anadromous fish criteria at J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate Dams would provide less substantial benefits to endangered suckers because of the small numbers dispersing past these dams and the lack of suitable habitat for completion of life cycles of suckers in these reservoirs. The listed suckers that reside in these reservoirs may provide a long-term conservation benefit for a small number of adult suckers that serves as insurance against potential loss of the other viable populations in the upper basin.

b. False Attraction and Harm at Tailrace Barriers

Eastside and Westside
After a license is issued, and until tailrace barriers are installed, false attraction and harm at tailrace barriers would continue as described in the Environmental Baseline section[4]. Accordingly, we estimate that 2 fish may be injured annually in the Eastside and Westside turbine discharges and up to 20 adult suckers may be falsely attracted to turbine discharges each year and unable to reach suitable spawning habitat when they are ready to spawn or conditions are optimal for survival.

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[4]In accordance with a stipulation with the Applicant, the U.S. Fish and Wildlife Service and National Marine Fisheries Service have revised the prescriptions for spillway modifications and tailrace barriers in the Modified Prescriptions to allow the Applicant to conduct site-specific studies on the need for and design of spillway modifications

The continued operation of Eastside and Westside Power Diversions following installation and operation of prescribed tailrace barriers will exclude suckers from turbine discharges and minimize injury or mortality to suckers. The effects related to migration delays are believed to be small. By not operating Eastside and Westside Power Diversions when flows below Link River Dam are 500 cfs or less, adult sucker migrations will not be delayed or disrupted during dry years.

J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate Dams
Based on low listed sucker numbers entering fish ladders at Keno and J.C. Boyle Dams (PacifiCorp 1997), the dearth of adults sampled in river reaches below project dams (PacifiCorp 2004e), and the lack of habitat to support self-sustaining endangered sucker populations in the Klamath hydroelectric project reservoirs (National Research Council 2004), continued operation of hydroelectric facilities under existing operations will have minimal effect on endangered suckers falsely attracted to powerhouse discharges at J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate Dams. However, installation and operation of the prescribed tailrace barriers may provide substantial benefits to other resident and anadromous fish including listed coho salmon (National Marine Fisheries Service 2007; U.S. Department of the Interior 2007). These benefits include protection from injury to anadromous fish in the draft tubes and guidance of upstream migration.

c. Stranding and Ramp Rate Effects

The flow and ramp rate conditions will be implemented upon issuance of the new license; therefore, there will be no interim period.

Eastside and Westside
Assuming Eastside and Westside facilities are included in the new project license and will not be operated when flows are 500 cfs or less ((Federal Energy Regulatory Commission 2006); 5-62) and ramp rates are less than 2 inches per hour, we estimate the number of stranded suckers at approximately 10 percent of current levels (500 larvae and 50 juvenile suckers per year).

Keno
Assuming the Commission includes the Keno development in the project license and requires PacifiCorp to immediately operate it as a run-of-river facility, with flow below Keno Dam to be within 10 percent of the measured project inflow based on a 3-day running average and ramp rate of about 1-2 inches per hour ((Federal Energy Regulatory Commission 2006); 5-63), the Service estimates larval and juvenile sucker stranding will be reduced to 10 percent of current rates (200 larvae and 10 juvenile suckers).

J.C. Boyle Bypassed Reach
Project operations under the proposed action with the new ramp prescription of 125 cfs per hour or about 2 inches per hour (BLM Condition 4A2) should minimize the risk of stranding of larval and juvenile suckers dispersing downstream from J.C. Boyle Reservoir, reducing the annual mortality from stranding to an estimated 10 percent of current amount, or about 20 larvae and 1 juvenile sucker in the J.C. Boyle Bypassed Reach.

J.C. Boyle Peaking Reach

Continued operations, with the new ramp rate of 2 inches per hour and minimum flow of 690 cfs or 40 percent of the combined inflow from Keno Reach and Spencer Creek, whichever is greater of the two flows (BLM Condition 4A1(a)(b) in the J.C. Boyle Peaking Reach), will greatly reduce dewatering of sucker embryos and stranding of sucker larvae. The Service estimates stranding mortality under the new license at 10,000 eggs and 1,000 larvae per year (Mark Buettner, USFWS, pers. comm.).

The proposed action includes up-ramp rates or 2 inches per hour or less in the J.C. Boyle Peaking Reach that should reduce scouring of spawning substrate and SNS eggs. However, few juvenile suckers were collected in the reservoir, which suggests that little recruitment is occurring (Desjardins and Markle 2000).

Copco No. 2
The proposed action includes a down ramp rate of 125 cfs per hour or about 2 inches per hour. Operation of Copco No. 2 development with a 2 inch per hour down-ramp rate and minimum flow of 70 cfs will have minimal effects on larval, juvenile, and sub-adult/adult suckers dispersing downstream because of their rarity in this reach. Stranding mortality is estimated at 10 larvae and 1 juvenile per year (Mark Buettner, USFWS, pers. comm.).

Iron Gate
Since endangered suckers in Iron Gate Reservoir are rare and few suckers disperse below the dam operation of the Iron Gate development under the proposed action will result in no stranding and mortality of larval, juvenile, and sub-adult/adult suckers.

Summary
Operation of Project developments and associated ramp rates under the proposed action may strand suckers, but because these habitats are not part of the original habitat complex of the suckers and probably are inherently unsuitable for completion of life cycles of suckers, there will be minimal impacts within the context of the overall population size and geographic range of LRS and SNS.

d. Reservoir Fluctuations and Stranding Potential

Keno Dam
Assuming the Commission includes the Keno development in the project license and requires PacifiCorp to immediately operate it as a run-of-river facility, with flow below Keno Dam to be within 10 percent of the measured project inflow based on a 3-day running average and ramp rate of about 1-2 inches per hour ((Federal Energy Regulatory Commission 2006); 5-63), the Service anticipates that up to 1,000 sucker larvae would be stranded as a result of this operation annually. Because juvenile and adult suckers occupy deeper water, we do not anticipate any stranding of these life stages. There also would be temporary displacement of larval suckers using the shallow shoreline areas and turbidity in these areas would likely increase for 1-4 days but we are unable to quantify the impacts of this action to federally listed suckers.

J.C. Boyle Reservoir

We estimate that that up to 5,000 larvae would continue to be stranded each year under the conditions of a new license. We estimate that up to 5,000 larvae and 1,000 juveniles may be killed annually by predation associated with daily reservoir fluctuations.

Copco and Iron Gate
Operation of Copco and Iron Gate Reservoirs under the proposed action with the same operating levels and ramp rates will result in the same sucker stranding numbers as current operations (up to 1,000 larval suckers stranded per year in Copco No. 1 Reservoir and up to 100 larvae in Iron Gate Reservoir). No juvenile and sub-adult/adult suckers would likely be stranded because they are generally located in deeper water and have better swimming ability to escape shallow water. Because of the small daily reservoir fluctuations and lack of emergent vegetation habitat providing cover for larval and juvenile suckers, we do not believe there would be increased predation impacts due to habitat displacement.

2. Migration Barriers

Eastside and Westside
If Eastside and Westside developments are included in the new project license and the facilities are not operated when Link River flows are less than 500 cfs, upstream sucker passage conditions will be improved.

Keno Dam
Assuming the Commission includes the Keno development in the project license, the continued operation of the existing upstream fishway at Keno Dam may restrict upstream migration of endangered suckers from J.C. Boyle Reservoir and those entrained from UKL and Keno Reservoir. Based on the estimated number of suckers entrained at Keno Dam (Appendix 1), 14,416 juveniles and 15 sub-adults/adults may be lost annually to the populations upstream since they may not return upstream until an improved fish ladder is installed. The Service considers the amount of information available to be inadequate to assess either the existing degree of impact on the sucker populations or the potential utility of modifying this ladder for sucker use. The Service has recommended additional studies to evaluate the need for a ladder built to sucker criteria at Keno Dam under its Section 10(j) authority.

J.C. Boyle
Proposed operation of J.C. Boyle fish ladder would have no impact to adult LRS and SNS because none appear to be attempting to migrate upstream of the dam to spawn or return to upstream rearing areas.

Copco No. 1, Copco No. 2, and Iron Gate Dams
The proposed action, including Section 18 prescriptions for Copco No. 1, Copco No. 2, and Iron Gate Dams, calls for construction of new fishways with a slope of <10 percent and 0.5 foot/drop criteria at each of these facilities. These fishways will improve passage opportunities for endangered suckers but will not provide unimpeded passage because suckers are not as effective at passing higher sloped ladders with surface drops as are other resident fish. These fishways are designed primarily for salmonids rather than suckers. The Service considers Copco No. 1, Copco No. 2 and Iron Gate Reservoirs inherently unsuitable for completion of life cycles of suckers, but valuable as refuge populations.

3. Degradation and Loss of Habitat

a. Instream Flows

Operation of Eastside and Westside facilities under the new license and establishment of minimum flows in the Link River by not diverting flows to the Eastside and Westside facilities when flows are 500 cfs or less will benefit endangered suckers by increasing available habitat in the Link River and reducing predation by fish and bird predators. Larval, juvenile, and sub-adult/adult sucker mortality associated with minimum flows under the new license are estimated at 10 percent of current rates or 500 larvae, 50 juveniles, and 2 sub-adult/adults per year.

In the event the Commission should include the Keno development in a new license and it is operated in a run-of-the river mode, with hourly outflows to be held within 10 percent of the 3-day running average of inflows, continued operation of Keno development will result in a lower risk of predation by fish eating birds and fish on endangered larval, juvenile, and sub-adult/adult suckers dispersing through this reach. The Service estimates larval and juvenile sucker predation mortality will be reduced to 10 percent of current rates (200 larvae and 10 juvenile suckers). The Service based its predation estimates on the sucker entrainment estimates in this reach (Appendix 1) and the assumption that higher minimum instream flow prescriptions required under the new license will substantially decrease vulnerability of the larval and juvenile suckers to predation by increasing water depth, velocity, turbulence, and hiding cover making it more difficult for predators to prey on these fish.

Continued operation of J.C. Boyle and Copco No. 2 developments under the proposed action with minimum instream flow prescriptions of 470 cfs in the J.C. Boyle Bypassed Reach, 690 cfs in the J.C. Boyle Peaking Reach (470 cfs released at J.C. Boyle Dam + 220 cfs spring flow accretions), and at least 70 cfs in the Copco No. 2 Bypassed Reach, will likely reduce the risk of mortality related to predation by fish or fish-eating birds to larval, juvenile, and sub-adult/adult suckers dispersing downstream through these reaches. Estimated predation mortality per year under the new minimum instream flow prescriptions are estimated at 10 percent of current rates (20 larvae and 1 juvenile in the J.C. Boyle Bypassed Reach; 1,000 larvae in the J.C. Boyle peaking reach; <10 larvae in the Copco No. 2 Bypassed Reach). These number are based on a relative proportion of the sucker entrainment estimates in this reach (Appendix 1) and the assumption that higher minimum instream flow prescriptions required under the new license will substantially decrease vulnerability of larvae and juvenile suckers to predation by increasing water depth, velocity, turbulence, and hiding cover making it more difficult for predators to prey on these fish.

b. Wetlands Loss

Keno Reservoir
By continuing to provide flood control, Keno Dam is preventing some of the agricultural lands surrounding and connecting to Keno Reservoir from reverting to wetlands. However, we are unable to quantify PacifiCorp's contribution to the wetland loss from perpetuation of agricultural conversion.

Continued operations imposing stable water levels under the proposed action will continue to prevent the re-establishment of about 230 acres of fringe wetlands and will perpetuate the degraded condition of approximately 1,625 acres of existing emergent wetlands. This operational regime will also result in the continuation of shoreline areas dominated by grass and submerged aquatic plants, which provide lower quality habitat for larval and juvenile suckers. These impacts are expected to be causing lower larval sucker survival rates and higher downstream dispersion of sucker larvae and juveniles out of Keno Reservoir.

4. Water Quality

Keno Reservoir

Large quantities of nutrients in the form of decomposing algae arrive in Keno Reservoir from outside the Project area. Additional inputs from sources around Lake Ewauna and Keno Reservoir also contribute to water quality problems (Federal Energy Regulatory Commission 2006). The Water Quality Management Plan that FERC would require in the new license if Keno Dam is included, would begin repairing nutrient recycling in Keno Reservoir, but the effectiveness this plan will have on nutrient conditions in Keno Reservoir is unknown. Also, the degree and timing of water quality improvement that will result from the issuance and implementation of Federal Clean Water Act Section 401 Certification Conditions cannot currently be quantified. Continuing operations of Keno Dam, including the effects of the impoundment (see section 1d of the Factors Affecting the Species Environment in the Action Area, of the Environmental Baseline section, above) and the water management regime's impairment of the function of at least 230 acres of wetlands connected to Keno Reservoir (see section 3b, Wetlands loss, above) will continue to inhibit nutrient cycling at Keno Reservoir, contributing to the observed water quality effects for some time. Therefore, we assume that current levels of effects to suckers will continue for a few years following license issuance, and will gradually be reduced. Under this scenario, current levels of effects comprise a "worst case" effect of the proposed action.

Under the proposed action, about 6.14 million larvae, 100,000 juveniles, and 99 sub-adult/adult suckers are expected to disperse into Keno Reservoir from UKL (Appendix 1). We estimate that 80 percent of these fish perish due to poor water quality conditions in Keno Reservoir/Lake Ewauna. An estimated 10 percent of these fish reach Keno Dam (Terwilliger et al. 2004) and the Service estimates that an additional 10 percent may persist in Keno Reservoir and in the Link River. We estimate loss of listed suckers in Keno Reservoir to be up to 4.91 million larvae, 80,000 juveniles, and 79 sub-adult/adults annually. For larval suckers, this equates to approximately 7 percent of the estimated 73 million larvae entering UKL from the Williamson River (Klamath Tribes 1996); this estimate does not include larvae produced at the eastside springs and the Wood River. There are no reliable population estimates for juvenile or sub-adult/adult suckers for UKL (USDI Fish and Wildlife Service 2007b, and 2007c) against which to judge the proportional loss in Keno Reservoir. However, few sub-adult and adult suckers disperse out of UKL (USDI Fish and Wildlife Service 2002; Gutermuth et al. 2000a, 2000b), so the impact to adult populations is believed to be minimal.

Although we regard the above estimate of population loss in the Keno Reservoir as reasonable based on available information, there is currently no information available to apportion

responsibility for that loss among the various sources and parties contributing to the Keno Reservoir water quality problems. Therefore, the amount of take of listed suckers caused by the water quality impacts of the proposed action in Keno Reservoir cannot be determined.

J. C. Boyle Reservoir

Effects of Project operations under the proposed action on water quality in J.C. Boyle Reservoir are small and water quality conditions will likely be acceptable for endangered suckers.

Keno and Boyle River Reaches

Continued operation of Keno Dam (if included in the new license) and the J.C. Boyle developments under the new license conditions will not likely result in water quality conditions that are adverse to sucker survival in the Keno, J.C. Boyle Bypassed, and J.C. Boyle Peaking Reaches.

Copco and Iron Gate Reservoirs

Operation of Copco and Iron Gate facilities under the proposed action will result in seasonal thermal stratification and low DO in the bottom waters that are stressful to suckers. However, water quality conditions in the surface waters will be acceptable for suckers.

With operations of the Project under the proposed action, blue-green algae blooms, including the toxin producing *Microcystis aeroginosa,* will continue to cause stressful and possibly lethal conditions for suckers (Perkins et al. 2000a). If endangered sucker die-offs related to algae blooms occur in these reservoirs, their value as storage of suckers for potential reintroduction in historic habitat will be reduced.

5. Construction Effects

There may be effects to LRS and SNS associated with construction of fishway, spillway, and turbine tailrace barrier upgrades in the Project. However, limited information exists on the effects of human presence and construction activities in or near fish-bearing streams. Since basic information on the general behavior of fish during construction is lacking, it is difficult to assess how a fish may alter its behavior or respond when it encounters a human or piece of working machinery in a stream it occupies. However, it is known that fishes, like other animals, can detect a wide range of external stimuli. Environmental factors that most often affect fish behavior are sound, light, chemicals, temperature, and pressure. For instance, the classic fright response of fish to sounds is the "startle" behavior (Popper and Carlson 1998). Such behaviors involve sudden bursts of swimming that are short in duration and length and are characterized as "startle" or general avoidance of the site. This could result in the disruption of normal sucker feeding and/or increased exposure to fish and fish-eating bird predation.

During construction there is an expectation of short-term disturbance and possible harm due to placement and removal of cofferdams and dewatering construction sites; stranding by reduced flow during cofferdam placement; placement of instream structures (i.e., downstream fishway bypass pipes, tailrace barriers, rock deflectors); general construction disturbance (noise,

vibration, and increased activity); reductions in flow during cofferdam construction, and effects on water quality; and fish strandings necessitating salvage following cofferdam placement.

Sediment inputs due to cofferdam placement/removal and construction activities are expected to be of short duration, and while turbidity and fine sediment may increase, they are not expected to cause significant adverse effects to suckers in the area. There is also the possibility of introducing construction-related contaminants (e.g., fuels and construction materials) into the water, although this will be minimized through best management practices which include restrictions and requirements for fuels management, isolation of contaminants from floodplain or near-water areas, separation of vehicle storage and service areas from near-water areas, and field inspections of contractor compliance.

During flow reductions, while the cofferdams for fishways and tailrace facilities are being constructed, suckers might be stranded below the dams. Adverse effects of stranding will be minimized by salvage actions proposed by PacifiCorp. Reduced flows in the Link River and Klamath River could result in lower levels of DO downstream where suckers hold up during the summer when water quality is poor. While this is not likely to be a problem, required water quality monitoring would indicate if DO falls below 4 mg/L and, if necessary, flows could be increased.

6. Reintroduction of Anadromous Fish

The Klamath River watershed once produced large runs of Chinook salmon and steelhead and also supported significant runs of other anadromous fish including coho salmon, green sturgeon, eulachon, coastal cutthroat trout, and Pacific lamprey (Hamilton et al. 2005). The Upper Klamath River above Iron Gate Dam once supported the spawning and rearing of large populations of Chinook salmon and steelhead (Hamilton et al. 2005; Lane and Lane Associates 1981). The extent of upstream distribution of Chinook salmon and steelhead included tributaries to UKL including the Sprague River and Williamson River below the Klamath Marsh. Anadromous fish have not been able to inhabit these areas above Copco No. 1 Dam since 1918, and Iron Gate Dam since 1962, due to the lack of fish passage at these facilities (Fortune et al. 1966).

By providing fish passage at all dams in the Project, anadromous fish will be reintroduced to habitats above Iron Gate Dam that they formerly occupied. Reintroduction of Chinook salmon and steelhead into the Upper Klamath River watershed will affect fish communities including populations of listed LRS and SNS. However, these species coexisted for thousands of years before access to the Upper Klamath basin was blocked in 1918.

A comparison of the life history and habitat requirements of these species will provide some insight into potential effects on listed suckers. Lost River and SNSs rear mostly in lake environments, spawning during the spring in tributaries like the Sprague and Williamson Rivers. Progeny generally move downstream to the lake shortly after hatching, although some juveniles may rear for several months before emigrating to UKL.

Fall Chinook (ocean-type Chinook salmon) migrate upstream to spawn in the fall, and progeny rear in riverine or lake habitats until the following spring, when they migrate to the ocean.

Spring Chinook salmon migrate upstream in the spring months, hold in cool water habitats until fall, and then spawn. Progeny of Spring Chinook (stream-type Chinook salmon) rear up to a year in riverine and lake habitats before migrating to the ocean (Healy and Prince 1995).

Pacific Lamprey migrate upstream during the spring to spawn and their ammocoete larvae rear in tributaries for up to several years before transforming into adults and migrating downstream.

Of the fish species to be restored above dams on the Klamath River, steelhead may be the predator of greatest concern regarding resident fish. Steelhead progeny rear in riverine or lake habitats for 1 to 3 years before outmigrating to the ocean, and, in one study, were observed to prey upon Sacramento sucker eggs and young (Merz 2002). However, little evidence of diet overlap was found between salmonids and largescale suckers in the Hanford Reach of the Columbia River (Dauble 1986).

There probably would be minimal interaction between adult salmon and suckers with the reintroduction of anadromous fish above Iron Gate Dam because the salmon will quickly move through lake habitats occupied by LRS and SNS and will not be feeding. Spring Chinook salmon will be migrating up the Sprague and Williamson Rivers about the same time as LRS and SNS. However, they would likely be seeking holding habitat in cold tributaries and springs including the Williamson River near Spring Creek and the North Fork of the Sprague River (M. Buettner, USFWS, pers. comm.). Suckers would generally spawn further downstream in the mainstem Sprague River and the Williamson River below the confluence with the Sprague River.

SNS and LRS generally do not occupy riverine habitats during the fall, so there is little opportunity for interaction with fall Chinook salmon, which would migrate through UKL to spawn in tributaries during that time.

Progeny of spring and fall Chinook salmon will rear in the river habitats up to a year before migrating to the ocean. There may be small numbers of juvenile suckers rearing in the tributaries at the same time as juvenile salmon. Young salmon may prey on larval and small juvenile suckers. However, other fish species including dace, minnows, sculpins, redband trout, and a number of non-native species (including fathead minnows and yellow perch) are much more numerous than the suckers and would be the more accessible prey for salmonids. Unlike the salmon juveniles that would be associated with moving water, sucker larvae and juveniles occupy the shallow areas with low velocity (Buettner and Scoppettone 1990). Currently, salmonid species in the Sprague River, which is where most sucker spawning and larval rearing occurs, become restricted to spring inflow areas and colder tributaries during the summer (W. Tinniswood, ODFW, pers. comm.). Suckers also occupy the cold water inflow areas but, to a greater extent, the warmer mainstem habitats. Therefore, there would be less opportunity for overlap. However, if extensive habitat restoration occurs and summer water temperatures decrease in the Sprague River, there could be more interaction and potential predation by salmon juveniles on small suckers.

If salmon juveniles rear in UKL, there is more potential for interaction with suckers. However, UKL is a highly productive environment with extremely large populations of fish including native species such as blue chub, tui chub, sculpins, and redband trout, as well as non-native species (fathead minnows, yellow perch, brown bullhead, and pumpkinseed). The numbers and

biomass of these other species that are potential prey for salmon juveniles is enormous. Juvenile suckers currently constitute far less than 0.1 percent of the fish numerically in UKL. Even when robust populations of LRS and SNS are restored, other fish species would far outnumber the suckers. Also, juvenile suckers are bottom oriented while juvenile salmon are more likely to be water column oriented. Their different spatial distributions would reduce interactions.

Food interactions between juvenile salmon and juvenile suckers are also not considered to be a major impact. Because of the tremendous productivity of UKL, it is unlikely that food resources would be limiting for suckers or salmon. While the juvenile salmon feed on benthic macroinvertebrates and small fish, suckers feed on zooplankton, benthic macroinvertebrates, and algae. In tributaries like the Sprague River, where both suckers and salmon may co-occur, productivity is very high. This suggests that there would be plenty of food for both suckers and salmon.

Reintroduction of salmon will likely not increase the risk of introducing pathogens that are not currently present in the upper Klamath River basin (Scott Foott, USFWS, pers. comm.). While the viral pathogen, Infectious Hematopoietic Necrosis (IHN), and the bacteria *Renibacterium salmoninarum,* have been documented in Chinook salmon in the lower Klamath River basin, IHN is rare and is not virulent to trout and non-salmonid resident fishes in the upper Klamath system. *R. salmoninarum* is present in low levels in juvenile and adult Chinook salmon in the Klamath River basin but does not appear to induce significant disease (Scott Foott, USFWS, pers. comm.). The qualitative risk of introducing non-native or highly virulent pathogen into the upper basin by anadromous fish can be categorized as low (Scott Foott, USFWS, pers. comm.). Generally, both anadromous and upper basin resident fish share the same suite of pathogens. As mentioned previously, Columnaris disease or "gill rot" seems to be the primary disease involved on sucker die offs (Foott 1997; Holt 1997). Columnaris disease (*F. columnare*) is ubiquitous in freshwater systems, and present throughout the Klamath River system above and below Iron Gate Dam (Scott Foott, USFWS, pers. comm.; Administrative Law Judge 2006). And, as Chinook salmon, steelhead, and other native species have evolved together (69 FR 59996), it is likely that Pacific Northwest fish pathogens would be present in the resident native fish populations in the upper Klamath Basin, including LRS and SNS.

Reintroduction of anadromous fish may have an indirect effect to suckers by restoring marine-derived nutrients (MDNs) into the watershed. The enrichment of the freshwater ecosystem from input of salmon carcasses could have effects throughout the food web by increasing primary productivity. However, under certain circumstances, salmon smolts have been identified as important exporters of nutrients, such as phosphorous, from freshwater ecosystems (Scheuerell et al. 2005). In the upper Klamath basin, phosphorous reduction is a primary management goal (Kann and Walker Jr 1999). The extent of this increase will depend primarily on anadromous fish management decisions, not fish passage. If managers choose steelhead as the primary anadromous species for reintroduction, there will be far fewer carcasses because this species does not generally die after spawning. There are no data on the potential for MDNs to have adverse effects on the aquatic environment.

Effects of the Proposed Action on Proposed Critical Habitat

On December 1, 1994, the Service published a proposed rule for LRS and SNS critical habitat (59 FR 61744). Critical habitat has not been finalized. The proposed action has effects within or adjacent to one of six proposed critical habitat units, #3 Klamath River.

Physical habitat within the proposed critical habitat unit will be adversely affected by the proposed action through water elevation manipulation in the Project reservoirs, resulting in loss and degradation of littoral shoreline vegetation habitat. Shoreline habitats important for larval and juvenile suckers will be temporarily impacted by diurnal and seasonal water level fluctuations that result in dewatering or decreasing water depth. Stable water levels in Keno Reservoir negatively affect wetland habitat features for larval and juvenile suckers. Through alterations in flow timing, magnitude, and duration in riverine reaches, stranding of larval and juvenile suckers is likely to continue. Highly variable habitat conditions may increase risk of predation, stress, and delay migration. Fish passage may be restricted at Project dams causing population fragmentation.

The biological environment will be adversely affected by the proposed action through the enhancement of non-native fish populations that both prey upon and compete for food with LRS and SNS. Habitats that have been modified by human activity, in this case building dams and creating reservoirs on the Klamath River and continued operation of these dams and reservoirs, are more conducive to supporting abundant non-native fish populations than native fish (Moyle 2002). The relicensed Project reservoirs will contribute to water quality degradation (temperature, pH, DO) by increasing the surface area and hydraulic retention time (see Water Quality Effects section). These impacts are specifically addressed elsewhere in this consultation. However, the contribution of riverine and reservoir habitat in the Project area to the recovery of federally listed suckers is questionable. The National Research Council (2004) stated that sucker populations in the Klamath River reservoirs do not have a high priority for recovery because they are not part of the original habitat complex of the suckers and probably are inherently unsuitable for completion of life cycles by suckers.

Cumulative Effects

Cumulative effects are those impacts of future State and private actions that are reasonably certain to occur within the area of the action subject to consultation. Future federal actions will be subject to the consultation requirements established in section 7 of the Act and, therefore, are not considered cumulative to the proposed action.

The following non-Federal activities are proposed in the action area:

1) The completion of the water adjudication process for Klamath Basin in Oregon is expected in 2010, providing for more efficient water management in the Klamath River Basin and more opportunities to enhance water quantity and quality in habitats occupied by endangered suckers.
2) In 2007 and 2009, the Tulana and Goose Bay sections of the Lower Williamson River Delta (5,000 acres) will be restored back to functioning wetland, riparian, and lake habitats supporting suckers and enhancing water quality in UKL.
3) The State of Oregon is enlarging its fish screening program in the Klamath Basin to complement completion of the adjudication process. Following adjudication, diversions will require water measurement devices and fish screens.

4) The Klamath Watershed Council and its partners are scheduled to complete all 7 subbasin watershed assessments in the next few years, providing a roadmap for watershed restoration needs to support healthy aquatic ecosystems and aid in the recovery of listed suckers and other at-risk species.
5) Following completion of the subbasin watershed assessments and revision of the Lost River and Shortnose Sucker Recovery Plan, there will be greater interest and investment in specific habitat restoration projects by state and private interests, including Oregon Watershed Enhancement Board, The Nature Conservancy, and others.
6) With the completion of the Klamath River TMDL (Oregon) in the next few years, private, municipal, and industrial entities contributing to the degradation of water quality in Keno Reservoir will be required to develop and implement water quality management plans that reduce nutrient loading and aid in the improvement of water quality in the Klamath River.

Most of the non-Federal actions will improve water quantity, water quality, and habitat in areas supporting listed suckers, including UKL and Keno Reservoir. Screening will reduce entrainment of suckers and improve overall survival. Habitat restoration will increase the amount and quality of areas important for completion of life cycles. Water quality improvement Projects will address a major factor limiting listed sucker recovery in the Upper Klamath Basin. If water quality is improved in Keno Reservoir, this area may be able to support a substantial population of suckers or provide habitat to support larval and juvenile suckers that eventually inhabit UKL as adults.

Climate Change

Climate change is expected to significantly affect water resources in the western United States by the mid 21st century (Leung et al. 2004), about the time the new license for the Project will expire. Climate change is generally expected to result in increased surface and water temperatures, decreased water quality, increased evaporation rates, increased proportion of precipitation as rain instead of snow, earlier and shorter runoff seasons, and increased variability in precipitation patterns (Adams and Peck 2006). Precipitation projections with climate change vary widely (California Energy Commission 2005).

In the Klamath Basin, Bartholow (Bartholow 2005) found that water temperatures in the Lower Klamath River have been increasing by about 0.5°C per decade since the 1960s. A preliminary analysis of climatologic and hydrologic information for the Upper Klamath River Basin indicates a trend of rising temperatures and decreasing amounts of snow-pack at lower elevations (Jon Hicks, USBR, pers. comm.).

Climate change could exacerbate existing poor habitat conditions for suckers by degrading water quality, reducing snow-pack, and increasing agricultural water demand. Higher temperatures could exacerbate current water quality conditions by increasing the incidence of episodes of peak summer temperatures when die-offs are most likely to occur. The conditions documented during the last three fish die-offs in UKL were characterized by higher than average temperatures (Wood et al. 2006). Because UKL is shallow, water temperatures tend to closely follow air temperatures so even a week of high air temperatures will affect water temperatures in the lake.

Higher water temperatures could have multiple adverse effects on suckers including: (1) stressing AFA, causing bloom collapse; (2) increasing respiration rates of microorganisms, thus elevating DO consumption in the water column and on sediments; (3) raising respiration rates for suckers and other fish; and (4) reducing the DO holding-capacity of water which is highest in cold water. Sucker growth rates might be increased for part of the year but if temperatures lead to reduced water quality, the benefits could be negated.

Higher temperatures would also increase water use by agriculture because evapotranspiration would be increased and the water needs of crops would be greater. Also, higher temperatures would lead to increased evaporation rates, meaning greater water loss from water bodies. This is particularly a problem for reservoirs in the upper Klamath Basin because they are shallow and thus have a large surface to volume ratio.

Climate change will likely have gradual adverse effects on suckers. However, these effects will occur over a long time period, and recovery efforts that restore wetlands and water quality conditions for suckers will likely occur more rapidly.

Conclusion

The implementing regulations for section 7 of the ESA (50 C.F.R. 402) define "jeopardize the continued existence of" to mean "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, and distribution of that species."

After reviewing the current status of the LRS and SNS, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the Service's BO that the action, as proposed, is not likely to jeopardize the continued existence of the LRS or SNS, and is not likely to destroy or adversely modify proposed critical habitat for the suckers.

The Service reached this conclusion for the following reasons:

1. We expect the level of LRS and SNS injury or mortality resulting from entrainment and spillway passage through the Project developments, particularly at Eastside and Westside facilities, will be reduced by the requirements of the fishway prescriptions in the proposed action.
2. The upstream and downstream fish passage measures to be required by the new license will reduce the impacts to LRS and SNS associated with the continued operation of the Project. The installation of fish passage facilities will restore connectivity between local populations and provide important access between foraging, spawning, rearing, and overwintering habitats.
3. New instream flow and ramp rate license requirements for riverine reaches below Link River, Keno, J.C. Boyle, and Copco No. 2 Dams will reduce injury or mortality resulting from stranding and predation by fish and fish-eating birds, and increase survival of endangered suckers migrating upstream or dispersing downstream through these habitats.
4. Reintroduction of anadromous fish into the Project area will not negatively impact survival of LRS and SNS because these species coexisted before the Project was initially constructed, there is minimal habitat overlap, and the system's high productivity should support viable

populations of both suckers and anadromous fish.

5. While the numbers of larval and juvenile suckers that will be taken appear to be large, these numbers are actually small in comparison to the potential fecundity of the breeding population.
6. The Keno Reservoir water quality management plan in the proposed action (if Keno Dam is included in the license) and conditions required by Clean Water Act 401 Certification will result in improved survival of all sucker life stages.

LRS and SNS should benefit from the reduction of the continuing adverse impacts associated with the Project, most notably through the reduction in entrainment at the Eastside and Westside Power Diversions and stranding losses in the Link River. Over time, we expect the implementation of the license-required measures will contribute to the recovery of the LRS and SNS.

Sucker Proposed Critical Habitat

Proposed critical habitat for the LRS and SNS was developed in 1994. There has been no further action to designate critical habitat. Destruction or adverse modification is defined as "a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining the habitat to be critical." [50 CFR § 402.02] Project activities are not likely to result in the destruction or adverse modification of the LRS and SNS proposed critical habitat because the function of most of primary constituent elements, which are currently not fully functional, will be improved by the various measures incorporated into the proposed action (e.g., fishway prescriptions, instream flows and ramp rates, management plan for Keno Reservoir to improve water quality, adaptive management plan for federally listed suckers) to a level that will not appreciably diminish their value for both survival and recovery of the species.

BULL TROUT

Introduction

The proposed action will result in reintroduction of salmon and steelhead into a portion of the range of the listed bull trout, and into designated critical habitat. The Klamath River Distinct Population Segment (DPS) is one of five DPSs of bull trout identified in the coterminous United States (64 FR 58909). The following section analyzes the effects of the action on the bull trout, the Klamath River DPS, and on bull trout critical habitat.

Status of the Species/Critical Habitat

Background

Bull trout (*Salvelinus confluentus*) are members of the char subgroup of the family Salmonidae and are native to waters of western North America. The historical range of the bull trout includes major river basins in the Pacific Northwest at about 41 to 60 degrees North latitude, from the southern limits in the McCloud River in northern California and the Jarbridge River in

Nevada to the headwaters of the Yukon River in the Northwest Territories, Canada (Bond 1992; Cavender 1978). To the west, the bull trout's range includes Puget Sound, and various coastal rivers of British Columbia, Canada, and southeast Alaska (Bond 1992). Bull trout occur in portions of the Columbia River and tributaries within the basin, including its headwaters in Montana and Canada and the Klamath River basin of south-central Oregon. East of the Continental Divide, bull trout are found in the headwaters of the Saskatchewan River in Alberta and Montana and in the MacKenzie River system in Alberta and British Columbia, Canada (Brewin and Brewin 1997; Cavender 1978).

Historical records for the Klamath River basin suggest that bull trout in this population segment were once widely distributed and exhibited diverse life history traits in this part of their range (Ziller 1992). Currently, however, bull trout in this basin are almost entirely non-migratory, resident fish that are confined to headwater streams (Goetz 1989). At the time of listing (1999), there were only seven naturally occurring, non-migratory populations (62 FR 32268) occurring in the UKL, Sprague River, and Sycan Marsh watersheds in Oregon. Since then, two small resident and one remnant fluvial populations have been discovered; however, as of 2007, both resident populations (Coyote and Sheepy Creek populations) appear to have been locally extirpated again (John Bowerman, USFWS, pers. comm). The extant populations represent an estimated 21 percent of the estimated historical range of bull trout in the Klamath River basin (Quigley and Arbelbide 1997). These known remaining local populations are considered to be quite low in abundance; they are highly isolated from one another as a result of natural and human-caused conditions; and they are at substantial risk of extirpation due to natural disturbance cycles, random events, and other risk factors (Light et al. 1996).

Listing History and Threats

The coterminous United States population of bull trout was listed as threatened on November 1, 1999 (64 FR 58901). Throughout its range, the bull trout is threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels, and introduced non-native species (64 FR 58910). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats.

The bull trout was initially listed as three separate DPSs (Columbia River DPS, Klamath River DPS, and Jarbridge River DPS)(63 FR 31647; 64 FR 17110). The preamble to the final listing rule for the United States coterminous population of the bull trout discusses the consolidation of these DPSs with the Columbia and Klamath population segments into one listed taxon and the application of the jeopardy standard under section 7 of the Act relative to this species (64 FR 58910):

> Although this rule consolidates the five bull trout DPSs into one listed taxon, based on conformance with the DPS policy for purposes of consultation under section 7 of the Act, we intend to retain recognition of each DPS in light of available scientific information relating to their uniqueness and significance. Under this approach, these DPSs will be treated as interim recovery units with

respect to application of the jeopardy standard until an approved recovery plan is developed. Formal establishment of bull trout recovery units will occur during the recovery planning process.

Critical habitat for the Klamath River DPS of the bull trout was designated (70 FR 56212) September 26, 2005. No five year review for bull trout has been finalized.

Previous Significant Formal Consultations

There have been four formal consultations for bull trout that have been specific to, and have originated in the Klamath DPS/Recovery Unit. Most recently, the Service consulted formally with the USDI Forest Service on grazing leases within the Silver Creek pasture of the Foster Butte Allotment, Silver Lake District, Fremont National Forest, in early 2000 (1-10-00-F-071; 07/26/02). The scope or action area addressed by the BO for the Forest Service included proposed grazing and related activities within the Coyote Creek drainage. The other three formal consultations were a programmatic consultation with the Freemont National Forest (1-10-98-F-40; 07/10/98) for road maintenance, a programmatic consultation with Freemont National Forest (1-10-98-F-83; 10/20/98) for grazing, and the Degree & North Fork Sprague River Habitat Restoration Project (1-10-99-F-067; 07/20/99). Coyote Creek is within the Long Creek watershed, which drains into the Sprague River, a tributary of UKL. Bull trout are presently known to occur in a 3.4 km to 5.0 km (2 to3 mi) reach of Long Creek above river kilometer 21.1 (mile 12.7) (Buchanan et al. 1997; Light et al. 1996). Within the area covered by Klamath River DPS, there are no Habitat Conservation Plans involving bull trout (67 FR71236).

Current Status, Conservation Needs, and Range-wide Trend

In recognition of available scientific information relating to their uniqueness and significance, five segments of the coterminous United States population of the bull trout are considered essential to the survival and recovery of this species and are identified as interim recovery units: 1) Jarbridge River, 2) Klamath River, 3) Columbia River, 4) Coastal-Puget Sound, and 5) St. Mary-Belly River (USDI Fish and Wildlife Service 2002d, 2004a, b). Each of these interim recovery units is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions.

A summary of the current status and conservation needs of the bull trout within these interim recovery units is provided below and a comprehensive discussion is found in the Service's draft recovery plans for the bull trout (USDI Fish and Wildlife Service 2002d, 2004a, b).

The conservation needs of bull trout include cold, clean water, and complex, connected habitat. These conditions are all needed to promote conservation of bull trout at multiple scales ranging from the coterminous to local populations. The recovery planning process for bull trout (USDI Fish and Wildlife Service 2002d, 2004a, b) has also preliminarily identified the following conservation needs: 1) maintenance and restoration of multiple, interconnected populations in diverse habitats across the range of each interim recovery unit, 2) preservation of the diversity of life-history strategies, 3) maintenance of genetic and phenotypic diversity across the range of each interim recovery unit, and 4) establishment of a positive population trend. Bull trout

populations need to be protected from catastrophic fires across the range of each interim recovery unit (Rieman et al. 2003).

Bull trout can be grouped into population units that share an evolutionary legacy, termed metapopulations, and local populations (Kanda and Allendorf 2001). Metapopulations are composed of one or more local populations. A local population is a group of bull trout that spawn within a particular stream or portion of a stream system. For recovery planning, bull trout have been grouped into distinct population segments, recovery units, core areas, and local populations. Core areas are composed of one or more local populations that overlap in their use of rearing, foraging, migratory, and overwintering habitat; recovery units are composed of one or more core areas; and a distinct population segment is composed of one or more recovery units. Maintenance of viable core areas is central to the survival and recovery of bull trout (USDI Fish and Wildlife Service 2002d, 2004a, b). Each of the 5 interim recovery units listed above consists of 1 or more core areas. There are 121 core areas identified across the coterminous range of the bull trout (USDI Fish and Wildlife Service 2002d, 2004a, b).

The manner in which bull trout were grouped in the draft recovery plans represents an adaptive comparison of genetic population structure and management considerations. (See Strategy for Recovery section (in Chapter 1-Introduction; (USDI Fish and Wildlife Service 2002b) for additional discussion of recovery units, core areas, local populations, and genetic structure of bull trout.)

Bull trout exhibit both resident and migratory life-history strategies (Rieman and McIntyre 1993). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. Migratory bull trout spawn in tributary streams where juvenile fish rear one to four years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989; Goetz 1989), or in certain coastal areas, to saltwater (anadromous) (Cavender 1978; McPhail and Baxter 1996; Washington Department of Fish and Wildlife et al. 1997) Resident and migratory forms may be found together, and either form may give rise to offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993). There is no evidence that anadromous *Salvelinus sp.* occurred historically in the Klamath River watershed (Goetz 1989). For additional information on the biology and habitat requirements, please refer to the proposed critical habitat rule (67 FR 71235) and final listing rule (63 FR 31647).

Jarbridge River (Nevada) Interim Recovery Unit

This interim recovery unit currently contains a single core area with six local populations. Less than 500 resident and migratory adult bull trout, representing about 50 to 125 spawning adults, are estimated to occur in the core area. The current condition of the bull trout in this interim recovery unit is attributed to the effects of livestock grazing, roads, incidental mortalities of released bull trout from recreational angling, historical angler harvest, timber harvest, and the introduction of non-native fishes (USDI Fish and Wildlife Service 2004b). The draft bull trout recovery plan (USDI Fish and Wildlife Service 2004b) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout within the core area, 2) maintain stable or increasing trends in abundance of both resident and migratory bull trout in the core area, 3) restore and maintain suitable habitat conditions for all life history stages and forms, and 4) conserve genetic diversity and increase natural opportunities for genetic

exchange between resident and migratory forms of the bull trout. An estimated 270 to 1,000 spawning bull trout per year are needed to provide for the persistence and viability of the core area and to support both resident and migratory adult bull trout (USDI Fish and Wildlife Service 2004b).

The overall status of the Jarbridge River population has likely not changed appreciably since its listing. Bull trout and their habitat in this area have been affected by a small number of actions addressed through informal and formal consultations under section 7 of the ESA. A few of these actions may have resulted in degradation of the environmental baseline, while some also analyzed the potential for incidental take of bull trout. In general, some of the factors considered to be threats to bull trout have been improving slightly in some areas (i.e., grazing and fisheries management).

Klamath River (Oregon) Interim Recovery Unit

This interim recovery unit currently contains 3 core areas and 7 local populations. The current abundance, distribution, and range of the bull trout in the Klamath River Basin are greatly reduced from historical levels due to habitat loss and degradation caused by reduced water quality, timber harvest, livestock grazing, water diversions, roads, and the introduction of non-native fishes (USDI Fish and Wildlife Service 2002c). Bull trout populations in this interim recovery unit face a high risk of extirpation (USDI Fish and Wildlife Service 2002c). The draft Klamath River bull trout recovery plan (USDI Fish and Wildlife Service 2002c) identifies the following conservation needs for this interim recovery unit: 1) maintain the current distribution of bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and strategies, 4) conserve genetic diversity and provide the opportunity for genetic exchange among appropriate core area populations. Eight to 15 new local populations and an increase in population size from about 2,400 adults currently to 8,250 adults are needed to provide for the persistence and viability of the 3 core areas (USDI Fish and Wildlife Service 2002c).

Improvements in the Threemile, Sun, and Long Creek local populations have occurred through efforts to remove or reduce competition and hybridization with non-native salmonids, changes in fishing regulations, and habitat-restoration projects. Population status in the remaining local populations (Boulder-Dixon, Deming, Brownsworth, and Leonard Creeks) remains relatively unchanged. Grazing within bull trout watersheds throughout the recovery unit has been curtailed. Efforts at removal of non-native species of salmonids appear to have stabilized the Threemile Creek and positively influenced the Sun Creek local populations. The results of similar efforts in Long Creek are inconclusive. Mark and recapture studies of bull trout in Long Creek indicate a larger migratory component than previously expected.

Although the status of specific local populations has been slightly improved by recovery actions, the overall status of Klamath River bull trout continues to be depressed. Factors considered threats to bull trout in the Klamath Basin at the time of listing — habitat loss and degradation caused by reduced water quality, past and present land use management practices, water diversions, roads, and non-native fishes — continue to be threats today.

Columbia River Interim Recovery Unit

The Columbia River interim recovery unit includes bull trout residing in portions of Oregon, Washington, Idaho, and Montana. Bull trout are estimated to have occupied about 60 percent of the Columbia River Basin, and presently occur in 45 percent of the estimated historical range (Quigley and Arbelbide 1997). This interim recovery unit currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in central Idaho and northwestern Montana. The Columbia River interim recovery unit has declined in overall range and numbers of fish (63 FR 31647). Although some strongholds still exist with migratory fish present, bull trout generally occur as isolated local populations in headwater lakes or tributaries where the migratory life history form has been lost. Though still widespread, there have been numerous local extirpations reported throughout the Columbia River basin. The draft Columbia River bull trout recovery plan (USDI Fish and Wildlife Service 2002d) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of the bull trout within core areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all bull trout life history stages and strategies, and 4) conserve genetic diversity and provide opportunities for genetic exchange.

All core areas in this unit have been subject to the combined effects of habitat degradation and fragmentation caused by the following activities: dewatering; road construction and maintenance; mining; grazing; the blockage of migratory corridors by dams or other diversion structures; poor water quality; incidental angler harvest; entrainment into diversion channels; and introduced non-native species. The Service completed a core area conservation assessment for the 5-year status review and determined that, of the 97 core areas in this interim recovery unit, 38 are at high risk of extirpation, 35 are at risk, 20 are at potential risk, 2 are at low risk, and 2 are at unknown risk (USDI Fish and Wildlife Service 2005a).

The overall status of the Columbia River interim recovery unit has not changed appreciably since its listing on June 10, 1998. Populations of bull trout and their habitat in this area have been affected by a number of actions addressed under section 7 of the Act. Most of these actions resulted in degradation of the environmental baseline of bull trout habitat, and all permitted or analyzed the potential for incidental take of bull trout. The Plum Creek Cascades HCP, Plum Creek Native Fish HCP, and Forest Practices HCP addressed portions of the Columbia River population segment of bull trout.

Coastal-Puget Sound (Washington) Interim Recovery Unit

Bull trout in the Coastal-Puget Sound interim recovery unit exhibit anadromous, adfluvial, fluvial, and resident life history patterns. The anadromous life history form is unique to this interim recovery unit. This interim recovery unit currently contains 14 core areas and 67 local populations (USDI Fish and Wildlife Service 2004a). Bull trout are distributed throughout most of the large rivers and associated tributary systems within this interim recovery unit. Bull trout continue to be present in nearly all major watersheds where they likely occurred historically, although local extirpations have occurred throughout this interim recovery unit. Many remaining populations are isolated or fragmented and abundance has declined, especially in the southeastern portion of the interim recovery unit. The current condition of the bull trout in this

interim recovery unit is attributed to the adverse effects of dams, forest management practices (e.g., timber harvest and associated road building activities), agricultural practices (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation), livestock grazing, roads, mining, urbanization, poaching, incidental mortality from other targeted fisheries, and the introduction of non-native species. The draft Coastal-Puget Sound bull trout recovery plan (USDI Fish and Wildlife Service 2004a) identifies the following conservation needs for this interim recovery unit: 1) maintain or expand the current distribution of bull trout within existing core areas, 2) increase bull trout abundance to about 16,500 adults across all core areas, and 3) maintain or increase connectivity between local populations within each core area.

Although the status of bull trout in Coastal-Puget Sound interim recovery unit has been improved by certain actions, it continues to be degraded by other actions, and it is likely that the overall status of the bull trout in this population segment has not improved since its listing on November 1, 1999. Improvement has occurred largely through changes in fishing regulations and habitat-restoration projects. Fishing regulations enacted in 1994 either eliminated harvest of bull trout or restricted the amount of harvest allowed, and this likely has had a positive influence on the abundance of bull trout. Improvement in habitat has occurred following restoration projects intended to benefit either bull trout or salmon, although monitoring the effectiveness of these projects seldom occurs. On the other hand, the status of this population segment has been adversely affected by a number of Federal and non-Federal actions, some of which were addressed under section 7 of the Act. Most of these actions degraded the environmental baseline; all of those addressed through formal consultation under section 7 of the Act permitted the incidental take of bull trout.

Section 10(a)(1)(B) permits have been issued for HCPs completed in the Coastal-Puget Sound population segment. These include: 1) the City of Seattle's Cedar River Watershed HCP, 2) Simpson Timber HCP, 3) Tacoma Public Utilities Green River HCP, 4) Plum Creek Cascades HCP, 5) Washington State Department of Natural Resources HCP, 6) West Fork Timber HCP (Nisqually River), and 7) Forest Practices HCP. These HCPs provide landscape-scale conservation for fish, including bull trout. Many of the covered activities associated with these HCPs will contribute to conserving bull trout over the long-term; however, some covered activities will result in short-term degradation of the baseline. All HCPs permit the incidental take of bull trout.

St. Mary-Belly River (Montana) Interim Recovery Unit

This interim recovery unit currently contains 6 core areas and 9 local populations (USDI Fish and Wildlife Service 2002e). Currently, bull trout are widely distributed in the St. Mary River drainage and occur in nearly all of the waters that it inhabited historically. Bull trout are found only in a 1.2-mile reach of the North Fork Belly River within the United States. Redd count surveys of the North Fork Belly River documented an increase from 27 redds in 1995 to 119 redds in 1999. This increase was attributed primarily to protection from angler harvest (USDI Fish and Wildlife Service 2002e). The current condition of the bull trout in this interim recovery unit is primarily attributed to the effects of dams, water diversions, roads, mining, and the introduction of non-native fishes (USDI Fish and Wildlife Service 2002e). The draft St Mary Belly bull trout recovery plan (USDI Fish and Wildlife Service 2002e) identifies the following

conservation needs for this interim recovery unit: 1) maintain the current distribution of the bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and forms, 4) conserve genetic diversity and provide the opportunity for genetic exchange, and 5) establish good working relations with Canadian interests because local bull trout populations in this interim recovery unit are comprised mostly of migratory fish, whose habitat is mostly in Canada.

The overall status of bull trout in the Saint Mary-Belly River interim recovery unit has not changed appreciably since its listing on November 1, 1999. Extensive research efforts have been conducted since listing to better quantify populations of bull trout and their movement patterns. Limited efforts in the way of active recovery actions have occurred. Habitat occurs mostly on Federal and Tribal lands (Glacier National Park and the Blackfeet Nation). Known problems due to instream flow depletion, entrainment, and fish passage barriers resulting from operations of the Reclamation's Milk River Irrigation Project (which transfers Saint Mary River water to the Missouri River Basin) and similar Projects downstream in Canada constitute the primary threats to bull trout and to date they have not been adequately addressed under section 7 of the Act. Plans to upgrade the aging irrigation delivery system are being pursued, which has potential to mitigate some of these concerns but also the potential to intensify dewatering. A major fire in August, 2006 severely burned the forested habitat in Red Eagle and Divide Creeks, potentially affecting 3 of 9 local populations and degrading the baseline.

Consulted-on Effects to Bull Trout

Consulted-on effects are those effects to the listed species that have been analyzed through section 7 consultation as reported in a BO. These effects are an important component of objectively characterizing the current condition of the species. To assess consulted-on effects to bull trout we analyzed all of the BOs addressing the species from the time of listing in 1998 through 2007. Our analysis showed that we consulted on a wide array of actions which had varying level of effects. Many of the actions resulted in only short-term adverse effects – some with long-term beneficial effects. Some of the actions resulted in long-term adverse effects. No actions that have undergone consultation were found to appreciably reduce the likelihood of survival and recovery of the bull trout. Furthermore no actions that have undergone consultation were anticipated to result in the loss of local populations of bull trout (Clay Fletcher, USFWS, pers. comm.).

Ongoing Conservation Measures

At present, there are several State, Federal, Tribal, and Canadian programs and conservation efforts that may help achieve recovery objectives for bull trout in the coterminous United States. Examples of these programs are efforts to educate the public regarding bull trout conservation, restrictions or prohibitions on the harvest of bull trout, and the eradication of non-native fish species which compete with bull trout. Recovery planning for bull trout will proceed under the direction of an overall recovery team as well as individual recovery unit teams working to address bull trout conservation needs in specific geographic locations. The bull trout recovery planning process has built upon previous State and locally-driven processes throughout the range of the species. For additional information on ongoing conservation measures throughout the

range of the bull trout, please refer to Chapter 1 of the Draft Recovery Plan for Bull Trout (USDI Fish and Wildlife Service 2002b).

Bull Trout Critical Habitat

The Service published a final critical habitat designation for the coterminous United States population of the bull trout on September 26, 2005 (70 FR 56212); the rule became effective on October 26, 2005. The scope of the designation involved the Klamath River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments (also considered as interim recovery units). Rangewide, the Service designated 143,218 acres of reservoirs or lakes and 4,812 stream or shoreline miles as bull trout critical habitat (Table 4).

Table 4. Stream/shoreline distance and acres of reservoir or lakes designated as bull trout critical habitat by state.

	Stream/shoreline Miles	Stream/shoreline Kilometers	Acres	Hectares
Idaho	294	474	50,627	20,488
Montana	1,058	1,703	31,916	12,916
Oregon	939	1,511	27,322	11,057
Oregon/Idaho	17	27		
Washington	1,519	2,445	33,353	13,497
Washington (marine)	985	1,585		

Although critical habitat has been designated across a wide area, some critical habitat units were excluded in the final designation pursuant to section 4(b)(2) of the Act, which permits the Secretary to exclude from critical habitat areas if the benefit of exclusion outweighs the benefit of inclusion, unless he or she determines that the failure to designate as critical habitat will result in the extinction of species. In the final rule, nine of the proposed critical habitat units were excluded from designation. Despite their exclusion from the final designation under the above-described balancing test, the water bodies within the proposed units remain important for bull trout conservation.

Conservation Role and Description of Critical Habitat - The conservation role of bull trout critical habitat is to support viable core area populations (70 FR 56212). The core areas reflect the metapopulation structure of bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses. Critical habitat units generally encompass one or more core areas and may include foraging, migration, and overwintering (FMO) areas, outside of core areas, that are important to the survival and recovery of bull trout.

Because there are numerous exclusions that reflect land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments. These individual critical habitat segments are expected to contribute to the ability of the stream to support bull trout within local populations and core areas in each critical habitat unit.

The primary function of individual critical habitat units is to maintain and support core areas which 1) contain bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993); 2) provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (Montana Bull Trout Scientific Group (MBTSG) 1998; Rieman and McIntyre 1993); 3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (Hard 1995; Healy and Prince 1995; Montana Bull Trout Scientific Group (MBTSG) 1998; Rieman and McIntyre 1993); and 4) are distributed throughout the historical range of the species to preserve both genetic and phenotypic adaptations (Hard 1995; Montana Bull Trout Scientific Group (MBTSG) 1998; Rieman and Allendorf 2001; Rieman and McIntyre 1993).

Within the designated critical habitat areas, the primary constituent elements (PCEs) for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering.

The PCEs are as follows:

> (1) Water temperatures that support bull trout use. Bull trout have been documented in streams with temperatures from 32 to 72 °F (0 to 22 °C) but are found more frequently in temperatures ranging from 36 to 59 °F (2 to 15 °C). These temperature ranges may vary depending on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shade, such as that provided by riparian habitat; and local groundwater influence. Stream reaches with temperatures that preclude bull trout use are specifically excluded from designation.
>
> (2) Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and instream structures.
>
> (3) Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. This should include a minimal amount of fine substrate less than 0.25 inch (0.63 centimeter) in diameter.
>
> (4) A natural hydrograph, including peak, high, low, and base flows within historical ranges or; if regulated, currently operate under a BO that addresses bull trout; or a hydrograph that demonstrates the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation.
>
> (5) Springs, seeps, groundwater sources, and subsurface water to contribute to water quality and quantity as a cold water source.
>
> (6) Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.

(7) An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

(8) Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.

Critical habitat includes the stream channels within the designated stream reaches and the shoreline of designated lakes.

Critical habitat includes the stream channels within the designated stream reaches, and includes a lateral extent as defined by the ordinary high-water line. In areas where ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series. For designated lakes, the lateral extent of critical habitat is defined by the perimeter of the water body as mapped on standard 1:24,000 scale topographic maps.

Adjacent stream, lake, and shoreline riparian areas, bluffs, and uplands are not designated as critical habitat. However, the quality of marine and freshwater habitat along streams, lakes and shorelines is intrinsically related to the character of these adjacent features, and human activities that occur outside of the designated critical habitat can have major effects on physical and biological features of the aquatic environment.

Activities that cause adverse effects to critical habitat are evaluated to determine if they are likely to "destroy or adversely modify" critical habitat by altering the PCEs to such an extent that critical habitat would not remain functional to serve the intended conservation role for the species (70 FR 56212). The Service's evaluation must be conducted at the scale of the entire critical habitat area designated, unless otherwise stated in the final critical habitat rule (USDI Fish and Wildlife Service and National Marine Fisheries Service 1998). Therefore, adverse modification of bull trout critical habitat is evaluated at the scale of the final designation, which includes the critical habitat designated for the Klamath River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments.

The condition of bull trout critical habitat varies across its range from poor to good. Although still relatively widely distributed across its historical range, the bull trout occurs in low numbers in many areas, and populations are considered depressed or declining across much of its range (67 FR 71236). These depressed populations reflect the condition of bull trout habitat.

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat, and continue to do so. Among the many factors that contribute to degraded PCEs, those which appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows: 1) fragmentation and isolation of local populations due to the proliferation of dams and water diversions that have eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Dunham and Rieman 1999; Rieman and McIntyre 1993); 2) degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive

development of roads (Fraley and Shepard 1989; Montana Bull Trout Scientific Group (MBTSG) 1998); 3) the introduction and spread of nonnative fish species, particularly brook trout and lake trout, as a result of fish stocking and degraded habitat conditions, which compete with bull trout for limited resources and, in the case of brook trout, hybridize with bull trout (Leary et al. 1993; Rieman et al. 2006); 4) degradation of mainstem river FMO habitat, and the degradation and loss of marine nearshore foraging and migration habitat due to urban and residential development; and 5) degradation of FMO habitat resulting from reduced prey base, roads, agriculture, development, and dams (62 FR 32268).

Environmental Baseline

The Environmental Baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. [50 CFR § 402.02].

Status of the Species in the Action Area

Due to the indirect effects to bull trout from providing fishways for anadromous fish, the Action Area is defined to include areas outside the Project Boundary. Remaining bull trout populations in the Klamath River basin and the Klamath River Interim Recovery Unit will eventually be affected indirectly by relicensing the Project under the proposed action. Fishways at downstream dams on the Klamath River will result in the restoration of anadromous fish into the Klamath River Interim Bull Trout Recovery Unit. Restoration of these anadromous fish runs will mean that salmon, steelhead, and possibly Pacific lamprey populations will access, for the first time in approximately 90-100 years, areas where bull trout habitat is extant. Therefore, the Service includes the headwaters of the Klamath River watershed in the Action Area because the proposed action will result in anadromous fish reintroduction and its potential effects. For a description of the status of bull trout in the Action Area, see the section above titled Klamath River (Oregon) Interim Recovery Unit (under current status, Conservation Needs, and Range-wide Trend) and USDI Fish and the Service's Biological Opinion regarding grazing within the Silver Lake District of the Fremont National Forest (USDI Fish and Wildlife Service 2000).

Factors Affecting the Species Environment in the Action Area

Forestry, agriculture, and recreation are the predominant human uses of the Upper Klamath River watershed. Human population densities are generally low and about 20 percent of occupied bull trout habitat in the action area is on private land (John Bowerman, USFWS, pers. comm.). Bull trout are, however, threatened by degraded habitat conditions, habitat fragmentation, restricted spawning distribution, inbreeding, low population numbers, hybridization, competition with non-native brook trout, and additional environmental disturbances. Also, due to small population sizes and isolation within the Klamath Basin, the overall probability for extinction from a catastrophic, stochastic event is significantly increased relative to historical conditions. Bull trout are not currently affected by the Klamath Hydroelectric Project, but will be affected when fishways are constructed at all Project facilities.

Relationship of the Action Area to Conservation of the Bull Trout

The Action Area encompasses one of the 5 Recovery Units for the species (the Klamath Recovery Unit). As stated in the final listing rule (63 FR 31647), conservation of the species in all 5 interim recovery units is essential for conservation of the listed entity.

Conservation of bull trout is dependent on preserving viable self-sustaining populations in as much of their historical range as possible, including: 1) maintenance and restoration of multiple, interconnected populations in diverse habitats across the range of each interim recovery unit, 2) preservation of the diversity of life-history strategies, 3) maintenance of genetic and phenotypic diversity across the range of each interim recovery unit, and 4) establishment of a positive population trend. Reiman et al. (Rieman et al. 2003) also stated that bull trout populations need to be protected from catastrophic fires across the range of each interim recovery unit.

As mentioned above, at time of listing, there were only 7 naturally occurring, non-migratory populations (62 FR 32268) occurring in the UKL, Sprague River, and Sycan Marsh watersheds in Oregon. Since then, 2 small resident and 1 remnant fluvial populations have been discovered; however, as of 2007, both resident populations (Coyote and Sheepy Creek populations) appear to have been locally extirpated again (John Bowerman, USFWS, pers. comm).

All investigators have detected extremely low levels of genetic variation in Klamath bull trout, suggesting that the Klamath Basin was either founded by a few individuals or that the bull trout population has been held at low numbers for the past several generations (Spruell and Allendorf 1997). Aside from the small bull trout sub-population in the Jarbridge River Basin, Nevada, the Klamath Basin population is the only significant population at the southern end of the species range. The Klamath population has probably adapted to different conditions than northern populations, and therefore represent an important adaptive component of the entire species (Light et al. 1996).

Status of Critical Habitat within the Action Area

The Service designated critical habitat for the Klamath River population of bull trout, pursuant to the ESA, on September 26, 2005 (70 FR 56212). Portions of Sun Creek, Coyote Creek, Long Creek, Sycan Marsh, Boulder Creek, Brownsworth Creek, Deming Creek, Dixon Creek, Leonard Creek, North Fork Sprague River, Threemile Creek, and Sheepy Creek in the Klamath River watershed were designated as critical habitat. This rule became effective October 26, 2005.

As mentioned above, there is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat, and continue to do so. At the time of designation, this was true for critical habitat for the Klamath River population of bull trout as well as for critical habitat designated rangewide.

Most bull trout critical habitat in the action area is on public lands (70 FR 56212) protected because of federal ownership and its remote location. In general there are no indications that conditions have declined since designation with respect to PCEs for stream temperatures (PCE 1), channel complexity (PCE 2), adequate substrates (PCE 3), natural hydrographs (PCE 4), springs and subsurface connectivity (PCE 5), migratory corridors (PCE 6), foodbase (PCE 7),

and permanent sources of water (PCE 8) (John Bowerman, USFWS, pers. comm.). Grazing has been curtailed in the riparian zone of nearly all occupied streams ((USDI Fish and Wildlife Service 2000); John Bowerman, USFWS, pers. comm.).

With respect to the presence and abundance of non-native competing fishes, there have been some improvements. Competing non-native salmonids (primarily eastern brook trout) have been successfully removed from Sun Creek within Crater Lake National Park (John Bowerman, USFWS, pers. comm.). The United States Forest Service has successfully removed non-native competing species from the upper reaches of Threemile Creek and the Klamath Basin Bull Trout Working Group has an ongoing Project to remove non-native competing species from Long Creek (John Bowerman, USFWS, pers. comm.).

Although the status of Klamath River critical habitat has been slightly improved by recovery actions, the overall status of the species continues to be depressed. Factors considered threats to bull trout in the Klamath Basin at the time of designation continue to be threats today.

Effects of the Proposed Action on Bull Trout

The effects of relicensing the Project on bull trout were analyzed in the same way as the effects of a new development. This analysis is consistent with the approach used to analyze effects on federally listed suckers (for more specifics on this approach, see the section of this BO titled 'Effects of the Proposed Action on Federally Listed Suckers').

Effects of Fishways for Anadromous Salmonids on Bull Trout and Their Habitats

Bull trout, Chinook salmon, steelhead, and other native species have evolved sympatrically throughout most of the bull trout range (69 FR 59996) and there is historical evidence that this sympatry included the Klamath River (John Hamilton, USFWS, pers. comm.). With a fish ladder suitable for anadromous fish passage currently in place at Link River Dam on the Klamath River, Chinook salmon and steelhead trout will access UKL and upstream tributaries, such as Brownsworth and Long Creeks. Most populations of bull trout in the Klamath Basin occur in isolated portions of headwater streams that may not be accessible to anadromous fish in the foreseeable future. Section 3.3.5.2.4 of the DEIS contains the Commission's analysis and conclusion that the proposed action will have minimal effects on bull trout. We generally agree with this analysis, although we disagree with the Commission's assessment that fish passage has the potential to adversely affect bull trout by introducing or increasing the prevalence of disease pathogens.

Disease

Under the proposed action, the Licensee will provide or improve passage for anadromous fish at the lower five dams on the Klamath River. The risk that fishways will facilitate the introduction of diseases that may affect bull trout is discountable. There have been no direct disease impacts noted across the range of bull trout and it is assumed no known diseased hatchery fish would be released. The Administrative Law Judge's findings in the Klamath trial-type hearing addressed concerns regarding the potential introduction of the *Infectious Hematopoietic Necrosis* (IHN) virus to resident fish above dams (Administrative Law Judge 2006a). The existence of virus

IHN in the Klamath River system is uncommon and the type of IHN present in coastal California is not virulent to trout species, only Chinook salmon (direct testimony of J. Scott Foott, Project Leader of California-Nevada Fish Health Center (U.S. Fish and Wildlife Service), on behalf of U.S. Fish and Wildlife Service and U.S. National Marine Fisheries Service in the Matter of: Klamath Hydroelectric Project (Administrative Law Judge 2006a) (hereinafter Foott Direct Testimony) and since the majority of pathogens currently found in the lower basin also exist in the upper basin of the Klamath River system, a logical conclusion is that migration of anadromous fish would not be a significant factor contributing to disease of resident fish (Foott Direct Testimony).

Prey Base

Bull trout above constructed dams lose a major food source with the blockage of anadromous fish passage upstream (see, for example, the discussion of Snake River effects, 69 FR 59996). In the Klamath River Basin, fishways for salmon and steelhead will eventually create access to headwater areas where bull trout are currently extant. The reintroduction will likely increase their prey base, by restoring anadromous fish eggs, fry, juveniles, and carcasses bull trout feed upon. In particular, adult and sub-adult bull trout are likely to benefit. The fishways will also indirectly increase the bull trout prey base by restoring marine-derived nutrients (MDNs) into the ecosystem and increasing primary production.

Marine-Derived Nutrients

Reintroduction of anadromous fish to the upper watershed under the proposed action will have an indirect benefit to bull trout by restoring MDNs into the watershed. The watershed historically had anadromous fish access before the dams were built. The enrichment of the freshwater ecosystem from input of salmon carcasses may have far reaching benefits throughout the food web by increasing primary productivity. The increase in MDNs will likely increase the aquatic invertebrate biomass, thereby increasing the forage base for the reintroduced juvenile anadromous salmonids as well as juvenile bull trout and other native fishes in streams such as Brownsworth and Long Creeks. There are no data on the potential for MDNs to have adverse effects on the aquatic environment.

Interspecific Competition for Food and Space

In most stream environments, juvenile bull trout do not occupy the same microhabitat as any salmon or steelhead. Rather, bull trout are more benthic, nocturnal, cryptic (concealed by their coloration), cold water dependent, and prey on fish at an earlier age than salmon or steelhead (Frederick Goetz, USACE, pers. comm.).

On the Lewis River, Washington, the Service estimated a minimal level of incidental take of bull trout would occur due to interspecific competition for food and space between bull trout and reintroduced anadromous salmonids (USDI Fish and Wildlife Service 2006). The severity of competition on the Klamath, if it occurred, would probably increase over the period of implementation. It would likely be greatest after full restoration and when all barriers to anadromous fish passage are removed. Adverse competitive interspecific interactions could result in streams, such as Brownsworth and Long Creeks, if the populations of reintroduced

salmon and steelhead increase to the point where they are forced to use habitats marginal to these species but preferred by bull trout.

However, in the Yakima River Basin, reintroduced Spring Chinook rarely overlapped spatially with bull trout in tributaries and careful management decisions associated with restoration of anadromous fish runs contributed a general absence of impact to non target taxa (Pearsons and Temple 2007). Therefore, while some incidental take may occur due to interspecific competition for food and space between bull trout and reintroduced anadromous salmonids in the Klamath River watershed, we do not anticipate substantial competitive interactions.

Competition for Spawning Habitat

Steelhead and Chinook salmon do not spawn during the same time as bull trout and therefore do not pose a risk of competition for available spawning grounds (Fred Goetz, USACE, pers. comm.). Salmon and steelhead spawning may improve spawning gravel conditions for bull trout through their excavation of redds which loosen and clean spawning gravels. Because of temporal overlap in spawning, coho salmon would likely pose a risk of competition to bull trout for spawning habitats. However, no evidence has been found that coho salmon historically occurred in headwater areas currently containing bull trout in the Klamath River watershed (Hamilton et al. 2005) and we do not expect coho to reach these areas. If coho salmon were to colonize bull trout habitat, because bull trout are expected to spawn in the higher reaches of streams and are known to use stream gradients greater than 4 percent whereas coho salmon prefer gradients less than 4 percent, we do not expect a complete overlap in coho salmon and bull trout spawning.

Predation on Juvenile Bull Trout

On the Lewis River, Washington, the Service analyzed the risk that reintroduced salmon and steelhead juveniles may prey upon young bull trout (USDI Fish and Wildlife Service 2006). This analysis anticipated that bull trout fry would be more susceptible to predation than larger juveniles. However, bull trout fry typically emerge in February and occur in upper watersheds when the feeding activity of the reintroduced species would be low due to cold water temperatures. In addition, bull trout fry tend to be cryptic and associated with the substrate which helps them avoid predation. For these reasons, the Service in this analysis concluded that risks due to predation by reintroduced salmon and steelhead would be low, but that some associated bull trout incidental take would occur (USDI Fish and Wildlife Service 2006).

In the Klamath Watershed, if predation on small bull trout were to occur in streams such as Brownsworth and Long Creeks, it would likely be attributed to steelhead juveniles, which are larger than bull trout fry and small juveniles. While minimal, this risk of predation on small bull trout would probably increase over the period of implementation and be greatest after any active restoration of salmon and steelhead.

Effects of Recreational Fishing on Bull Trout

Bull trout are known to be susceptible to angling pressures. If recreational fishing pressure increases with the restoration of anadromous salmonids, there may be bycatch of bull trout in the

tributaries. Angling, and the potential bycatch or harvest of bull trout, is managed through Oregon State Fishing Regulations. Prior to 1990, anglers fishing in the upper Klamath River watershed could legally catch and keep native bull trout. Bull trout harvest is now prohibited (Oregon Department of Fish and Wildlife 2007).

Summary of the Effects of Fishways for Anadromous Salmonids on Bull Trout

Bull trout, Chinook salmon, and steelhead have co-existed and evolved sympatrically in the Klamath River and throughout most of the bull trout range (USDI Fish and Wildlife Service 2004a). Nonetheless it will take time to reach equilibrium between these sympatric populations that have been separated for nearly a century, and this equilibrium may be different than what existed prior to dam construction due to changes in habitat types and habitat availability within the watershed.

The risk to bull trout of disease from reintroduced anadromous fish runs is low. The reintroduction effort may create interspecific competition between juvenile salmon, steelhead, and bull trout for food and space. The potential for steelhead predation of juvenile bull trout also exists. We anticipate only a small degree of overlap in habitat use of the tributaries by juvenile bull trout and reintroduced juvenile salmonids. We do not anticipate this level of competition for food and space to result in a decline in the local populations of bull trout. Overall, fishways for anadromous fish will likely be beneficial for bull trout by providing MDNs and increasing the forage base.

If the Service determines that restoration efforts are having negative impacts on bull trout, adaptive measures would be taken to minimize these impacts. These measures might include weirs to restrict anadromous fish from bull trout populations, or other means to isolate bull trout populations from the threat posed by anadromous fish.

Effects on Bull Trout Critical Habitat

This action will not directly affect or adversely modify Critical Habitat in the Action Area for bull trout and any indirect effects to Critical Habitat will be insignificant or discountable. None of the primary constituent elements will be affected significantly because the proposed action will not result in any removal or irreversible alteration of physical habitat. In some cases, spawning anadromous fish will rearrange and move substrate during spawning which may improve spawning gravel conditions for bull trout the following fall.

Cumulative Effects

Cumulative effects are those impacts of future State and private actions that are reasonably certain to occur within the area of the action subject to consultation. Future federal actions will be subject to the consultation requirements established in section 7 of the Act and, therefore, are not considered cumulative to the proposed action.

The following non-Federal activities are proposed in the action area:

- The completion of the water adjudication process for Klamath Basin in Oregon is expected in 2010, providing for more efficient water management in the Klamath River Basin and more opportunities to enhance water quantity and quality in habitats occupied by bull trout.

- The State of Oregon is enlarging its fish screening program in the Klamath Basin to complement completion of the adjudication process. Following adjudication, diversions will require water measurement devices and fish screens.

- The Klamath Watershed Council and its partners are scheduled to complete all 7 subbasin watershed assessments in the next few years, providing a roadmap for watershed restoration needs to support healthy aquatic ecosystems and aid in the recovery of bull trout and other at-risk species.

Most of the non-Federal actions will improve water quantity, water quality, and habitat in areas supporting bull trout. Screening will reduce entrainment of bull trout and improve overall survival. Water quality improvement Projects will address factors limiting listed bull trout recovery in the Upper Klamath Basin.

Because bull trout are listed under the ESA, non-Federal land owners in bull trout areas should take steps to curtail or avoid practices that would result in the take of the species. Take of bull trout is prohibited by Section 9 of the ESA, and actions resulting in take may be subject to the incidental take permitting process under Section 10 of the ESA.

Climate Change

Bull trout may be especially vulnerable to climate change given that spawning and early rearing are constrained by cold water temperatures creating a patchwork of natal, headwater habitats across river networks. Because size and connectivity of patches also appear to influence persistence of local populations, climate warming could lead to increasing fragmentation of remaining habitats and accelerated declines of this species. Climate strongly influences regional and local bull trout distributions and estimated bull trout habitat response to a range of predicted climate warming effects (Rieman et al. 2007). Warming over the range predicted could result in losses of 18 percent to 92 percent of thermally suitable habitat area and 27 percent to 99 percent of large (>10,000 ha) habitat patches—suggesting that population impacts may be disproportionate to the simple loss of habitat area. Predicted changes were not uniform across the species' range and some populations appear to face higher risks than others.

However, the conclusions of Rieman et al. (2007) must be tempered based upon the limits of their methods. Their analysis was not based on direct modeling of stream temperatures and presumed critical thermal limits. It did not take into account the fact that remaining habitat in many locations, such as where Klamath River watershed populations are extant, are now located in spring-driven, as opposed to snowmelt-driven, systems. Given the fact that these springs and groundwater features are relatively stable and the result of geological processes and inputs hundreds or thousand of years in the past, they may be less influenced by climate changes over the next century. Thus, bull trout habitat in the Klamath River watershed and other spring (or

groundwater) driven systems may be buffered from the effects of climate change relative to other systems.

Conclusion

Bull Trout

The implementing regulations for section 7 of the ESA (50 C.F.R. 402) define "jeopardize the continued existence of" to mean "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, and distribution of that species."

After reviewing the current status of the bull trout, the environmental baseline for the action area, the effects of the proposed action and the cumulative effects, it is the Service's BO that the action, as proposed, is not likely to jeopardize the continued existence of the bull trout, and is not likely to destroy or adversely modify critical habitat for the bull trout.

The Service reached this conclusion for bull trout because: 1) bull trout populations will benefit from positive effects of the proposed action, in restoring anadromous fish populations, including MDN and an increased forage base for bull trout in the form of anadromous fish eggs, fry, and juveniles; 2) disease risks to bull trout associated with providing passage for anadromous species are minimal; and 3) adverse effects due to predation and the potential competition for food and space are expected to be minimal in comparison to the beneficial effects associated with anadromous fish reintroduction.

In addition, the environmental baseline for bull trout in the action area is improving because: 1) restoration efforts to address bull trout recovery, such as the elimination of competing non-native fish, have been ongoing on Federal lands; and 2) other contributing threats to the long-term persistence of bull trout (including sedimentation, grazing, and non-native species) are being reduced by federal land management agencies such as the National Park Service and USDA Forest Service.

Bull Trout Critical Habitat

The implementing regulations for section 7 of the ESA (50 C.F.R. 402) state that Federal agencies shall, in consultation with the Service, ensure that any action they authorize, fund, or carry out is not likely to result in the destruction or adverse modification of critical habitat. The term ''destruction or adverse modification'' means direct or indirect alteration that appreciably diminishes the value of the critical habitat for both the survival and recovery of a listed species (50 CFR 402.02).

The proposed Project is not likely to result in the destruction or adverse modification of bull trout critical habitat. Other than the excavation of redds by anadromous fish, impacts to bull trout critical habitat due to the proposed project would take place. Any associated changes to function and structure of critical habitat would be minimal and the critical habitat unit system is likely to function as intended.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct [16 USC § 1532(19)]. Harm is further defined (50 CFR § 17.3) by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by the Service (50 CFR § 17.3) as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, carrying out of an otherwise lawful activity (50 CFR § 402.02). Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA, provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are non-discretionary, and must be implemented by the Commission so that they become binding conditions of any grant or permit issued to the permittee, as appropriate, in order for the exemption in section 7(o)(2) to apply. The Commission has a continuing duty to regulate the activity covered by this incidental take statement. If the Commission (1) fails to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Commission must report the progress of the action and its impact on the species to the Service as specified in the Incidental Take Statement [50 CFR § 402.14(i)(3)].

The Commission and PacifiCorp in their comments on the Draft Biological Opinion objected to the inclusion in the Service's Opinion of the Eastside and Westside and Keno developments (Commission comment letter at 2, PacifiCorp at 3). The terms and conditions below, which pertain to Eastside and Westside and Keno developments, are premised on the inclusion of these developments in the new license because Commission staff have not indicated the ultimate disposition of these developments.

Given that it is not certain at present whether the new license will include the East Side, West Side, and Keno developments, the terms and conditions, below, that address these developments will not be applicable to this BO unless the pertinent development is incorporated in a new license for the project. Should the Commission determine that these developments will not be included in the new license, it must determine an appropriate action to address future operation and/or status of these facilities. This further action has not been included as part of the Commission's proposed action for this consultation, and this will require the re-initiation of the consultation to address the effects of that proposed action.

The Incidental Take Statement accompanying this Biological Opinion exempts from the take prohibitions of the ESA, take of the LRS, Shortnose Sucker, and bull trout carried out in

accordance with the terms and conditions of the Incidental Take Statement. It does not address the restrictions or requirements of other applicable laws.

Amount or Extent of Take

Below, we estimate annual levels of take resulting from the proposed action during an interim period before all fishways are installed, and during the period after installation. Estimates of the amount or extent of take are based on the schedule of installation of fishways and other structures. If the installation schedule is delayed, reinitiation would likely be appropriate as take estimates may increase.

Lost River and Shortnose Suckers

1. Injury/Mortality

1a. Mortality through turbine entrainment, spillway entrainment, and seasonal trap and haul around Keno Reservoir

Turbine Entrainment - As indicated in the analysis of effects of the proposed action, the Service anticipates that take of larval, juvenile, and adult suckers in the form of **harassment, wounding and/or killing** will occur from entrainment of LRS and SNS through the turbines. Physical strikes and pressure changes associated with passing through these facilities could result in the injury or death of individual suckers. It is also likely that suckers that successfully navigate the turbines may be subject to increased susceptibility to predation caused by disorientation following turbine passage, or increased susceptibility to infection caused by scale loss or non-lethal wounds incurred during turbine or spillway passage. Although we estimate impacts of spillway operation of Link River Dam in the Environmental Baseline section of this document, these impacts are not part of the effects of the proposed action because they are the responsibility of Reclamation.

Currently, flows up to 1,200 cfs; 250 cfs; 3,000 cfs; 3,200 cfs; 3,200 cfs; and 1,735 cfs pass through the turbines at Eastside, Westside Power Diversions, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate Dams, respectively. Additional flows pass over the spillways at Keno Dam throughout the year, and for 6-8 months at other facilities. As explained above and in Appendix 1, Francis turbines such as those at Eastside and Westside Power Diversions and other developments are expected to exhibit turbine passage mortality rates up to approximately 25 percent for larval, juvenile, and adult suckers. Spillway mortality is estimated at up to 2 percent at each facility.

Rates of mortality of suckers due to entrainment are difficult to quantify due to lack of available information and monitoring. However, we are required to specify the amount or extent of incidental taking of the species [50 CFR § 402.14(i)(3)] in this Incidental Take Statement. We have described our assumptions and the information that we used to develop reasonable estimates of mortality rates from entrainment that will result from the continued operations of this Project in the Effects of the Proposed Action on Federally Listed Suckers section 1a, above, and in Appendix 1.

The Service anticipates that the incidental take of individual suckers will be difficult to detect or quantify for the following reasons: 1) low likelihood of finding dead or injured larvae, juveniles, and adults; 2) delayed mortality; 3) rapid rate of fish decomposition; and 4) high probability of scavenging by predators. Take estimates in the form of entrainment mortality are provided in Table 3 in the Effects of the Proposed Action on Federally Listed Suckers section 1a, above. The Service considers that under the new license, there will be an initial period prior to construction and implementation of fishways. Until downstream fishways are constructed and with continued current operation of these facilities, the Service anticipates that all the suckers entrained at Eastside and Westside Power Diversions will be harassed, including up to 4,044,000 larvae, up to 85,031 juveniles and up to 84 sub-adult/adults annually. Harassment will be in the form of stress to suckers from abrupt pressure changes, exposure to greater than normal turbulence at facilities, increased susceptibility to predation caused by disorientation following turbine passage, or increased susceptibility to infection caused by scale loss or non-lethal wounds incurred during turbine passage.

Incidental take associated with turbine mortality will be up to 1,011,000 larvae annually at the Eastside and Westside Power Diversions during the interim period and prior to construction of fishways. At Keno Dam, there are no Power Diversions and no turbine entrainment impacts. At J.C. Boyle Dam with the existing downstream fishway, the Service anticipates that up to 50,800 sucker larvae, up to 1,297 juveniles, and 1 sub-adult/adult pass through the screens and will be harassed and up to 12,700 larvae, 324 juveniles, and 0 sub-adult/adults each year will be killed by passing through the turbines until fishways are installed. At Copco No. 1, the Service anticipates take through harassment of 48,900 larvae, 100 juveniles, and 0 sub-adults/adult suckers entrained annually until the new downstream fishways are installed. Lethal take at Copco No. 1 is expected to be up to 12,200 larvae, 25 juveniles, and 0 sub-adult/adults each year. At Copco No. 2, we anticipate annual take through harassment of up to 37,800 larvae, 78 juveniles, and 0 sub-adult/ adult suckers that pass through the facility until fishways are installed. Turbine entrainment mortality at Copco No. 2 is estimated at 9,500 larvae, 19 juveniles, and 0 sub-adults/adult suckers entrained annually. Annual entrainment at Iron Gate Dam hydropower facilities is anticipated to result in incidental take due to harassment at levels up to 2,900 larvae, 6 juveniles, and 0 sub-adult/adult (100 percent harassed) until fishways are installed. Lethal take at Iron Gate Dam is expected to be 700 larvae, 1 juvenile, and 0 sub-adult/adults each year until fishways are installed.

It is anticipated that by year 6 after final issuance of the new license, downstream fishways will be designed and installed at Eastside, Westside Power Diversions, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate Dams to help minimize the number of fish passing through the turbines. However, up to 50 percent of larval suckers will not be bypassed because of their small size, and will pass through the turbines with passage mortality up to about 25 percent. At Eastside and Westside Power Diversions, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate Dams up to 2,022,000; 27,400; 24,900; 21,900; and 1,900 larvae will be harassed annually by entrainment through the screens and turbines, respectively. Up to 505,500; 6,800; 6,200; 5,500; and 500 will be lethally taken associated with turbine mortality annually at Eastside and Westside Power Diversions, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate Dams, respectively.

Spillway Entrainment - The anticipated take of suckers in the form of **wounding and/or killing** from entrainment over Project spillways is difficult to quantify. Because current spillways do not meet state and federal standards, we assume all fish passing through the spillways will be harassed prior to modification of the gates.

Until spillway improvements are completed at Keno Dam under continuing operations of the Project if Keno is included in the new license, up to 567,500 larvae, 14,710 juveniles, and 15 sub-adult/adult suckers will be harassed each year. Based on 2 percent injury and mortality, incidental take in the form of wounding or killing is expected to be up to 11,400 larvae, 294 juveniles and 0 sub-adult/adult suckers annually.

At J.C. Boyle Dam, PacifiCorp (PacifiCorp 2006b) estimated that 20 percent of outmigrating anadromous salmonids would likely be spilled if they were reintroduced. While we are uncertain of the exact timing of sucker outmigration past J.C. Boyle Dam and lower river facilities, the downstream peak would likely be later for suckers than for anadromous salmonids, because there is typically less spill later in the season. Thus, we estimate that a smaller percentage of suckers would be spilled (10 percent). We estimate annual harassment through spillway entrainment at up to 5,600 larvae, 144 juveniles, and 0 sub-adult/adults at J.C. Boyle Dam; 5,400 larvae, 11 juveniles, and 0 sub-adult/adult at Copco No. 1 Dam; 4,200 larvae, 9 juveniles, and 0 sub-adult/adult at Copco No. 2 Dam; and 300 larvae, 1 juveniles, and 0 sub-adult/adult suckers at Iron Gate Dam. Injury and mortality incidental take is estimated to be up to 100 larvae, 3 juveniles and 0 sub-adult/adult at J.C. Boyle Dam; 100 larvae, 0 juveniles, and 0 sub-adult/adults at Copco No. 1 Dam; and 100 larvae, 0 juveniles, and 0 sub-adult/adult suckers at Copco No. 2 Dam and no larvae, juveniles, and sub-adult/adults at Iron Gate Dam.

In accordance with a stipulation with PacifiCorp, the Services revised the prescriptions for spillway modifications in the Modified Prescriptions to allow PacifiCorp to conduct site-specific studies on the need for and design of spillway modifications (Administrative Law Judge 2006b). Spillway improvements, if required, at Keno, J.C. Boyle, Copco No. 1, and Copco No. 2 Dams will provide for the safe, timely, and effective downstream passage of suckers. Annual incidental take is estimated at 1 percent of fish passed after construction of prescribed spillways modifications. If the spillway modification constructed pursuant to the stipulation with PacifiCorp differ from those prescribed, the Commission may need to reinitiate consultation to analyze effects of the modified action.

After spillway improvements are in place, we estimate that at Keno Dam (if included in the license) up to 614,000 larvae, 10,000 juveniles, and 10 sub-adult/adult suckers will be harassed each year. Based on 1 percent injury and mortality with spillway improvements, incidental take in the form of wounding or killing at Keno Dam is expected to be up to 6,100 larvae, 100 juveniles and 0 sub-adult/adult suckers annually. At J.C. Boyle Dam, PacifiCorp (PacifiCorp 2006b) estimated that 20 percent of outmigrating anadromous salmonids would likely be spilled if they were reintroduced. While we are uncertain of the exact timing of sucker outmigration past J.C. Boyle Dam and lower river facilities, the downstream peak would likely be later for suckers than for anadromous salmonids when there is typically less spill. Thus, we estimate that a smaller percentage of suckers would be spilled (10 percent). We estimate harassment through spillway entrainment at up to 6,100 larvae, 99 juveniles, and 0 sub-adult/adults at J.C. Boyle Dam; 5,500 larvae, 10 juveniles, and 0 sub-adult/adults at Copco No. 1 Dam; 4,900 larvae, 10

juveniles, and 0 sub-adult/adult at Copco No. 2 Dam; and 400 larvae, 1 juveniles, and 0 subadult/adult suckers at Iron Gate Dam. Injury and mortality incidental take is estimated to be up to 100 larvae, 1 juvenile, and 0 sub-adult/adult at J.C. Boyle Dam; 100 larvae, 0 juvenile and 0 sub-adult/adults at Copco No. 1 Dam; 100 larvae, 0 juveniles, and 0 sub-adult/adults at Copco No. 2 Dam; and 0 larvae, 0 juveniles and 0 sub-adult/adults at Iron Gate Dam.

Seasonal Trap and Haul Around Keno Reservoir - Take of juvenile and adult suckers in the form of **harm, harassment, wounding, and/or killing** may occur from the operation of temporary, seasonal trap and haul around Keno Reservoir as part of the Services' prescriptions for downstream fishways at the Eastside and Westside Power Diversions. The amount of incidental take is estimated based on juvenile and adult sucker entrainment documented by Gutermuth et al. (Gutermuth et al. 2000b) and adjusted for effects of operation of the A-Canal fish screen (Appendix 1). We estimate that up to 68,025 juvenile suckers and 67 sub-adult/adult suckers will be trapped and hauled each year at Eastside and Westside Power Diversions. We estimate that trapping, sorting, and hauling mortality for juvenile and adult suckers would be 15 percent or a loss of 10,204 juveniles and 10 sub-adult/adults annually during the seasonal trap and haul around Keno Reservoir.

1b. False attraction and harm at downstream tailrace barriers

Take of adult suckers in the form of **wounding and/or killing** due to false attraction during upstream migration at the hydroproject turbine discharges (with no tailrace barriers) under current operations and under the new license (with tailrace barriers) are probably small but unquantifiable because of the small number of adult suckers migrating past these facilities. An exception to this is at the Eastside and Westside Power Diversions where current sucker spawning runs likely number up to 200 fish; therefore, tailrace injury and mortality is estimated at 2 suckers per year until tailrace barriers are installed (if the facilities are included in the license).

In accordance with a stipulation with PacifiCorp, the Services revised the prescriptions for tailrace barrier modifications in the Modified Prescriptions to allow PacifiCorp to conduct site-specific studies on the need for and design of tailrace barrier modifications (Administrative Law Judge 2006b). Tailrace barrier improvements, if required, will provide for the safe, timely, and effective downstream passage of suckers. Incidental take is estimated at zero after construction of prescribed tailrace barriers. If the tailrace barriers at the Eastside and Westside Power Diversions constructed pursuant to the stipulation with PacifiCorp differ from those prescribed, the Commission may need to reinitiate consultation to analyze effects of the modified action.

Take of adult suckers in the form of **harm** will occur from the disruption or delay of normal migration behaviors caused by false attraction to Eastside and Westside Power Diversions under current and continued operations if the facilities are included in the license. These developments have no tailrace barriers and have never been tested for impacts to federally listed suckers, other resident fish, or salmonids. Water discharging from the Eastside and Westside Power Diversions represents a significant portion of the total river flow. The natural tendency for fish attracted to such an area is to hold and wait for passage conditions to improve, or to attempt to move past the obstacle either by swimming or leaping. The Service estimates that 10 percent of the adult suckers migrating up the Link River will be incidentally taken through harm under operations

under the proposed action. Based on recent spawning migration monitoring, this is estimated at up to 20 adult suckers.

1c. Stranding and ramp rate effects

Because the conditions regarding flow and ramp rate will be implemented immediately upon license issuance, there will no interim period of continuation of existing effects.

Take of larval and juvenile suckers in the form of **harm, wounding, and killing** may occur through stranding of larval and juvenile suckers associated with the rapid downramping of flows below Project facilities (Eastside and Westside Power Diversions, Keno Reach, J.C. Boyle Bypassed Reach, J.C. Boyle Peaking Reach, and Copco No. 2 Bypassed Reach). The Service anticipates incidental take of individual suckers will be difficult to detect or quantify for the following reasons: 1) low likelihood of finding dead or injured larvae, juveniles, and adults; 2) delayed mortality; 3) rapid rate of fish decomposition; and, 4) high probability of scavenging by predators.

Under a new license, take of larval suckers from stranding is estimated to be 10 percent of the current rates under the proposed action and its more restrictive ramp rates. An estimated 10,000 sucker eggs will be killed in the J.C. Boyle peaking reach per year. Annual larval sucker mortality from stranding is anticipated to be up to 200; 20; 1,000; and 10 respectively, at Keno Reach, J.C. Boyle Bypassed Reach, J.C. Boyle Peaking Reach, and Copco No. 2 Bypassed Reach. Annual juvenile sucker mortality from stranding for these reaches is anticipated to be up to 10, 1, 5, and 1, respectively.

Under the new license, as higher minimum flows and lower ramp rates are implemented, incidental take of sucker eggs by lethal take from stranding is anticipated to be 10,000/year, which is less than the average annual production of one female.

1d. Reservoir fluctuations and stranding potential

Take of larval and juvenile suckers in the form of **killing** may occur through stranding associated with rapid water level drawdowns in Project reservoirs. The Service anticipates annual incidental take of individual larval suckers due to continued reservoir operations under the proposed action that result in drawdown rates of less than 2 inches per hour estimated at 1,000; 5,000; 1000; and 500 for Keno, J.C. Boyle, Copco No. 1 and Iron Gate Reservoirs, respectively. No lethal take of juvenile and adult suckers is anticipated.

The Service estimates that up to 5,000 larvae and 1,000 juvenile suckers will be taken in the form of **harm and killing** as a result of temporary displacement and predation associated with daily reservoir fluctuation in J.C. Boyle Reservoir under the proposed action. Displaced fish are likely more vulnerable to predation by large populations of non-native fish species including largemouth bass, yellow perch, and brown bullhead. Because of the small daily reservoir fluctuations in Keno, Copco No. 1, Copco No. 2, and Iron Gate Reservoirs, we do not believe there is currently any take associated with habitat displacement and predation in these reservoirs, and this will continue in the proposed action.

2. Migration Barriers

Thousands of juvenile suckers and a few adults from UKL disperse downstream through Keno Reservoir. This movement is probably related to a lack of habitat and poor water quality in Keno Reservoir in the summer. However, the Keno Dam may form a barrier to return migration upstream, thus restricting sucker access from J.C. Boyle Reservoir to upstream spawning habitat primarily in tributaries to UKL (Williamson and Sprague Rivers). Take of adult suckers in the form of **harm** may occur from this disruption of normal migration behaviors caused by this potential passage barrier for upstream migration at Keno Dam. Take associated with this migration barrier may continue under the proposed action if Keno Dam is included in the new license pending the completion of studies. Since fish may not able to return to upstream habitats, this could constitute a loss to the reproductive capacity of the species.

Currently, the magnitude of this loss is unknown. As part of the mandatory fishway prescription, PacifiCorp will conduct monitoring studies which will provide a better estimate of numbers of suckers attempting to pass this upstream fishway. Until the results of those studies are available, we have estimated the level of anticipated take through **harm** of suckers to be based on the numbers of adult suckers in J.C. Boyle Reservoir that migrate upstream to spawn each year, i.e., up to 100 suckers (see Effects of the Proposed Action on Listed Suckers, section 2). The continued operation of the existing fish ladder that does not meet Service sucker passage criteria may harass some unknown percentage of the migrating suckers each year. Once fish passage monitoring information is available at Keno Dam, the Service can re-evaluate potential take and modify, if necessary, the level of take exempted.

There is no evidence that LRS and SNS populations in Copco and Iron Gate Reservoirs attempt to migrate to historical spawning and rearing habitat above Keno Dam. Any suckers attempting to move upstream from these populations are likely restricted by the high gradient Caldera reach. Therefore, the Service anticipates no incidental take of adult suckers associated with fish passage at J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate Dams.

3. Degradation and Loss of Habitat

3a. Instream flows

Take of larval, juvenile, and adult suckers through habitat degradation and loss in the form of **harm and harassment** may occur from Project alterations to the hydrologic regime associated with operation of impoundments at five dam sites, use of storage to change the timing of flows through hydroelectric dams and river reaches, diverting flows from bypassed reaches of the Klamath River, and ramping river water surface elevation rapidly. In the Effects of the Proposed Action on Listed Suckers section, under *3a Instream flows*, the Service describes how current and continuing minimum flows result in reductions in larval, juvenile, and adult rearing, holding, passage, and water quality refuge habitat. This effect likely leads to take in the form of harm and harassment as the fish are forced to occupy less optimal habitats. The Service is unable to quantify take in these types due to a lack of adequate information; however, the existing level of take will be reduced under the proposed action.

Under the new license operations, the Service anticipates take in the form of **killing** associated with predation at the Eastside and Westside Power Diversions to be 500 larvae, 50 juveniles, and 2 sub-adult/adults per year under the proposed action if these facilities are included in the new license (Mark Buettner, USFWS, pers. comm.).

For the Keno Reach, the Service estimates take in the form of **killing** enabled under the new license with higher minimum flows to be 200 larvae and 10 juvenile suckers annually. No take of sub-adult/adults from predation is anticipated under the higher flow regime.

Estimated take in the form of **killing** by predation enabled under the new minimum instream flow of the proposed action is 20 larvae and 1 juvenile in the J.C. Boyle Bypassed Reach; 1,000 larvae in the J.C. Boyle Peaking Reach; and <10 larvae in the Copco No. 2 Bypassed Reach.

3b. Wetlands Loss

Take of larvae and juvenile suckers through habitat degradation and loss in the form of **harm and harassment** may occur from continued control of water levels in areas connected to the Klamath River between Link River and Keno Dam. In the Effects of the Proposed Action on Federally Listed Suckers section of this BO, under *3b Wetlands Loss,* the Service describes how reduction in shallow emergent wetland habitats (used by larval and juvenile suckers) resulted from imposition of stable water levels in Keno Reservoir, specifically regarding the loss of about 230 acres of wetlands and degradation of approximately 1,625 acres of existing emergent wetlands. The effects of these losses would be continued with the proposed action by the continued provision of flood control and management that reduces water surface elevation fluctuations. Based on larval sucker densities in UKL for emergent fringe wetlands (5 per m^2; (Klamath Tribes 1996)), the total of 230 acres of wetlands loss represents rearing habitat for about 4.65 million larval and 93,000 juvenile suckers per year.

4. Adverse Water Quality

Take of larvae, juvenile, and adult suckers in the form of **harm, harassment, wounding, and/or killing** may occur from adverse water quality in the Project area. During the summertime, when water temperatures are warm and algae proliferate in Project reservoirs, DO levels can reach stressful and lethal levels. As mentioned in the Effects of the Proposed Action on Federally Listed Suckers section 4, above, information indicates that nutrient cycling is prevented by operation of the project. The proposed action includes implementation of a Water Quality Management Plan for Keno Reservoir that will fully comply with Federal Clean Water Act Section 401 Certification Conditions if Keno Dam is included in the license. The degree and timing of water quality improvements is uncertain, and because there are multiple contributors to water quality problems, the amount of take attributable to PacifiCorp cannot be quantified. We assume that the proportion of responsibility for take is commensurate with the proportion of impacts to water quality; these impacts will be determined more precisely in future regulatory actions regarding water quality standards.

5. Construction Effects

Take of larvae, juvenile, and adult suckers in the form of **harm, harassment, wounding, and/or killing** may occur from construction of upstream and downstream fishways and turbine tailrace barriers, and spillway upgrades under the proposed action. As mentioned in the Effects of the Proposed Action on Federally Listed Suckers section 5, above, fish may be harassed by instream construction activities which disrupt normal feeding behavior and/or increased exposure to predation. Furthermore, there may be temporary sediment inputs and contaminants introduced. The Service anticipates that no more than 10 larvae or juveniles and 1 adult sucker may be harmed, harassed, wounded, or killed during construction activities, and construction activities.

6. Reintroduction of Anadromous Fish

A small number of suckers may be incidentally taken as a result of competition for food and space with introduced salmon and steelhead in Project reservoirs and UKL. This incidental take would be in the form of **harm** through the impairment of access to prey or access to preferred microhabitat with the lake environment. The amount of incidental take is unknown but expected to be less than 1,000 juvenile and adult suckers based on the relatively small number of salmon and steelhead expected to occupy the same habitat as suckers.

Although there are millions of larval suckers in UKL, we do not anticipate incidental take as a result of predation by reintroduced salmon and steelhead because they are too small to be a prey item and there would not likely be much overlap in habitat. A small number of juvenile suckers may be incidentally taken as a result of predation by reintroduced salmon and steelhead in Project reservoirs and UKL. This incidental take would be in the form of **wounding** and/or **killing**. The amount of incidental take is unknown but expected to be less than 1,000 juvenile suckers based on the tremendous abundance of other fish species as potential prey compared to the abundance of suckers and the lack of overlap in habitat between anadromous fish and suckers. Most of the reintroduced salmon and steelhead will likely rear in the tributaries to and in UKL for a short period, and then disperse downstream out of the area occupied by suckers, while most of the suckers continue to reside in UKL.

Bull Trout

The Service anticipates incidental take of bull trout will occur for the following reason(s):

1. Competition for Food and Space

A small number of bull trout may be incidentally taken in the form of **harm or harassment** as a result of competition for food and space with introduced salmonids in Brownsworth and Long Creeks. Areas of other creeks supporting bull trout are likely to be above barriers to anadromous migration, or too small for anadromous fish spawning. This incidental take would be in the form of harm through the impairment of access to prey or access to preferred microhabitat within the stream channel. The amount of incidental take is difficult to quantify. On the Lewis River, the Service estimated this type of incidental take would amount to a loss of <10 percent of the population of juvenile bull trout (USDI Fish and Wildlife Service 2006). Because much of the tributary bull trout habitat in the Lewis River watershed is similar to habitat in Brownsworth and

Long Creeks, we believe that this estimate is reasonable. Therefore, we estimated take to be <10 percent of bull trout population estimates shown in Table 5, or a maximum of 22-73 juvenile bull trout for Brownsworth Creek, and 18-59 juvenile bull trout for Long Creek annually (Table 5).

2. Predation

A small number of juvenile bull trout may be incidentally taken as a result of predation by reintroduced salmon and steelhead in Brownsworth and Long Creeks. This incidental take would be in the form of **killing** individuals. On the Lewis River, the Service estimated this type of incidental take would amount to <10 percent (USDI Fish and Wildlife Service 2006). Because bull trout habitat in tributaries of the Lewis River watershed is similar to habitat in Brownsworth and Long Creeks, we believe that this estimate is reasonable. Therefore we estimated take to be <10 percent of juvenile bull trout population estimates shown in Table 5, or a maximum annual take of 22-73 juvenile bull trout for Brownsworth Creek and 18-59 juvenile bull trout for Long Creek (Table 5).

Table 5. Estimated Annual Take of Klamath Basin Bull Trout Due to Project Relicensing

Stream[1]	Effective Population	#Eggs	#Juveniles	Take[5] due to Competition	Take[5] due to Predation
Brownsworth Creek	Pop. Low[2]	Low[3]	Low[4]	Low	Low
	44	10956	219	22	22
	Pop. Hi[2]	Hi[3]	Hi[4]	Hi	Hi
	146	36354	727	73	73
Long Creek	Pop. Low[2]	Low[3]	Low[4]	Low	Low
	36	8964	179	18	18
	Pop. Hi[2]	Hi[3]	Hi[4]	Hi	Hi
	119	29631	593	59	59

[1]Anadromous fish would be most likely overlap with bull trout in tributaries such as Long and Brownsworth Creeks (John Bowerman, USFWS, pers. comm.)
[2]Effective Population estimates are from USDI Fish and Wildlife Service (USDI Fish and Wildlife Service 2000)
[3]Number of eggs = ~249/female from Wallis (Wallis 1948)
[4]Egg to fry survival = ~2 percent from Neave and Wickett (Neave and Wickett 1953) for coho salmon
[5]Losses due to competition and predation each estimated to be <10 percent (USDI Fish and Wildlife Service 2006)

Effect of the Take

In the Conclusion portions of the Effects of the Action on Listed Sucker Species and on Bull Trout sections of this BO, the Service determined that this level of anticipated take is not likely to result in jeopardy to SNS, LRS, or bull trout or destruction or adverse modification of proposed critical habitat for SNS or LRS or destruction or adverse modification of critical habitat for bull trout.

Reasonable and Prudent Measures

The Service believes that the proposed Action, the relicensing of the Project including the Department's FPA section 18 fishway prescriptions and section 4(e) conditions, does not include all measures that are needed to minimize and track the level of incidental take associated with the Project relicensing and continued operation of the Project. The fishway prescriptions include

requirements for: (1) development of a fish passage resource management plan in consultation with resource agencies that includes designs for any fishways included in a new license; (2) provisions for developing fishway operation and maintenance plans; (3) provisions for evaluating and monitoring fish passage at the fishways; (4) provisions for modifying the fishways in response to evaluation and monitoring the number and condition of fish (including endangered suckers) attempting upstream and downstream passage; and (5) provisions for recommending Project operations and facilities modifications in response to monitoring results. Implementation of the proposed action will include some instream flow and ramping rate measures in Project reaches to protect and/or enhance endangered suckers from stranding or habitat degradation; however, additional such measures are deemed necessary and required here. The proposed action requires the development and implementation of a comprehensive water quality management plan for all Project-affected waters. Under the proposed action analyzed here, this plan will include management of water quality at Keno Reservoir because the Keno facility will remain in the license (see Description of the Proposed Action section, above). The water quality management plan would include specification of long-term water quality monitoring programs that would enable adaptive management decisions to occur and provisions for periodically updating the water quality management plan. Therefore, provided the Commission issues a new license consistent with the proposed action and this BO, only the following Reasonable and Prudent Measures and Terms and Conditions are considered to be necessary at this time. If the results of future monitoring studies indicate that the levels of take anticipated and exempted in this Incidental Take Statement are being exceeded, the Service, in coordination with the Commission, will re-evaluate this Incidental Take Statement to see what additional measures or actions, including potential reinitiation of section 7 consultation, may be warranted.

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize incidental take of LRS and SNS.

1. Injury/Mortality to Suckers

   a. (i). Implement operational adjustments at Eastside and Westside Powerhouses (unless these facilities are decommissioned), J.C. Boyle and Copco No. 1 facilities, and at the Keno Dam spillway (if included in the license) to minimize entrainment.

      (ii). Haul to UKL for release the suckers that will otherwise be trapped, sorted, and released at Eastside and Westside Power Diversion downstream fishways, if an evaluation shows survival of suckers would be increased by doing so and if these facilities are included in the license.

   b. Provide for the safe, timely, and effective upstream passage of suckers at the Eastside and Westside Powerhouses.

   c. Provide flows and ramp rates to reduce impacts related to stranding in the Link River and Keno Reaches.

   d. There are no practicable measures that would minimize the take resulting from reservoir fluctuations.

2. Migration Barriers for Suckers

   Upgrade the upstream fishway at Keno Dam (if included in the license) to sucker criteria, if it would be beneficial to recovery of listed suckers.

3. Degradation and Loss of Habitat for Suckers

   a. If the relevant facilities are included in the license, provide flows in the Link Bypassed Reach and below Keno Dam to reduce effects of habitat degradation and loss from alterations in the hydrologic regime.

   b. Restore wetlands habitats connected with Keno Reservoir to minimize the impacts of wetland habitat loss due to facilitated agricultural conversion and water level management (see Effects of the Proposed Action on Federally Listed Suckers section 3b, above).

4. Water Quality for Suckers

   Improve water quality conditions at Keno Reservoir if the facility is included in the license.

5. Construction Effects to Suckers

   Restrict construction from disturbing suckers above Keno Dam during their spawning runs, if the facility is included in the license.

6. Ensure protection of listed species throughout the term of the license (30 to 50 years).

Terms and Conditions

To be exempt from the prohibitions of section 9 of the Act, the Licensee must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary, and, along with the monitoring requirements outlined below, must be included as conditions of any new license issued that authorizes the proposed action.

1a. (i). Using FEMPs implemented as part of Interior's Section 18 Modified Prescriptions, the Licensee shall identify operational adjustments to minimize and/or avoid entrainment at Eastside and Westside Power Diversions (if included in the license), J.C. Boyle, and Copco No. 1 turbines. Entrainment reduction is not required at Copco No. 2 and Iron Gate Dams because suckers residing immediately upstream of these facilities are not expected to provide storage of adult suckers for potential future conservation needs, as discussed in the Conclusion of the Status of the Species in the Action Area section, above. Such adjustments to operations will be implemented upon approval by the Service. The Licensee shall provide annual reports of the operational adjustments by December 31 for each year's activities, throughout the term of the license.

(ii). If the Eastside and Westside Power Diversions are included in the license, the Licensee shall haul suckers back to UKL that are trapped, sorted, and released at Eastside and Westside Power Diversions instead of releasing them at Keno Reservoir during periods of poor water quality when DO and temperatures are at levels harmful to suckers, if monitoring required in the Monitoring section, below, indicates this would benefit survival of suckers. A Service-approved plan to this effect shall be developed and implemented within four years of license issuance.

1b. Unless the Service determines, based on site-specific studies approved by the Service (in accordance with the stipulation to conduct site-specific studies on the need for and design of tailrace barrier modifications (Administrative Law Judge 2006b)), that tailrace barriers are unnecessary in accordance with Department's Modified Specific Prescriptions (Sections 8.2.2 and 8.2.3), the Licensee shall construct a tailrace barrier and guidance system at both the Eastside and Westside Powerhouses, if included in the license, to provide for the safe, timely, and effective upstream passage of suckers consistent with the requirements of Section 8.2.1. The tailrace barriers and guidance system shall be constructed according to approved design plans and within 3 years of the issuance of the new license.

1c. (i). The Licensee shall not operate Eastside and Westside Power Diversions, if included in the license, when flows are 500 cfs or less below Link River Dam. Ramp rates at the powerhouses shall not exceed one inch per hour any time of the day or night or shall not exceed 300 cfs in any one 24 hour period. Ramp rates shall apply to all hydroelectric flow-regulated (controlled) operations including load following, re-regulating, and Project start-up and planned Project shutdowns. To ensure that Eastside and Westside Power Diversions are not operated at flows less than 500 cfs, the Licensee shall install and operate flow gages on Eastside and Westside power canals using USGS flow protocols so that the gage would have a USGS accuracy rating of not less than "good."

(ii). If included in the license, the Keno facility shall be managed as a modified run of the river facility and the Licensee shall discharge inflow as available, below Keno Dam. On a 24 hour basis, the Licensee shall make every reasonable effort to hold river flows below Keno Dam to within +/- 10 percent of the measured Project inflow. Project inflow shall be measured as the sum of the three-day running average flow from Link River and the Reclamation projects including Straits Drain, Lost River, and North/Ady Canal. This is included in the proposed action as a commitment in the DEIS to implement if Keno Dam remains in the license. We have added some specificity defining the inflows and acquiring flow records in Monitoring requirements, below.

2. The Licensee shall construct the fish ladder at Keno Dam (if included in the license) to sucker criteria if monitoring described in the Monitoring Requirements, below, indicates to the Service that the numbers of suckers excluded from fish passage exceeds 100 adults of either sucker species.

3a. Implement condition 1.c., above, to minimize the effects of flow fluctuations on habitat degradation and loss.

3b. If Keno is included in the license, within one year of license issuance, the Licensee shall complete a Wetland Habitat Improvement Plan (WHIP) to address wetland habitat loss due to facilitated agricultural conversion and water level management at UKL and Keno Reservoir. The Licensee shall develop the WHIP in consultation with the Service, and other parties listed in Term and Condition 4, below. The goal of the WHIP shall be to adaptively manage license conditions designed to restore the functions for larval and juvenile suckers of wetland habitats that were historically connected to Keno Reservoir and to minimize the continued effects of stable water level operations on wetland habitats in the Keno Reservoir area. The WHIP shall include the following elements:

(i) A minimum of 230 acres of fringe wetland habitat shall be restored in Keno Reservoir. If feasible, this shall occur upstream of Miller Island Wildlife Area, since this is the area where most suckers occur and where water quality conditions are potentially best to support their survival. Funds shall be provided for the purchase, design, construction, operation, and maintenance of these wetlands throughout the term of the license. Before implementation, plans shall be approved by the Service.

(ii) A minimum of an additional 1,600 acres of wetland habitat function shall be restored for larval and juvenile sucker habitat either in Keno Reservoir or UKL. This measure is intended to mitigate for the ongoing effects of stable water levels in wetlands near the Straits Drain. Funds shall be provided for the purchase, design, construction, operation, and maintenance of these wetlands throughout the term of the license. Before implementation, plans shall be approved by the Service.

Wetland habitat functions shall be restored for larval and juvenile suckers within five years of license issuance. The criteria for wetland function is occupation by sucker larvae and juveniles at densities of at least 5 and 0.1 fish per m^2 as measured at the transition for wetland fringe to open water habitat. The schedule for completing the WHIP shall include a 60 day period for comment by the parties identified above, and an explanation of how all comments are accommodated in the WHIP. The approved WHIP shall be implemented upon approval by the Service.

4. If the Keno Dam and Reservoir remain within the license, the licensee shall develop and implement a plan that will fully comply with the Federal Clean Water Act 401 Certification Conditions for the Project. Compliance with the Klamath River 401 Certification Conditions will constitute adequate mitigation for water quality-related take of listed suckers. If these conditions are not completed by January 1, 2012, the Service shall retain the authority to impose a revised term and condition.

5. Construction of downstream fishways or other facilities at the Eastside and Westside Power Diversions, if included in the license, shall not take place in waterways or areas within 100 feet of waterways during the period that suckers move upstream to spawn (the months of February through May, or as otherwise recommended by the Service).

6. Formal section 7 consultation shall be reinitiated if the levels of incidental take identified in this Incidental Take Statement are exceeded, new information indicates effects or an extent of effects that were not considered in this BO, the proposed action is modified in a manner

that causes an effect to the listed species or critical habitat not considered in this BO, or if new species become listed or critical habitat designated that may be affected by this continuing action.

Monitoring and Reporting Requirements

In order to monitor the impacts of incidental take, the Federal agency or any applicant must report the progress of the action and its impacts on the species to the Service as specified in the Incidental Take Statement. The reporting requirements are established in accordance with 50 CFR ' 13.45 and ' 18.27 and specified as follows:

Prior to January 31st of each year for the duration of Project implementation, the Commission shall provide annual monitoring reports of the estimated take that may have occurred in relation to the amount of take for the prior year that is identified in this Incidental Take Statement and any other reports required in the terms and conditions. These reports shall be submitted at least 60 days prior to the due date in draft form to allow review and commenting by the Service. All comments shall be addressed in the Final reports. These reports shall be submitted to:

Field Supervisor
Yreka Fish and Wildlife Office
U. S. Fish and Wildlife Service
1829 S. Oregon St.
Yreka, CA 96097

Monitoring of the impacts of incidental take shall be conducted as follows:

1a. (i) Within one year of license issuance, the Licensee shall develop a Service-approved interim sucker entrainment monitoring plan (Interim Plan) that estimates losses of suckers at Eastside and Westside Power Diversions, J.C. Boyle, and Copco No. 1 facilities until fishways are in place. Upon approval, the Interim Plan shall be implemented annually until downstream fishways are installed. One year prior to the construction of downstream fishways, the Licensee shall present to the Service for approval a statistically valid sucker entrainment sampling plan (Entrainment Plan) using suckers captured at downstream turbine bypass facilities at Eastside and Westside Power Diversions (if included in the license), J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate developments. Prior to the operation of the Project with downstream fishways, the Entrainment Plan must be approved by the Service. The Entrainment Plan will include measures for testing over a two year period the assumptions used herein to estimate take and effectiveness of fishways. Any capture and handling of listed species will be carried out under the terms of separate Endangered Species Permits issued by the Service. The methods of Gutermuth et al. (2000) will be used if deemed appropriated by the Service. Methods used to expand these estimates in downstream turbine bypass facilities to an estimate for the Project must be included. Upon approval, the Entrainment Plan shall be implemented and the loss of suckers shall be estimated annually for each facility and the Project in total. The Licensee shall provide annual monitoring reports by March 1 of each year and shall include the preceding year's activities, throughout the term of the license.

(ii) If Eastside and Westside Power Diversions are included in the license, the Licensee shall develop and implement a Service-approved plan to monitor and evaluate the fate of suckers trapped, sorted, and released at Eastside and Westside downstream fishways and evaluate the potential benefits of hauling suckers back to UKL during periods of poor water quality in Keno Reservoir when DO and temperatures are at levels harmful to suckers. The plan to conduct this monitoring shall be developed by the Licensee 6 months after license issuance, subject to a 60 day review period, and implemented upon approval by the Service.

1b. The Licensee shall report on the progress of construction of the tailrace barrier and guidance system at both the Eastside and Westside Power Diversions, if these facilities are included in the license[5].

1c.(i). Flow records below Link River Dam and at Eastside and Westside Power Canals, operational records of the Eastside and Westside Power Diversions, and an analysis to determine compliance with Term and Condition 1c(i), above shall be provided in the Annual Reports, if these facilities are included in the license.

(ii). Flow records and analysis that demonstrates compliance, shall be provided in Annual Reports to the Service, and made available to the Tribal, Federal, and State resource agencies upon request.

2. The Licensee shall develop and implement, as appropriate, a monitoring plan in consultation with ODFW and the Service to evaluate the need for a ladder built to sucker criteria at Keno Dam, if it is included in the license. During the months of February through May, for at least three years, or as otherwise recommended by the Service, the anadromous fish trap at that location shall be operated to gather data on the possible need for such a ladder for suckers. Data collected shall include information on species, size, sex, and estimated sucker numbers entering the trap. Regular visual examinations shall also be conducted to evaluate use of the ladder. The plan shall be implemented upon approval by the Service. Implementation shall begin within one year of license issuance, and be completed within 5 years of license issuance. The schedule for completing the plan shall accommodate a 60-day review period for ODFW and the Service to submit comments. The Licensee shall include in the Plan all comments received during consultation with the agencies identified above, and an explanation of how all comments are accommodated in the Plan. The plan shall be implemented upon Service approval. The Licensee shall provide annual sucker passage reports by March 1 of each year covering the preceding year's activities. A final report shall be submitted no later than six months after completion of the three year study.

[5] In accordance with a stipulation with PacifiCorp, the Services have revised the prescriptions for tailrace barrier modifications in the Modified Prescriptions to allow PacifiCorp to conduct site-specific studies on the need for and design of tailrace barrier modifications (Administrative Law Judge 2006b). Tailrace barrier improvements, if required, will provide for the safe, timely, and effective downstream passage of suckers. Incidental take is estimated at zero after construction of prescribed tailrace barriers. If the tailrace barriers at Eastside and Westside Powerhouses constructed pursuant to the stipulation with PacifiCorp differ from those prescribed, the Commission may need to reinitiate consultation to analyze effects of the modified action.

3a. Monitoring under this section is required as in 1c, above.

3b. Each year after license issuance, the Licensee shall monitor the use by suckers of restored habitats connected to Keno Reservoir and UKL and report on the number of acres restored. Sucker habitat use shall be monitored using a stratified sampling design that is representative of all restored habitats in existence during the spring, summer, and fall of each year. Larval and juvenile sucker collection methods used by The Nature Conservancy at the Williamson River Delta shall be employed (Hendrixson 2006). When average densities of larvae and juveniles exceed 5 per m^2 and 0.1 per m^2, respectively, for three consecutive years, indicating fully functional wetlands, monitoring will no longer be required.

4. The Licensee shall perform all water quality monitoring necessary to demonstrate compliance as mandated in Term and Condition #4, if Keno Dam is included in the license.

5. PacifiCorp shall provide a designated observer of all construction within 0.5 mile of waterways upstream of Keno Dam during the period that suckers move upstream to spawn (the months of February through May, or as otherwise recommended by the Service). Annual Reports shall report on the Licensee's compliance in implementing Term and Condition 5, and any take of suckers that may have occurred.

6. Each year, the required Annual Report shall include a section stating whether any information indicates that: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; 3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; 4) a new species is listed or critical habitat designated that may be affected by the action.

Upon locating a dead, injured, or sick endangered sucker, initial notification must be made to the nearest Service Law Enforcement Office. In Oregon, contact the U.S. Fish and Wildlife Service, Division of Law Enforcement, 1946 California Avenue, Klamath Falls, Oregon, 97601 (phone 541/883-6900). In California, contact the U.S. Fish and Wildlife Service, Division of Law Enforcement, District 1, 2800 Cottage Way, Room W-2928, Sacramento, California 95825 (phone 916/414-6660). The Service, in conjunction with the licensee, shall determine if the mortality is attributable to Project effects. Care should be taken in handling sick or injured specimens to ensure effective treatment and care or the handling of dead specimens to preserve biological material in the best possible state for later analysis of cause of death. In conjunction with the care of sick or injured endangered species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.

The Service is to be notified within three (3) working days of the finding of any endangered species found dead or injured in the Project area. Notification must include the date, time, and precise location of the injured animal or carcass, and any other pertinent information. In California and Oregon, contact the U.S. Fish and Wildlife Service, Project Leader, Yreka Fish and Wildlife Office, 1829 S. Oregon Street, Yreka CA, 96097 (phone 530/842-5763). Any LRS

or SNS found dead or injured in California shall be provided to the California Department of Fish and Game (530/225-2300).

The Service believes that the amount of take of listed species quantified above constitutes the number of SNS and LRS and bull trout that will be incidentally taken as a result of the proposed action. The reasonable and prudent measures, with their implementing terms and conditions are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, the noted levels of incidental take are exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Commission must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS

Section 7(a)(l) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species and the ecosystems on which they depend. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Service offers the following conservation recommendations:

1. The Service recommends that the Commission implement the license conditions recommended by the Fish and Wildlife Service for this Project pursuant to section 10(j) of the FPA, to the extent that they pertain to listed species.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in the request. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required when discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; 3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; 4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations (i.e., actions) causing such take must cease pending reinitiation.

Questions regarding this BO should be directed to John Hamilton or Laurie Simons of this office at (530) 842-5763 or via email at john_hamilton@fws.gov or laurie_simons@fws.gov.

Sincerely,

Phil Detrich
Klamath Issues Coordinator

cc: Service List for the Klamath Hydroelectric Project

Federal Register Notices

53 FR 27130. Fish and Wildlife Service. Endangered and Threatened Wildlife and Plants; Determination of Endangered Status for the Shortnose Suckers and Lost River Sucker. July 18, 1988. Federal Register 53(137):27130-27134.

59 FR 61744. Fish and Wildlife Service. Endangered and Threatened Wildlife and Plants; Proposed Determination of Critical Habitat for Shortnose Sucker and Lost River Sucker. December 1, 1994. Federal Register 59(230):61744-61759.

62 FR 32268. Fish and Wildlife Service. Endangered and Threatened Wildlife and Plants; Proposal to List the Klamath River Population Segment of Bull Trout as an Endangered Species and Columbia River Population Segment of Bull Trout as a Threatened Species. June 13, 1997. Federal Register 62(114):32268-32284.

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69 FR 59996. Fish and Wildlife Service. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Klamath river and Columbia River Populations of Bull Trout. October 6, 2004. Federal Register 69(193):59996-60076.

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Appendix 1

Klamath Hydroelectric Project Entrainment Analysis
11/29/07

This appendix describes how the Service estimated endangered sucker entrainment and mortality at Klamath Hydroelectric Project (Project) facilities under current operations and those proposed for the new FERC license. Entrainment is defined as the downstream movement of fish into power or irrigation diversions and spillways by drift, dispersion, and volitional migration. Entrainment studies at Project facilities have been limited to work conducted at the Eastside and Westside power diversions from 1997-1999 (Gutermuth et al. 2000b). In addition, fish entrainment was quantified at the A-Canal, an irrigation diversion on Upper Klamath Lake (UKL) near Link River Dam, from1996-1998 (Gutermuth et al. 1998; Gutermuth et al. 2000a). The estimates from these studies serve as the foundation for our entrainment analysis.

Current Project Entrainment and Mortality

Larval entrainment and mortality

Although the A-Canal and Eastside and Westside entrainment studies cited in this report (Gutermuth et al. 1998; Gutermuth et al. 2000a; Gutermuth et al. 2000b) did not identify sucker larvae to species, it is likely that nearly all were endangered Lost River and shortnose suckers. Of the four Klamath basin sucker species (Lost River sucker, shortnose sucker, Klamath smallscale sucker, and Klamath largescale sucker) only one specimen of Klamath smallscale sucker has been reported from Upper Klamath Lake (Markle et al. 2005). Klamath largescale suckers are common in the tributaries to UKL but rare in UKL (Markle et al. 2007; U.S. Geological Survey 2007). Thus, based on the best available evidence, it is a reasonable conclusion that larval suckers documented by Gutermuth et al. (Gutermuth et al. 1998; Gutermuth et al. 2000a; Gutermuth et al. 2000b) were either Lost River suckers (LRS) or shortnose suckers (SNS). There are Klamath smallscale sucker larvae present in J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate Reservoirs. However, entrainment of these fish was not included in this analysis. In computations of larval entrainment numbers, we rounded estimates to the nearest 100 larvae to avoid the perception of false precision.

Link River - Initial larval entrainment estimates are based on data collected prior to the construction of the A-Canal fish screen in 2003. Fish entrainment studies at Eastside and Westside power diversions from 1997-1999 assessed entrainment of all sucker life stages but did not compute total larval entrainment estimates (Gutermuth et al. 2000b). However, larval sucker entrainment estimates available for the A-Canal, which is located nearby, were used to estimate entrainment and mortality associated with current Project operations at the Eastside and Westside power diversions. Larval sucker entrainment at the A-Canal was estimated at 3.3 million in 1996 and 1.7 million in 1997 (Gutermuth et al. 1998). Because Gutermuth et al. (Gutermuth et al. 2000b) concluded that entrainment at the Eastside and Westside power diversions was generally proportional to the volume

of flow diverted into the canals, we used the A-Canal larval sucker entrainment numbers for the Eastside and Westside diversions because the mean diversion rates were similar for both locations during the April through July larval emigration period ((Federal Energy Regulatory Commission 2006), page 3-62). Therefore, the initial larval entrainment estimate at the Eastside and Westside power diversions is 3.3 million per year (using the larger of the two years of entrainment estimates) and that this represents 60 percent of the larvae passing the facility. We estimate the remaining 40 percent of larvae that reached the Eastside/Westside/Link River Dam area are proportional to the flow passed through the Link Dam spillways, fish ladder, or auxiliary water structure. These larvae equate to 2.2 million (2.2 million = 40 percent of the total; 3.3 million larvae = 60 percent of the total). Therefore a total of 5.5 million sucker larvae passing Link River Dam annually. The 40 percent figure was based on the average amount of water passing through the Link River Dam spillway compared with the average quantity of water passing through the Eastside and Westside power diversions during the April through July period ((Federal Energy Regulatory Commission 2006) page 3-62).

With the completion of the A-Canal fish screen in 2003, many larval fish entering the A-Canal are bypassed back to UKL in the vicinity of the Link River Dam where they can continue to disperse downstream through Link River Dam or the power diversions, or swim back upstream into UKL. Based on larval sucker exclusion estimates at the A-Canal (USDI Bureau of Reclamation, unpublished data) and a similar fish screen facility on the Sacramento River (Borthwick and Weber 2001), about 50 percent of the larvae are excluded by the screens and bypassed back to UKL. Therefore, of the estimated 3.3 million larvae entering A-Canal annually, 1.65 million would be bypassed back to UKL near Link River Dam. Because larval suckers are poor swimmers and generally have a propensity to drift, we estimate that about 75 percent (1.24 million) of the sucker larvae bypassed at the A-Canal continue to disperse downstream and 25 percent (412,500) swim upstream into UKL (Mark Buettner, USFWS, pers. comm.). Therefore, since the A-Canal fish screen was installed, larval suckers passing by the Eastside/Westside/Link Dam, including the entrainment at the Eastside and Westside power diversions, is estimated at up to 6.74 million yearly (5.5 million + 1.24 million; Table 1). When larvae are present (April through July) we estimate that approximately 60 percent of the flow passing Link River Dam is diverted through the turbines and 40 percent through the spillway (Federal Energy Regulatory Commission 2006). A total of 4,044,000 larval suckers (60 percent of the 6.74 million larvae) are entrained through the Eastside and Westside power diversions and 2,696,000 (40 percent of the 6.74 million larvae) through the Link River Dam spillway.

Mortality of larval suckers through the turbines is estimated at 25 percent (Electric Power Research Institute 1987). This mortality rate is based on the average of several studies conducted on various sizes of salmonids and thus on the best evidence available. Application of this rate to larval suckers is reasonable because they are small, fragile, and would be subject to powerful turbulence and pressure changes passing through turbines. We use 2 percent mortality through the unimproved spillway based on estimates for anadromous salmonids from Whitney et al. (1997) as cited in (National Marine Fisheries

Service 2000); Table 2). (These sources are the basis for estimated mortality rates for turbines and unimproved spillways throughout this Appendix.)

Using these calculations, turbine mortality at the Eastside and Westside power diversions is estimated at 1,011,000 sucker larvae per year. It is also assumed that the general health of entrained larval suckers is good because they are present during the spring and early summer when water quality conditions are good in all project waters (Federal Energy Regulatory Commission 2006). Of the larval suckers passing the Eastside and Westside facilities, we estimate that 5,675,000 move downstream.

Keno - At Keno Dam, Terwilliger et al. (Terwilliger et al. 2004) found that approximately 10 percent of the number of larval suckers at the upper end of Keno Reservoir made it to Keno Dam. This study, and similar findings regarding the relative number of suckers entrained at A-Canal compared with the numbers entering UKL from the Sprague and Williamson Rivers (Klamath Tribes 1996), were the basis for our estimate that 10 percent of larval suckers entering Keno Reservoir from UKL (5,675,100) are entrained at Keno Dam (567,500). The remaining 90 percent would be accounted for by either: 1) natural mortality, 2) entrainment at other diversions in Keno Reservoir, or 3) suckers that take up residence in the impoundment. Keno Dam does not have turbines or downstream fish passage facilities. Fish moving downstream must pass through the spill gates, fish ladder, sluice conduit, or auxiliary water supply. Fish passing under the narrow gate opening of the spill gates during low flow conditions are subject to mechanical or hydraulic-caused injury and mortality. Also, flows passing the dam discharge into shallow areas that may be predator holding areas (Oregon Department of Fish and Wildlife 2006). Mortality rates through the spillway release gates, downstream passage through the fish ladder, auxiliary water supply, and/or sluice conduit are collectively estimated at 2 percent of the 567,500 larvae entrained (11,400). Of the larval suckers passing the Keno facility, we estimate that 556, 100 move downstream,

J.C. Boyle - We estimate that 10 percent of the larvae entering J.C. Boyle Reservoir from Keno Reservoir are entrained at J.C. Boyle Dam (Terwilliger et al. 2004). Based upon PacifiCorp's (PacifiCorp 2006) estimated that 20 percent of outmigrating anadromous salmonids would likely be spilled at J.C. Boyle if they were reintroduced, we reasoned that a smaller percentage of suckers would be spilled (10 percent) because the timing of downstream migration for suckers (Gutermuth et al. 2000b) is later than the anticipated timing for anadromous salmonids and spill is reduced when young suckers move downstream. Therefore, of the 556,100 larval suckers entering J.C. Boyle Reservoir, an estimated 90 percent (55,700) remain by the time they get to J.C. Boyle Dam and are entrained, including 50,100 through the turbines (90 percent) and 5,600 (10 percent) over the spillway (Table 1). Although J.C. Boyle has fish screen facilities, they are generally ineffective at excluding juvenile fish and therefore even less effective in excluding small larval suckers. Mortality was estimated at 12,700 (25 percent) through the turbines and 100 (2 percent) through the spillway. Of the larval suckers passing the J.C. Boyle facility, we estimate that 43,600 move downstream,

Copco No. 1 - Of an estimated 43,600 larval endangered suckers dispersing downstream

of J.C. Boyle Dam, 10 percent (Terwilliger et al. 2004) remain by the time they get to Copco No. 1 Dam (4,400). Additionally, based on SNS spawning that occurs in the Klamath River just upstream from Copco No. 1 Reservoir and larval drift estimates in this reach (Beak Consultants Inc. 1987), we estimate that about 500,000 SNS larvae are produced and drift into Copco No.1 Reservoir annually. An estimated 10 percent of these (50,000) disperse through Copco No. 1 Reservoir to the dam. Of the total 54,400 listed sucker larvae that are entrained at Copco No. 1 Dam, an estimated 49,000 go through the turbines (90 percent) and 5,400 (10 percent) pass through the spillway. Mortalities through the turbines and spillway are estimated at 12,300 (25 percent) and 100 (2 percent), respectively. Of the larval suckers passing the Copco No. 1 facility, we estimate that 42, 000 move downstream.

Based on the low numbers of juvenile suckers collected in Copco No. 1 Reservoir (Desjardins and Markle 2000), we estimate that any survival of larvae to juveniles or adults is low. However, SNS adults reside in Copco No. 1 Reservoir as a result of recruitment and dispersion from upstream areas. Based upon the information in Desjardins and Markle (2000) and USDI Fish and Wildlife Service (USDI Fish and Wildlife Service 2006), we estimate the Copco No. 1 Reservoir population to be several hundred adult SNS.

Copco No. 2 - Because Copco No. 2 Reservoir is immediately below Copco No. 1 Dam, only 0.3 miles long, and water residence time is less than 1 hour, we estimate that all fish remain by the time they get to Copco No. 2 Dam. Of the 42,000 larval suckers passing Copco No. 2 Dam annually, an estimated 90 percent are entrained through the turbines (37,800) and 10 percent (4,200) pass through the spillway. Yearly, turbine and spillway mortality estimates are 9,500 (25 percent) and 100 (2 percent) larval suckers, respectively. Of the larval suckers passing the Copco No. 2 facility, we estimate that 32,400 move downstream.

Iron Gate - Of the 32,500 larval suckers entering Iron Gate Reservoir annually, we assume 10 percent remain by the time they get to the dam (3,200). Of this number, 2,900 (90 percent) enter the turbines and 300 (10 percent) through the spillway. Mortality through the turbines is 700 (25 percent) and through the spillway 0 larvae (2 percent). Of the larval suckers passing the Iron Gate facility, we estimate that 2,500 move downstream.

Summary - Of the 6.74 million LRS and SNS larvae passing Link River Dam and Eastside and Westside powerhouses, an estimated 2,500 disperse below Iron Gate Dam.

Juvenile entrainment and mortality

Juvenile Klamath smallscale suckers and Klamath largescale suckers are present in some Project reservoirs but were not included in this analysis.

Link River – Before the A-Canal was screened, Gutermuth et al. (Gutermuth et al. 2000b) estimated juvenile sucker entrainment in 1997, 1998, and 1999 at the Eastside and

Westside power diversions, with the highest annual estimate of 83,000 in 1998 for both facilities combined. In 2006, a high production year in UKL, juvenile sucker entrainment was likely much higher than 1998 based on catches in a screw trap operated below Link River Dam (Tyler 2007).

In addition to entrainment at the Eastside and Westside power diversions, we estimate that an additional 20 percent of this number of juvenile suckers passed through Link River Dam spill release gates (20,750), based on the relative volume of flow passing through the spill release gates compared to that diverted into the Eastside and Westside power diversions for the period July through October (Mark Buettner, USFWS, pers. comm.). This is when most juvenile sucker entrainment occurs. Using this reasoning, we estimated that a total of 103,750 (83,000=89 percent; 20,750=20 percent) juvenile suckers were diverted annually at the Eastside and Westside power diversions based on studies conducted prior to the installation of the A-canal. We also estimate that since 2003, when the A-Canal fish screen became operational, additional juvenile suckers are entrained at the Eastside and Westside power diversions because the A-canal screens are a short distance upstream and fish are diverted towards the Eastside and Westside power diversions. Using the highest estimated juvenile sucker entrainment into the A-Canal (1998; 246,000) before the screen was installed (Gutermuth et al. 2000a), reasoning that 50 percent of these fish swim back to UKL after being bypassed (this percentage is higher than for larvae because juvenile suckers are better swimmers), and 50 percent move downstream towards Link River Dam (in 2005, BOR released 6 radio-tagged juvenile suckers in the A-Canal bypass and 2 of the 4 surviving fish moved upstream and 2 dropped over Link River Dam (D. Bennetts, BOR, pers. comm.) 226,750 juvenile suckers disperse downstream to Link River Dam and the Eastside and Westside power diversions (103,750 based on pre A-canal studies plus the 123,000 that do not swim back to UKL).

However, PacifiCorp operates the Eastside and Westside power diversions differently during the peak juvenile sucker entrainment period to reduce entrainment. From mid-July through mid-October, PacifiCorp generally shuts down the Westside and operates tat full capacity only during the day, when sucker entrainment is low (Gutermuth et al. 2000b; Tyler 2007). We estimate that this operation results in 25 percent (Mark Buettner, USFWS, pers. comm.) of the juvenile suckers approaching Link River Dam returning to UKL (56,688). Therefore, an estimated 170,062 (226,750 minus 25 percent) juveniles are entrained at Eastside and Westside power diversions each year. Of these 50 percent move through the turbines (85,031) and 50 percent through the spill gates (85,031). Mortality through the turbines is 21,258 (25 percent). Of the juvenile suckers passing the Eastside and Westside power diversions, we estimate that 147,104 move downstream.

It is reasonable to assume that there is an annual late summer entrainment of juvenile suckers, regardless of water quality conditions in UKL or condition of the fish. Although previous entrainment studies documented a high percentage of entrained juvenile suckers that were dead or debilitated during periods of poor water quality (i.e.,1997) in some years entrained juvenile suckers were in relatively good condition (1998; (Gutermuth et al. 2000a)). Juvenile sucker entrainment appears to be related to the relative sucker year

class size. For example, in 1998 and 2006 large numbers of age 0 suckers were entrained at Link River dam facilities (Gutermuth et al. 2000b; Tyler 2007) and were also documented in high densities in UKL (Simon and Markle 2001). There were no obvious fish die-offs in either of these years indicating fish were debilitated. Sucker entrainment also seems to be correlated with discharge (Gutermuth et al. 2000b; Tyler 2007). Higher catch rates were documented during periods of higher Link River Dam discharge.

Keno – Again, we estimated that 10 percent of the estimated 147,104 juvenile suckers entering Keno Reservoir make it downstream to Keno Dam (14,710). We estimated 2 percent mortality (294) of fish passing through the small gate openings of the spill gates, fish ladder, auxiliary water supply, or sluice conduit. Since there are no hydropower facilities at Keno Dam, we estimate there is only spillway mortality. Of the juvenile suckers passing the Keno facility, we estimate that 14,416 move downstream,

J.C. Boyle – An estimated 10 percent of the juvenile suckers entering J.C. Boyle Reservoir make it to the dam. Of these, 90 percent pass through the turbines and 10 percent through the spillway. With mortality rates of 25 percent and 2 percent, respectively, we estimate that turbine entrainment is 1,297 with a mortality of 324 fish. We estimate that spillway entrainment is 144 juvenile suckers and mortality is 3 fish. Of the juvenile suckers passing the J.C. Boyle facility, we estimate that 1,114 move downstream.

Copco No.1 – An estimated 10 percent of juvenile suckers entering Copco No.1 Reservoir pass make it to the dam. Of these, 90 percent pass through the turbines and 10 percent through the spillway. With mortality rates of 25 percent and 2 percent, respectively, we estimate turbine entrainment is 100 juveniles with a mortality of 25 fish and spillway entrainment is 11 juvenile suckers with a mortality of 0 fish. Of the juvenile suckers passing the Copco No.1 facility, we estimate that 86 move downstream.

Copco No.2 - We estimate that all juvenile suckers (86) entering the Copco No.2 reservoir make it to the Copco No.2 turbines and spillway (the same estimation for juveniles as for larvae for this small reservoir). With mortality rates of 25 percent and 2 percent mortality, respectively, we estimate turbine entrainment is 78 juvenile suckers pass, with a mortality of 19, and spillway entrainment is 9 with zero mortality. Of the juvenile suckers passing the Copco No. 2 facility, we estimate that 67 move downstream.

Iron Gate - An estimated 10 percent of juvenile suckers entering Iron Gate Reservoir make it to the dam. We estimate that 6 juveniles pass through the turbines (with 1 mortality) and 1 fish through the spillway, with no mortalities. Of the juvenile suckers passing the Iron Gate facility, we estimate 5 move downstream.

Summary - Of the estimated 170,062 juvenile LRS and SNS entrained at Link River Dam and the Eastside and Westside developments annually, 5 fish survive dispersal and entrainment through all project facilities.

Sub-adult and adult sucker entrainment and mortality

Link River – Since both the A-Canal and the Eastside and Westside power diversions had trash racks with openings of 2 5/8 inches, larger adult suckers were excluded from the estimates (Gutermuth et al. 2000a; Gutermuth et al. 2000b) that form the basis of this analysis. This analysis is based on those sub-adult and adult suckers passing through the trash racks with openings of 2 3/4 inches at Eastside and Westside and 1 5/8 inches at A-Canal. Before the A-Canal was screened, the highest number of sub-adult/adult LRS and SNS entrained at the Eastside and Westside power diversions during a non fish die-off year was 14 in 1998 (Gutermuth et al. 2000b). We estimate that an additional 20 percent of this amount were entrained through Link River Dam spill gates, fish ladder, and auxiliary water supply based on the relative volume of flow through the Link River (4 fish). Gutermuth et al. (Gutermuth et al. 2000a) estimated 411 sub-adult/adult listed endangered suckers entrained at A-Canal in 1998. With the screening of the A-Canal, sub-adult/adult suckers are bypassed back to the lake near Link River Dam. We estimate that 50 percent of these fish go back to UKL and 50 percent are entrained at Link River Dam. Thus, an estimated 205 fish move down near the dam for a total of 223 (205 + 14 +4).

However, since PacifiCorp shuts down the Westside and operates the Eastside mostly during the day in the peak juvenile and adult entrainment period (mid-July to mid-October), we estimate this operation leads to 25 percent (Mark Buettner, USFWS, pers. comm.) of the 223 suckers moving back to UKL (56) and that 167 (223 minus 25 percent) adults move downstream and pass the Eastside/Westside/Link river facilites. Of these, we estimate that 50 percent through the turbines (84) and 50 percent through the spill gates (84). We estimate turbine mortality at 21 sub-adults/adults (25 percent). Of the adult suckers passing the Eastside and Westside power diversions, we estimate that 145 move downstream.

Keno - We estimate that 10 percent of the sub-adult/adult LRS and SNS entering Keno Reservoir survive and disperse downstream to Keno Dam. Thus, a total of 15 sub-adult/adult suckers pass through Keno Dam with 2 percent spillway mortality (0); 15 adults survive to disperse downstream into J.C. Boyle Reservoir. Of the adult suckers passing the Keno facility, we estimate that 14 move downstream.

J.C. Boyle - With 10 percent of the sub-adult/adult fish making it downstream to J.C. Boyle Dam, only 1 enters the turbines and 0 pass through the spillway. One sub-adult/adult sucker survives passage through J.C. Boyle Dam and enters Copco No.1 Reservoir. Of the adult suckers passing the J.C. Boyle facility, we estimate that 1 moves downstream.

Copco No.1, Copco No. 2, and Iron Gate – We estimate that no sub-adult/adult suckers that originated from UKL are entrained at Copco No.1, Copco No.2 and Iron Gate dams. However, because there is a population of several hundred adult SNS in Copco No.1, there is likely occasional entrainment of an adult SNS at Copco No.1 Dam. Of the adult suckers passing the Copco No. 1 facility, we estimate that zero move downstream.

In summary, of the estimated 6.74 million larvae, 170,062 juveniles, and 167 sub-adult/adults (federally listed suckers) that are entrained at Link River Dam and the Eastside and Westside developments, due to residualism in reservoirs, natural mortality, and effects of the Project without of fishways, we estimate that few suckers pass through all Project facilities. The Link River Dam fishway provides for some adults to return to Upper Klamath Lake from Keno Reservoir (C. Korson, Reclamation, pers. comm.).

Table 1. Entrainment estimates at Klamath Hydroelectric Project for current facilities without fishways

Facility	**Eastside/Westside**	**Keno**	**J.C. Boyle**	**Copco No. 1**	**Copco No. 2**	**Iron Gate**
Turbines - Harassed (100%)						
Larvae	4,044,000	0	50,100	49,900	37,800	2,900
Juvenile	85,031	0	1,297	100	78	6
Adult	84	0	1	0	0	0
Turbines - Mortality (25%)						
Larvae	1,011,000	0	12,500	12,200	9,500	700
Juvenile	21,258	0	324	25	19	1
Adult	21	0	0	0	0	0
Spillway/ Dam release gates - Harassed (100%)						
Larvae	2,696,000	567,500	5,600	5,400	4,200	300
Juvenile	85,031	14,710	144	11	9	1
Adult	84	15	0	0	0	0
Spillway - Mortality (2%)						
Larvae	53,900	11,400	100	100	100	10
Juvenile	1,701	294	3	0	0	0
Adult	2	0	0	0	0	0
Without Fishways - Harassed						
Larvae	6,740,000	567,500	55,700	54,400	42,000	3,200
Juvenile	170,062	14,710	1,442	111	86	7
Adult	167	15	1	0	0	0
Without Fishways -Total Mortality						
Larvae	**1,064,900**	**11,400**	**12,600**	**12,300**	**9,500**	**710**
Juvenile	**22,958**	**294**	**327**	**25**	**20**	**2**
Adult	**23**	**0**	**0**	**0**	**0**	**0**
Number of suckers dispersing downstream						
Larvae	5,675,100	556,100	43,600	42,000	32,500	2,500
Juvenile	147,104	14,416	1,114	86	67	5
Adult	145	15	1	0	0	0

Table 2. Sucker entrainment and mortality assumptions for current operations at the Klamath Hydroelectric Project facilities.

Current License			
Life Stage	Turbine Mortality	Spillway Mortality	Percent Dispersal To Next Facility
Link River Dam - 60% of larval entrainment through turbines/40% through the spillway[1]; 50% of juvenile and sub-adult/adult entrainment into turbines/50% through spillway[2]			
Larvae	25%[3]	2%[4]	10%[5]
Juvenile	25%[3]	2%	10%
Sub-adult/adult	25%[3]	2%	10%
Keno Dam - 100% of entrainment through the spillway			
Larvae	No turbine	2%	10%
Juvenile	No turbine	2%	10%
Sub-adult/adult	No turbine	2%	10%
J.C. Boyle Dam - 90% of entrainment through turbines/10% through spillway			
Larvae	25%	2%	10%
Juvenile	25%	2%	10%
Sub-adult/adult	25%	2%	10%
Copco No. 1 - 90% of entrainment through turbines/10% through spillway			
Larvae	25%	2%	100%
Juvenile	25%	2%	100%
Sub-adult/adult	25%	2%	100%
Copco No. 2 - 90% of entrainment through turbines/10% through spillway			
Larvae	25%	2%	10%
Juvenile	25%	2%	10%
Sub-adult/adult	25%	2%	10%
Iron Gate Dam - 90% of entrainment through turbines/10% through spillway			
Larvae	25%	2%	-
Juvenile	25%	2%	-
Sub-adult/adult	25%	2%	-

[1]Based on relative proportion of flow passing the spillway and diverted at the Eastside and Westside facilities during the larval sucker entrainment period (April – July)

[2]Assume 50% of juvenile and sub-adult/adult suckers pass through the turbines and 50% through the spillway at Link River Dam based on proportion of flow passing the spillway and diverted at the Eastside and Westside facilities during the major juvenile and sub-adult/adult entrainment period (July through October)

[3] Without site-specific studies, the Service referred to studies of entrainment at other hydroelectric installations to estimate turbine mortality from the Klamath Hydroelectric Project. The Service believes that the Electric Power Research Institute (1987) entrainment study which focused on juvenile salmonids is the best information to estimate sucker turbine mortality in this project. We believe the average mortality of 25% in this study should apply for all life stages of suckers, including larval suckers that are fragile and easily killed.

[4] Estimates for computational purposes only; spillways are not part of the proposed action. Take will be part of the 2008 consultation with the Bureau of Reclamation; Spillway mortality estimate for anadromous salmonids from Whitney et al. (1997) in National Marine Fisheries Service (2000).

[5]Terwilliger et al. 2004

New License Entrainment and Mortality with Fishways

Larval entrainment and mortality

Link River - A total of 6.74 million larvae of federally listed suckers are estimated to pass Link River Dam (Table 3). Of these, approximately 4.04 million will be diverted towards the power canals instead of the spillways. Under the new FERC license with proposed fishways, larval entrainment at the Eastside and Westside facilities will still occur because there are no practical methods to exclude sucker larvae for the turbines. However, we expect that up to 50 percent of the larvae (2,022,000) will be bypassed away from the turbines by the fish screens and guided downstream below Link River Dam. Larval sucker mortality for turbine passage is estimated at 505,500 (25 percent; Table 4). We estimate that turbine bypass mortality is 2 percent, resulting in the loss of 40,400 larvae. Of the larval suckers passing the Eastside and Westside facilities, we estimate that 6,140,100 move downstream.

Keno - We estimate that 10 percent of the larvae entering Keno Reservoir (614,000) are entrained at Keno Dam and, with spillway improvements, larval sucker mortality is estimated at 1 percent (6,100). The estimated number of larval suckers dispersing downstream into J.C. Boyle Reservoir is 607,900.

With mortality rates of 25 percent and 2 percent, respectively, we estimate turbine entrainment is 100 juveniles with a mortality of 25 fish and spillway entrainment is 11 juvenile suckers with a mortality of 0 fish. Of the juvenile suckers passing the Copco No.1 facility, we estimate that 86 move downstream.

J.C. Boyle - At J.C. Boyle Dam, with downstream fishways and spillway improvements, we estimate 27,400 larval suckers pass through the screens, going through the turbines and turbine bypass with 25 percent (6,800) and 2 percent mortality (500). With 10 percent of the larvae entrained at Boyle Dam passing through the improved spillway (6,100), we estimate 1 percent mortality (100) from spillway mortality. Of the larval suckers passing the J.C. Boyle facilities, we estimate that 53,300 larvae move downstream.

Copco No. 1 - With an estimated 500,000 SNS (no LRS) larvae produced in the Klamath River above Copco No. 1 Reservoir, total larval sucker dispersal into the reservoir is 553,300 (500,000 + 53,300). With 10 percent of these fish passing Copco No.1 Dam, we estimate that 24,900 fish enter the turbines and mortality is 6,200 (25 percent). We estimate that turbine bypass mortality is 500 fish (2 percent). An estimated 5,500 larvae are entrained through the spillway and mortality estimated to be 100 (1 percent) in the improved spillways. Of the larval suckers passing the Copco 1 facilities, we estimate that 48,556 move downstream.

Copco No. 2 - At Copco No. 2 we estimate that all larval suckers entering the reservoir from Copco No. 1 make it to Copco No. 2 Dam. An estimated 21,900 larvae enter the turbines and mortality is 5,500 (25 percent mortality). Of an estimated 21,900 larval

suckers entering the turbine bypass mortality is 400 larvae (2 percent). An estimated 4,900 sucker larvae are entrained through the spillway and mortality is 100 (1 percent) in the improved spillways. Of the larval suckers passing the Copco No. 2 facility, we estimate that 42,608 move downstream.

Iron Gate – We estimate that 10 percent of the sucker larvae entering Iron Gate Reservoir pass downstream to the dam. We estimate that 1,900 pass through the turbines (mortality 500). We estimate another 1,900 enter the turbine bypass and mortality is 0. A total of an estimated 400 larval suckers pass through the spillway, with no mortality in the improved spillway. Of the larval suckers passing the Iron Gate Dam facility, we estimate that 3,700 move downstream.

Of the estimated 6.74 million larvae that are entrained annually at Link River Dam and the Eastside and Westside developments 3,700 disperse below Iron Gate Dam.

Juvenile entrainment and mortality

With downstream fishways at all Project facilities, turbine entrainment of juvenile suckers is estimated to be zero as all fish will be excluded by screens and bypassed downstream. However, we assume there will be a small amount of mortality associated with passage through the turbine bypass structures (2 percent, Table 4).

Link River - At Link River Dam, 68,025 juvenile suckers entering the turbine bypass facility will be trapped and hauled back to UKL during mid-June to mid-November during the interim period when water quality is poor. We estimate that 80 percent of the juvenile sucker entrainment occurs during this period and 20 percent during other months based on entrainment studies at the Eastside and Westside facilities (Gutermuth et al. 2000b). Therefore, an estimated 17,006 juveniles will pass downstream through the turbine bypass. We estimate turbine bypass mortality is 2 percent (340). Of the juvenile suckers passing the Eastside and Westside power diversion facilities, we estimate that 99,996 move downstream.

Keno - We estimate that 10 percent of the juvenile suckers entering Keno Reservoir will disperse to Keno Dam (10,000). With spillway improvements, we assume 1 percent mortality compared to 2 percent currently. Total spillway entrainment mortality is estimated at 100 fish. Of the juvenile suckers passing the Keno facility, we estimate that 9,900 move downstream.

J.C. Boyle – An estimated 891 juvenile suckers are entrained at J.C. Boyle Dam through the turbine bypass (90 percent) and 99 through the spillway (10 percent). Turbine bypass mortality is estimated at 18 fish and spillway mortality of 1 fish. Of the juvenile suckers passing the J.C. Boyle facility, we estimate that 971 move downstream.

Copco No.1 - At the Copco No. 1 facility, we estimate that 97 or 10 percent of those dispersing below J.C. Boyle pass through the dam, including 87 through the turbine bypass and 10 through the spillway. Turbine bypass mortality is estimated at 2 juvenile

suckers with no spillway mortality. Of the juvenile suckers passing the Copco No.1 facility, we estimate that 95 move downstream.

Copco No. 2 – At Copco No. 2 Dam we estimate that all 95 juveniles pass through the reservoir to the Copco No. 2 dam, including 86 through the turbine bypass and 9 through the spillway. Turbine bypass mortality is estimated at 2 juvenile suckers with no spill mortality. Of the juvenile suckers passing the Copco No. 2 facility, we estimate that 93 move downstream.

Iron Gate – We estimate that approximately 93 juvenile suckers disperse downstream into Iron Gate Reservoir. We estimate that eight juveniles are entrained through the turbine bypass and 1 through the spillway. We estimate that there is no turbine bypass mortality or spillway mortality. Of the juvenile suckers passing the Iron Gate Dam facility, we estimate that 9 move downstream.

Sub-adult and adult entrainment and mortality

Link River - At the Eastside and Westside power diversions, 68 sub-adult/adult suckers entering the turbine bypass facilities will be trapped and hauled back to UKL during mid-June to mid-November during the interim period when water quality is poor. We assume that 80 percent of the sub-adult/adult sucker entrainment occurs during this period and 20 percent during other months based on entrainment studies here (Gutermuth et al. 2000b). Therefore, an estimated 17 sub-adult/adult fish go through the turbine bypass structure and 1 dies (2 percent mortality). Of the sub-adult and adult suckers passing the Eastside and Westside power diversions, we estimate that 99 move downstream.

Keno - At Keno Dam, an estimated 10 (10 percent) survive and pass downstream through the spillway. There is no spillway mortality. Of the sub-adult and adult suckers passing the Keno facility, we estimate that 10 move downstream.

J.C. Boyle - At J.C. Boyle Dam, we estimate that 1 sub-adult/adult sucker is entrained through the turbine bypass and none through the spillway. There is no turbine bypass mortality or spillway mortality. Of the sub-adult and adult suckers passing the J.C. Boyle facility, we estimate that 1 moves downstream.

Copco No. 1, Copco No. 2, and Iron Gate – We estimate that no sub-adult/adult suckers move downstream of these facilities.

Table 3. Entrainment estimates at Klamath Hydroelectric Project facilities with fishways.

Facility	**Eastside/Westside**	**Keno**	**J.C. Boyle**	**Copco No. 1**	**Copco No. 2**	**Iron Gate**
Turbines - Harassed (100%)						
Larvae	2,022,000	0	27,400	24,900	21,900	1,900
Juvenile	0	0	0	0	0	0
Adult	0	0	0	0	0	0
Turbines - Mortality						
Larvae	505,500	0	6,800	6,200	5,500	500
Juvenile	0	0	0	0	0	0
Adult	0	0	0	0	0	0
Turbine bypass - Harassed (100%)						
Larvae	2,022,000	0	27,400	24,900	21,900	1,900
Juvenile	17,006	0	891	87	86	8
Adult	17	0	1	0	0	0
Turbine bypass - Mortality (2%)						
Larvae	40,400	0	500	500	400	0
Juvenile	340	0	18	2	2	0
Adult	0	0	0	0	0	0
Spillway/ Dam release gates - Harassed (100%)						
Larvae	2,696,000	614,000	6,100	5,500	4,900	400
Juvenile	85,031	10,000	99	10	9	1
Adult	84	10	0	0	0	0
Spillway - Mortality (2% at Link River/ 1% at other facilities)[%]						
Larvae	53,900	6,100	100	100	0	0
Juvenile	1,701	100	1	0	0	0
Adult	2	0	0	0	0	0
With Fishways - Harassed						
Larvae	6,740,000	614,000	60,900	55,300	48,700	4,200
Juvenile	170,062	10,000	990	97	95	9
Adult	101	10	1	0	0	0
With Fishways - Total Mortality						
Larvae	**599,900**	**6,100**	**7,400**	**6,800**	**5,900**	**500**
Juvenile	**2,041**	**100**	**19**	**2**	**2**	**0**
Adult	**2**	**0**	**0**	**0**	**0**	**0**
Number of suckers dispersing downstream						
Larvae	**6,140,100**	**607,900**	**53,300**	**48,500**	**42,800**	**3,700**
Juvenile	**99,996**	**9,900**	**971**	**95**	**93**	**9**
Adult	**99**	**10**	**0**	**0**	**0**	**0**

Table 4. Sucker entrainment and mortality assumptions under the new license at the Klamath Hydroelectric Project facilities.

New License				
Life Stage	Turbine Mortality	Turbine Bypass Mort	Spillway Mortality	Percent Dispersal To Next Facility
Link River Dam - 60% of larval entrainment through turbine bypass/40% through the spillway[1]; 50% of juvenile and sub-adult/adult entrainment into downstream fishway/50% through spillway[2]; 80% of juvenile and sub-adult/adult trapped at fishway and hauled back to UKL/20% entrained				
Larvae	25%[3]	2%[4]	2%[5]	10%[6]
Juvenile	0%	2%	2%	10%
Sub-adult/adult	0%	2%	2%	10%
Keno Dam - 100% of entrainment through the spillway				
Larvae	No turbine	No turbine	1%	10%
Juvenile	No turbine	No turbine	1%	10%
Sub-adult/adult	No turbine	No turbine	1%	10%
J.C. Boyle Dam - 90% of entrainment through the turbine bypass/10% through spillway				
Larvae	25%[3]	2%	1%	10%
Juvenile	0%	2%	1%	10%
Sub-adult/adult	0%	2%	1%	10%
Copco No. 1 - 90% of entrainment through the turbine bypass/10% through spillway				
Larvae	25%[3]	2%	1%	100%
Juvenile	0%	2%	1%	100%
Sub-adult/adult	0%	2%	1%	100%
Copco No. 2 - 90% of entrainment through the turbine bypass/10% through spillway				
Larvae	25%[3]	2%	1%	10%
Juvenile	0%	2%	1%	10%
Sub-adult/adult	0%	2%	1%	10%
Iron Gate Dam - 90% of entrainment through the turbine bypass/10% through spillway				
Larvae	25%[3]	2%	1%	-
Juvenile	0%	2%	1%	-
Sub-adult/adult	0%	2%	1%	-

[1]Based on relative proportion of flow passing the spillway and diverted at the Eastside and Westside facilities during the larval sucker entrainment period (April – July)
[2]Assume 50% of juvenile and sub-adult/adult suckers pass through the turbines and 50% through the spillway at Link River Dam based on proportion of flow passing the spillway and diverted at the Eastside and Westside facilities during the major juvenile and sub-adult/adult entrainment period (July through October)
[3] EPRI 1987
[4](Muir et al. 2001)
[5]Estimates for computational purposes only; spillways are not part of the proposed action. Take will be part of the 2008 consultation with the Bureau of Reclamation; Spillway mortality estimate for anadromous salmonids from Whitney et al. (1997) in National Marine Fisheries Service (2000).
[6]Terwilliger et al. 2004

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Appendix 2. Response to Comments Received on Draft FERC BO dated October 22, 2007

On October 22, 2007, in response to a request from Commission staff to review the draft BO, the Service provided the draft Biological Opinion to the Federal Energy Regulatory Commission for review and comment, pursuant to the Service's consultation regulations at 50 C.F.R. 402.14(g)(5). In that transmittal, the Service requested that comments on the draft BO be provided by November 2, 2007. By letter dated October 29, 2007, the Service provided notice to the Project service list of the submittal of the draft to the Commission and the availability of the draft from the Yreka Fish and Wildlife Service website or office. By letter dated November 9, 2007, the Service extended the deadline by which it would accept comments on the draft BO to November 15, 2007.

Comments on the draft BO were received from the Federal Energy Regulatory Commission by letter dated November 2, 2007 (hereafter "FERC Comments"), and from PacifiCorp by letter dated November 2, 2007 (hereafter "PacifiCorp Comments"). In addition, by letter dated November 15, 2007, PacifiCorp responded to the Service's extension of time for filing comments by indicating that it reserved its right to comment with additional information on the draft BO beyond November 15, 2007. This letter provided no substantive comments and is not further addressed in this BO. PacifiCorp's initial comment letter further criticized the time for review and comment on the draft BO (PacifiCorp Comments at 1). The Service notes, however, that PacifiCorp was provided the BO on October 23, and thus had twenty four days in which to comment. The review period was based upon FERC staff's representation that it required 14 days in which to review the draft BO. Given the need to finalize and submit the BO to the Commission by December 1, 2007, the Service cannot consider comments that are received too late to be incorporated.

Below are our responses to comments received from FERC on Nov. 2, 2007:

1. Proposed Agency Action

We have clarified, within the introductory portion of the Incidental Take Statement, that the terms and conditions that address the East Side, West Side, and Keno developments will not be applicable to this biological opinion unless one or more of these developments are incorporated in a new license for the project.

2. Assignment of Responsibility for Actions

The hydroelectric project retains some responsibility for perpetuating the conversion of an unknown amount of wetlands to agricultural lands by providing flood control at Keno Dam, by compensating for flooding damages from regulation of UKL to agriculturally converted wetlands, and by maintaining levees to prevent flooding of 2,100 acres at Caledonia Marsh. These are PacifiCorp's responsibility because without their continuing

action some or all of these lands could revert to wetlands and thus provide habitat to listed suckers.

PacifiCorp's Keno Dam and its impoundment continues to affect water quality primarily by increasing surface area, hydraulic retention time, and solar exposure of Keno Reservoir waters. In addition, the absence of wetland fringe caused by PacifiCorp's continuing operation of Keno Dam greatly reduces the potential for nutrient cycling in Keno Reservoir.

Therefore, we disagree with your claim that the biological opinion assigns responsibility for Bureau of Reclamation's Klamath Irrigation Project's impacts on wetlands and water quality. In fact, some of PacifiCorp's proposed continuing actions will contribute to water quality problems in Keno Reservoir.

3. Scope of Incidental Take Statement

The take identified in the Incidental Take Statement is incidental to the proposed action because the proposed continuing actions will have continuing effects on the listed sucker species. East Side, West Side, and Keno developments were included because the continuing operations of these facilities may be included in the new license. Continuing effects of the proposed action are expected at Upper Klamath Lake through facilitation of agricultural activities through flood control, which inhibits the re-establishment of wetland habitats for listed suckers.

Below are our responses to comments received from PacifiCorp on November 2, 2007:

1. The USFWS has allowed an inadequate amount of time for review and comment on the draft BO.

The amount of time available for review of the draft BO was agreed to by FWS and FERC. We will consider additional comments on the draft BO after the due date, especially regarding the Reasonable and Prudent Measures, but not after November 15, 2007.

2. USFWS failed to consult with the action agency and applicant to ensure the reasonable and prudent measures were, indeed, reasonable and prudent.

We provided the draft BO to PacifiCorp, in part, to receive comments on the reasonableness of the Reasonable and Prudent Measures.

3. By including the Keno, Eastside, and Westside developments within the draft BO, USFWS has improperly redefined the proposed agency action.

We have added language recommended by FERC to accommodate the contingencies regarding whether each of these facilities are included in the new license.

4. FWS fails to distinguish between environmental baseline and effects of the action.

A. The present and past impacts of the dams are included in the Environmental Baseline. We have increased the clarity of this in the document in response to this comment.

B. In some cases, Federal and third party impacts are difficult to distinguish from effects of the action. We have discussed these impacts in combination with the past effects of the Project in the Environmental Baseline section and separated out the continued Project effects in the Effects of the Action and Incidental Take Statement sections. We have added some clarifications that may assist the reader in response to this comment.

5. The cover letter for the draft BO failed to acknowledge the continued effect of the 1996 BO ITS and 2002 BOR BO ITS on Project operations.

We have included a discussion of the continued effect of the 1996 BO ITS and 2002 BOR BO ITS in the environmental baseline section of the BO and the Appendix (Klamath Hydroelectric Project Entrainment and Take Analysis). However, the 1996 BO became ineffective in 2002 when the Service issued a BO covering BOR's operations for the Klamath Irrigation Project which specifically superceded the 1996 BO. Only Reclamation's activities were covered under the 2002 BO.

6. USFWS does not support its analysis with credible evidence.

In the absence of adequate entrainment and mortality studies of Project facilities, we have utilized existing data in combination with credible assumptions to estimate entrainment and mortality rates. We have clarified these assumptions in the Appendix in response to this comment. The BO discusses the nature of habitats provided by the reservoirs on pages 51, 52, and 78. The reservoirs have limited conservation value for suckers.

7. USFWS failed to justify that the RPMs are necessary to minimize incidental take from the proposed agency action.

Regarding RPM 1a(ii), we believe that although the trap and haul operation will add additional stress and mortality to fish transported, overall survival of suckers in UKL is expected to be much higher than if they are allowed to pass into Keno Reservoir where most will perish due to poor water quality. Trapping and hauling suckers will not be necessary when water quality improvements are made in Keno Reservoir. This RPM would not likely have a significant, negative impact on anadromous fish reintroduction because anadromous fish movement (July through October) is not expected during the period that trap and haul would be needed (March through June). At A-Canal, fish screens and bypass facilities have been installed and an evaluation of the effects of implementing these actions is being required.

Regarding RPM 3b, we believe the role of wetlands in providing habitat for suckers is sufficiently known to support this measure. There could be a response by exotic fish, but we still believe suckers would benefit from the additional habitats.

RPM 2 requires PacifiCorp to upgrade the upstream fishway at Keno Dam to sucker criteria only if monitoring suggests that there would be a benefit to sucker recovery.

RPM 4 requires measures that are likely to improve water quality of Keno Reservoir, as indicated by two site specific studies (Deas and Vaughan 2005, Gearhardt 1995) and a large body of general literature on the effectiveness of wetlands in improving water quality.

8. The ITS provides no support or explanation for its RPMs, which must be consistent with the proposed agency action's basic design, location, scope, duration, and timing.

RPM 3b is reasonable and prudent because the proposed action may include relicensing of Keno Dam. Continued operations with the proposed action would include stable reservoir water levels that would preclude re-establishment of approximately 230 acres of wetlands along the margins of Keno Reservoir. It would be prudent to replace this wetland function with restored wetlands that will provide habitat for listed suckers. We reduced the number of acres to 230 acres because this is a reasonable estimate of lost wetland values. Restoration of wetlands is estimated to cost $3,000 per acre, making the total cost $690,000. This is a minor expenditure for a Project with a large budget and long time frame. If Keno Reservoir maintenance and operations are included in the new license, then it would not be a significant change to also include establishment and maintenance of adjacent wetland habitat areas, especially since FERC has already included a water quality management plan for Keno Reservoir in the event that Keno is included in the new license.

We believe sucker densities in the wetlands is an appropriate metric for determining wetland function because biological indicators integrate both habitat function and quality attributes. The larval and juvenile sucker density criteria are based on low to medium rearing densities documented in UKL where water quality conditions are generally good.

9. The draft BiOp is inconsistent with findings in Reclamation's Biological Assessment for the Klamath Irrigation Project.

In our draft BO on the FERC relicensing, we also include historic wetlands loss and water quality impacts as part of the environmental baseline. We have not completed our biological opinion on Reclamation's proposed action, thus it is premature to comment on analysis contained in it. In the relicensing opinion we acknowledge that a water quality management plan for Keno Reservoir would be in the proposed action if Keno Dam is in the new license. Past and current operations and impacts of the Project are now only discussed in the Environmental Baseline section to avoid any impression that we consider them part of the Effects of the Proposed Action.

10. The RPMs for the tailrace at the Eastside and Westside facilities alters the Agreement between PacifiCorp and USFWS.

In its comments on RMP 1, PacifiCorp states that, in the Energy Policy Act of 2005 (EPAct) trial-type hearing, the Services entered into an agreement with PacifiCorp regarding the need for and design of spillway modifications and tailrace barriers, and that the draft RPM and terms and conditions modify that agreement by stating that tailrace barriers will be built within three years of the license unless the Service determines otherwise. In response to this comment, RPM 1 has been revised to reflect the Agreement with PacifiCorp. It now provides that tailrace barriers be constructed, unless the Service determines, based on the site-specific studies to be conducted in accordance with the Agreement, that tailrace barriers are unnecessary. Three years is considered an adequate time for PacifiCorp to conduct the site-specific studies called for in the Agreement that would address the need for and design of tailrace barriers for both federally listed suckers and for anadromous fish.

Below are our responses to comments received from PacifiCorp on the Appendix:

1. New Link River Dam Fish Ladder Use

We have added new information to the BO that was recently provided by Reclamation on sucker passage.

2. Sucker Entrainment at Project Facilities – Listed and Non-listed Species

We have clarified that our entrainment analysis only includes listed suckers even though non-listed suckers (Klamath largescale sucker and Klamath smallscale suckers) are present throughout the project area.

3. Lost River Sucker Population Estimate for Keno Reservoir

We have revised our estimate based on additional information provided by Reclamation.

4. Natural Mortality of Suckers

Our estimates of fish dispersing downstream incorporate natural mortality and fish that take up residence in Project reservoirs.

5. Larval Sucker Entrainment Mortality Rate

We believe use of a turbine mortality rate of 25 percent for larval sucker is justified because they are fragile and easily killed.

6. Eastside and Westside Entrainment Estimates

We have revised our estimates based on average diversion rates rather than full hydraulic capacity.

7. Spillway Entrainment Mortality Rate

We have revised the rate from 5 percent to 2 percent based on Whitney et al. (1997) as cited in National Marine Fisheries Service (2000).

8. Existing J.C. Boyle Fish Screen Effectiveness

We acknowledged that the screen is partially effective and have revised our entrainment estimates accordingly.

9. Trash Rack Exclusion of Adult Suckers at Powerhouse Intakes

The entrainment studies used as the basis for our analysis were conducted on facilities with trash racks and therefore exclude larger suckers.

10. Sucker Pass-through Rates

We have revised these rates substantially.

11. Larval Sucker Entrainment Estimates at Link River Dam

We have revised and expanded our discussion of the rationale for these estimates in the Appendix.

12. Shortnose Sucker Spawning above Copco Reservoir

We clarified the sources of our information in the BO and Appendix.

13. Shortnose Sucker Egg Stranding in the J.C. Boyle Peaking Reach

Documentation on stranding of sucker eggs in the J.C. Boyle Peaking Reach is found in the BO on page 49.

14. Link River Fish Ladder Sucker Passage

Addition information on fish passage at Link River fish ladder for 2005 has been added documenting successful sucker passage. Data on fish passage monitoring in 2006 and 2007 has been requested from Reclamation but is not available at this time.

15. Sucker Spawning Migration at Keno Dam

We have revised our estimates downward based on smaller adult federally listed sucker populations in J.C. Boyle Reservoir.

16. J.C. Boyle Listed Sucker Population Estimates in J.C. Boyle Reservoir

The population estimates for adult LRS and SNS has been revised and lowered based on previous sucker population monitoring data.

17. False Attraction of Adult Suckers at Westside

We have clarified, within the f*alse attraction and harm at downstream tailrace barriers* section, that false attraction is a concern during dry years when most of the flow exiting UKL is diverted in the Eastside and Westside diversions.

18. Keno Dam Operations

We have provided added a reference which is the source of information on Keno Dam operations (USDI Bureau of Reclamation 2006; Section B: US Department of Interior Preliminary 4(e) Conditions – Reclamation Reservation).

19. Keno Reservoir Wetland Losses

We have revised and reduced our estimates of wetland losses.

20. Klamath River Water-Quality 303(d) Listings

We have clarified reaches that are water-quality limited by parameter on page 73 of the BO.

21. Marine-Derived Nutrients

We have provided additional information on the potential of MDNs to impact suckers.

22. Project Reservoir Nutrient Assimilation

We have provided more information on the effects of reservoirs on nutrient assimilation in Klamath River waters in response to this comment.

23. *Microcystis aeruginosa* Impacts to Suckers

We have revised our discussion to include effects on suckers in the *Water Quality* section pages 93-94.

24. Effects of Anadromous Fish Reintroduction on Disease Prevalence

We have clarified, within the *Reintroduction of Anadromous Fish* section, that we do not expect any significant disease effects on suckers related to anadromous fish reintroduction.