PacifiCorp Klamath Hydroelectric Project

Proposed Interim Operations Habitat Conservation Plan for Lost River and Shortnose Suckers

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PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

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I. Introduction and Background

PacifiCorp owns and operates the Klamath Hydroelectric Project (Project), located on the upper Klamath River in Klamath County (south-central Oregon) and Siskiyou County (north-central California). The Project consists of eight developments (Figure 1). Seven of the developments are located on the Klamath River between river mile (RM) 190.1 and 254.3, including (in order moving upstream) Iron Gate (RM 190.1 to 196.9), Copco No. 2 (RM 198.3 to 198.6), Copco No. 1 (RM 198.6 to 203.1), J.C. Boyle (RM 220.4 to 228.3), Keno (RM 233 to 253.1), East Side and West Side (both in Link River at RM 253.1 to 254.3). The eighth development is on Fall Creek, a Klamath River tributary at RM 196.3. Detailed descriptions of Project facilities on the Klamath River and their operations are provided in Chapter IV (Current Conditions) of this document. Operation of the Project, with the exception of Fall Creek, is made possible from water releases from the U.S. Bureau of Reclamation (Reclamation) from the Upper Klamath Lake Project via Link River dam (RM 254.3).

On February 25, 2004, PacifiCorp filed an application with the Federal Energy Regulatory Commission (FERC) for a new 50-year license for the Project. PacifiCorp proposes in its application to operate five of the developments in a manner similar to current operations with a set of 41 environmental measures (described in detail in PacifiCorp 2004a and FERC 2007, see below), the purposes of which include (but are not limited to) water quality and habitat enhancement, instream flows and ramp rates[1] management, facilitation of fish passage, and enhancement of Iron Gate Hatchery stock management. PacifiCorp's application for a new license proposes to remove the Keno development from the license, though it would remain in place. Keno dam currently regulates water levels of Keno reservoir to facilitate withdrawals to the Lower Klamath Lake National Wildlife Refuge and irrigation withdrawals – including those that supply a portion of the lands included within Reclamation's Klamath Irrigation Project. The Keno development has no hydroelectric generation capabilities and does not serve Project purposes for a new FERC license. PacifiCorp's application for a new FERC license also proposes to decommission the East Side and West Side developments (that is, cease operations and use of East Side and West Side facilities).

On November 16, 2007, FERC issued a Final Environmental Impact Statement (FEIS) on PacifiCorp's application for a new license, including PacifiCorp's proposed operations and environmental measures (FERC 2007). The FERC (2007) FEIS includes a detailed analysis of the environmental benefits and costs associated with PacifiCorp's proposed operations and environmental measures, and four other alternatives considered in the FEIS, including: (1) a No-Action Alternative; (2) a FERC Staff Alternative; (3) a FERC Staff Alternative with Mandatory Agency Conditions; and (4) Retirement of Copco No. 1 and Iron Gate Developments with FERC Staff Measures. The FERC (2007) FEIS concludes that the best alternative for the Project would be the FERC Staff Alternative, which incorporates most of

[1] Hydroelectric facilities typically have the capability of increasing and decreasing flow levels downstream of the facilities. In general, the rate at which these flow changes occur is called the "ramp rate" or "ramping."

PacifiCorp's proposed environmental measures, and also includes a number of additional environmental measures developed by FERC staff, including (but not limited to) implementation of anadromous and resident fish passage and disease management programs.

Following issuance of the FERC (2007) FEIS, the U.S. Fish and Wildlife Service (USFWS) issued a Biological Opinion (BiOp) under Section 7 of the federal Endangered Species Act (ESA) analyzing the effects of proposed Project operations on listed sucker species. The USFWS BiOp was issued in December 2007. The Proposed Action evaluated in the BiOp contains measures listed in the FERC Staff Alternative and PacifiCorp's proposal, and also includes measures contained within mandatory agency conditions, including Section 4(e) Conditions of the Bureau of Land Management (BLM) and Reclamation, and the USFWS and National Marine Fisheries Section 18 Fishway Prescriptions. This BiOp identifies potential Project effects that may result in incidental take[2] of the species listed under the ESA. The BiOp also identifies conservation measures that could be implemented to minimize and mitigate potential incidental take under a new FERC license scenario.

Since submitting the new license application to FERC in 2004, PacifiCorp has worked collaboratively with USFWS to develop "interim conservation measures" for listed sucker species, which include measures to be implemented in the interim period until issuance of a new FERC license or Project dam removal as specified in the Klamath Hydroelectric Settlement Agreement (as described further below). An Interim Conservation Plan (ICP) describing interim conservation measures was completed on November 9, 2008, in consultation with USFWS. The implementation of the ICP's conservation measures would conserve listed suckers and minimize potential Project impacts on such species. On November 10, 2008, PacifiCorp transmitted letters containing the ICP to USFWS indicating its commitment to early implementation of actions included as the conservation measures in the BiOp. On November 12, 2008, the USFWS indicated its support for implementation of ICP measures, stating that implementation of such measures would provide benefits to and minimize take of listed species. The ICP measures formed the starting point for the development of this Habitat Conservation Plan (HCP). Since the release of the ICP in 2008, ongoing discussions with USFWS have occurred regarding the development of the HCP and the actions included in the sucker conservation strategy described herein.

[2] "Incidental take" is defined as take of a listed species that results from, but not the purpose of, carrying out an otherwise lawful activity.

FIGURE 1
Map of Klamath River basin showing locations of rivers and lakes, and Klamath Hydroelectric Project facilities within the basin (source: Miller et al. 2004).

Following the submittal of its application for a new license, PacifiCorp began settlement discussions with a diverse group of stakeholders to resolve issues related to relicensing of the Project. PacifiCorp has worked collaboratively with this group of stakeholders, including USFWS, to develop and enter into the Klamath Hydroelectric Settlement Agreement (KHSA). The KHSA was signed by the involved parties on February 18, 2010. The KHSA identifies a process and path forward that provides for the decommissioning and removal of Iron Gate, Copco No. 2, Copco No. 1, and J.C. Boyle dams, subject to certain to contingencies including funding, the passage of federal legislation, and a determination by the Secretary of the Interior that removal of the dams should proceed. Specifically, the Secretary will determine whether removal of PacifiCorp's lower four dams on the Klamath River: (1) will advance restoration of the salmonid fisheries of the Klamath Basin; and (2) is in the public interest, which includes but is not limited to consideration of potential impacts on affected local communities and tribes. Under the terms of the KHSA, the Secretary agreed to use "best efforts" to make a decision by March 31, 2012. However, Congressional action is required to pass legislation authorizing the Secretary to make a Secretarial Determination. To date, such Congressional action has not occurred. PacifiCorp agreed to a potential dam removal path for the Project and executed the KHSA based upon an assessment that the KHSA provided superior cost and risk protections for PacifiCorp and its customers as compared to continuing on a path of relicensing.

The current FERC license for the Project (FERC No. 2082) expired on March 1, 2006, and the Project is now operating under annual licenses from FERC pending final resolution of the FERC licensing process. It is anticipated that the Project will continue operating under annual licenses until the dams are removed pursuant to the KHSA or until FERC makes a decision on the relicensing application. The KHSA provides that Project operations will continue over the interim period until the dams are removed. Should the Secretary of the Interior determine that dam removal should not proceed, or the KHSA terminates for other reasons, PacifiCorp would continue the FERC relicensing process for the Project. FERC's decision on the relicense application will determine the future of the Project's operations. The KHSA incorporates most of the ICP measures, i.e., those intended to benefit coho salmon, as well as additional measures not included as part of the ICP. These KHSA interim measures are now contractual obligations of PacifiCorp as long as the Settlement Agreement is in effect during the interim period. The KHSA interim measures do not include some ICP measures, specifically, those intended to benefit listed suckers. The KHSA also states the parties' intention that a new FERC license will not be issued and the licensing process will be held in abeyance pending the outcome of the Secretarial Determination and, should the Secretary render an affirmative determination, during the interim period prior to dam removal.

PacifiCorp has prepared this HCP (also referred to in this document as the "Plan") to support its application to USFWS for interim incidental take coverage of Project operations under Section 10(a)(1)(B) of the ESA. Section 10(a)(1)(B) of the ESA authorizes USFWS to issue permits to non-federal parties for the potential incidental taking of endangered and threatened species. PacifiCorp and USFWS have agreed to pursue this permitting process to formalize PacifiCorp's conservation commitments, and to provide additional regulatory certainty to the Company in view of its substantial financial commitments. The process for obtaining incidental take authorization is described below under *Regulatory Framework*.

Permit Holder/Permit Duration

PacifiCorp is applying to USFWS for an ESA Section 10(a)(1)(B) Incidental Take Permit (ITP) authorizing the incidental take of Covered Species that could potentially occur over the term of the ITP. The proposed term of the ITP ("Permit Term") is ten (10) years. The ITP would authorize the incidental take of Covered Species that could occur as a result of operating the Project. The Permit Term may be extended as provided in the Implementing Agreement (IA).

The transfer of the Project to a Dam Removal Entity (DRE) for Project decommissioning is contemplated by the KHSA to occur on or before December 31, 2020, if various contingencies are met. In the event that the transfer to a DRE does not occur prior to the end of the initial 10-year term of the ITP, then PacifiCorp may initiate discussions with USFWS to extend the term of the ITP as described in the IA.

While USFWS and PacifiCorp anticipate and intend that Project decommissioning will occur consistent with the terms of the KHSA, circumstances may arise resulting in the termination of the KHSA. In the event of such a termination, the ITP will remain in effect for a minimum term of 10 years. Following such termination, and should FERC issue a new license for the Klamath Project, the consultation provisions in Section 7 of the ESA would apply to provide any necessary incidental take coverage. In the event that incidental take associated with Project operations is not authorized under Section 7 of the ESA prior to the end of the initial 10-year term of the ITP, then PacifiCorp may initiate discussions with USFWS to extend the term of the ITP as described in the IA.

Covered Lands

Covered Lands include existing Project facilities, adjacent water and land areas, and riparian zones potentially influenced by Project maintenance and operations,, including the mainstem Klamath River (including the Link River) and Project reservoirs from the outlet of Upper Klamath Lake (River Mile 255) downstream to Iron Gate Fish Hatchery below Iron Gate Dam (River Mile 189.3) (see Figure 1). Project facilities and their operation are described in Chapter 4 (Current Conditions) of this HCP. The term "Covered Lands" is more specifically defined in the IA.[3]

Species to be Covered by the Permits

The aquatic species initially covered by this HCP are:

- Lost River sucker (*Deltistes luxatus*) (Endangered)
- Shortnose sucker (*Chasmistes brevirostris*) (Endangered)

[3] The term "Covered Land," as that term is used in this HCP and the IA, means areas of land and water covered by the ITP which are a subset of areas identified in the overall Permit Area. The term "Permit Area," means areas of land and water both within and outside Covered Land that may be directly or indirectly affected by Covered Activities.

Regulatory Framework

This HCP was prepared to comply with the existing regulatory framework that includes the ESA and the federal National Environmental Policy Act (NEPA). Summaries of the processes and requirements for each of these regulatory mechanisms are provided in the following descriptions.

Endangered Species Act

The ESA, as it relates to the species covered by this HCP, is administered by the Secretary of the Interior through the USFWS. The following sections of the ESA pertain to approval of incidental take permits. Species listed as endangered or threatened under the ESA are provided protection as described herein.

Section 9

Section 9 of the ESA prohibits the take of fish and wildlife species listed as endangered. As defined in the ESA, take includes harm or harassment as well as more directed activities such as hunting, capturing, collecting, or killing [16 USC 1532(19)]. By regulation, USFWS has defined harm as an act that actually kills or injures wildlife, and may include significant habitat alteration that significantly impairs essential behavioral patterns, such as feeding, breeding, and sheltering (50 CFR 17.3).

Section 10

Section 10(a)(1)(B) of the ESA allows USFWS to authorize taking of endangered and threatened species by non-Federal entities that is incidental to, but not the purpose of, otherwise lawful activities. Under Section 10(a)(1)(B), such authorizations are granted through the issuance of incidental take permits. The Section 10 process for obtaining an incidental take permit has three primary phases: (1) the HCP development phase, (2) the formal permit processing phase, and (3) the post-issuance phase.

During the HCP development phase, the project applicant prepares a plan that integrates the proposed project or activity with the protection of listed species. An HCP submitted in support of an incidental take permit application must include the following information:

- Impacts likely to result from the proposed taking of the species for which permit coverage is requested;
- Measures that will be implemented to monitor, minimize, and mitigate impacts;
- Funding that will be made available to undertake such measures;
- Procedures to deal with unforeseen circumstances
- Alternative actions considered that would not result in take; and
- Additional measures that USFWS may require as necessary or appropriate for purposes of the plan.

The HCP development phase concludes and the permit processing phase begins when a complete application package is submitted to the appropriate permit-issuing office. A complete application package consists of (1) a proposed HCP, (2) a draft IA, (3) a permit application, and (4) remittance of the application fee from the applicant. USFWS must publish a Notice of Availability of the proposed HCP package and typically a draft NEPA analysis document in the Federal Register to allow for public comment and evaluation of the impacts associated with issuing an incidental take permit. The USFWS also prepares an internal Section 7 BiOp and prepares a Set of Findings, which evaluates the Section 10(a)(1)(B) permit application in the context of permit issuance criteria (provided in the following list). An Environmental Assessment (EA) or Environmental Impact Statement (EIS) document that has undergone a public comment period serves as USFWS's record of compliance with NEPA. After consideration of public comment, a Section 10 incidental take permit may be issued upon a determination by USFWS that all permit requirements have been met.

To issue the permit, the USFWS must find that: (1) the taking will be incidental; (2) the applicant will, to the maximum extent practicable, minimize, and mitigate the impacts of such taking; (3) the applicant ensures adequate funding for the conservation plan and procedures to deal with unforeseen circumstances; (4) the taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild; (5) the applicant has amended the conservation plan to include any measures (not originally proposed by the applicant) that the USFWS determines are necessary or appropriate; and (6) there are adequate assurances that the conservation plan will be implemented.

During the post-issuance phase, the permittee and other responsible entities implement the HCP; and USFWS monitors the permittee's compliance with the HCP, as well as the long-term progress and success of the HCP. The public is notified of permit issuance through notification in the Federal Register.

The 'No Surprises' regulation adopted by USFWS, 63 Federal Register (FR) 8859 (February 23, 1998), codified at 50 CFR 17.22 and 17.32, also provides that, as long as the HCP is being properly implemented, USFWS will not require additional conservation and mitigation measures beyond those required in the plan in the event of changed circumstances not provided for in the plan. In the event of unforeseen circumstances, USFWS may require additional measures limited to modifications within the conserved habitat area or the plan's operating conservation program, but USFWS will not require the commitment of additional land, water, or money, or impose additional restrictions on the use of land, water, or natural resources beyond the level otherwise agreed upon without the consent of the permittee. However, the incidental take permit may be revoked only in certain circumstances, including if continuation of the permitted activities would be inconsistent with the issuance criteria that the activity will not appreciably reduce the likelihood of survival and recovery of the species in the wild and the inconsistency has not been remedied (50 C.F.R. 17.22(b)(8)).

Section 7

Section 7 of the ESA requires all federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any species listed under the ESA, or to result in the destruction or adverse modification of its designated critical habitat. Because issuance of an incidental take permit is a federal action, USFWS must conduct an internal Section 7 consultation on the proposed issuance. The internal consultation is conducted after an HCP is developed by the project applicant (a nonfederal entity).

National Environmental Policy Act

NEPA applies to all federal agencies and most of the activities they manage, regulate, or fund that affect the environment. It establishes environmental policies for the nation, provides an interdisciplinary framework for federal agencies to assess environmental impacts, and contains "action-forcing" procedures to ensure that federal agency decision makers take environmental factors into account.

II. Description of Covered Activities

Covered Activities under the ITP include activities that are necessary to operate and maintain Project facilities during the Permit Term, and mitigation and conservation measures identified in the HCP.

Covered Activities under the HCP include activities that are otherwise necessary to operate and maintain Project facilities during the Permit Term. Hydropower generation is the primary activity conducted at Project facilities, with the exception of the Keno development, which does not include power-generating equipment. Many of these activities are governed by the existing FERC license or agreements with other entities (e.g., Reclamation), or through voluntary commitments from PacifiCorp. Detailed descriptions of Project facilities and their operations are provided in Chapter IV (Current Conditions) of this HCP. In general, the Covered Activities necessary to operate and maintain Project facilities include the following:

- Operate and maintain the spill gates at Link River dam for regulation and releases of flows from Link River dam to maintain water in the East Side and West Side water conveyance features
- Operate and maintain Link River dam pursuant to PacifiCorp's agreements with Reclamation to provide instream flow and ramp rate releases from Link River dam, including: (1) flows and ramp rates in accordance with Reclamation's operational directives to PacifiCorp; and (2) flows and ramp rates to meet Project minimum flow and ramp rate requirements in accordance with PacifiCorp's FERC license and to facilitate Project operation and maintenance[4]
- Operate and maintain the East Side and West Side canals and flow lines following shutdown of the East Side and West Side powerhouse facilities[5]
- Operate and maintain Keno dam, spill gates, and fish ladder
- Regulate the water level upstream of Keno dam in accordance with the agreement with Reclamation (per PacifiCorp's existing FERC license) and for irrigation withdrawal activities
- Operate and maintain J.C. Boyle dam, fish bypass system, water conveyance system, turbines, and powerhouse facilities

[4] When adjusting flows to provide for flow, operation, and maintenance requirements, PacifiCorp will follow the Link River fish stranding prevention and salvage plan (e.g., Reclamation 2011). PacifiCorp anticipates that the fish stranding prevention and salvage plan may be subsequently modified through discussions between USFWS, Reclamation, and PacifiCorp.

[5] As discussed in Chapter VI, substantial shutdown of the East Side/West Side facilities will occur under the Conservation Strategy. Prior to decommissioning, brief operations of turbines at the East Side/West Side facilities (lasting less than one day) are possible for testing and maintenance purposes. Such operations, if done, would occur outside the June-October period of concern for potential entrainment of sucker larvae, juveniles, and adults (as described in Chapter V). PacifiCorp will contact the Service no later than 30 days before any such planned operations to provide information on the planned operations and allow the Service to recommend possible modifications of the planned operations to avoid take of listed suckers.

- Maintain an instream flow release from the J.C. Boyle dam to the river of not less than 100 cfs (per PacifiCorp's existing FERC license)
- Regulate flows from J.C. Boyle dam and powerhouse during normal operations such that ramping rates of flow in the river do not exceed 9 inches per hour (as measured at the United States Geological Survey [USGS] gage located 0.5 mile downstream of the J.C. Boyle powerhouse) per PacifiCorp's existing FERC license
- Operate and maintain Copco No. 1 and Copco No. 2 dams, water conveyance systems, turbines, and powerhouse facilities
- Operate and maintain Iron Gate dam (and associated appurtenances), penstocks, turbines, and powerhouse facilities
- Regulate releases from Iron Gate dam in accordance with instream flow and ramping rate requirements (as measured at the USGS gage located 0.5 mile downstream of Iron Gate dam) established in the current Operations Plan[6] for Reclamation's Klamath Irrigation Project and per PacifiCorp's existing FERC license
- Regulate water levels at Keno, J.C. Boyle, Copco, and Iron Gate reservoirs

The mitigation and conservation measures comprising the Sucker Conservation Strategy in this HCP also are Covered Activities. The Sucker Conservation Strategy derives from portions of the USFWS BiOp (USFWS 2007a) that identified reasonable and prudent measures to minimize incidental take of listed suckers associated with the Project. To address the potential influence of interim operation on listed suckers, PacifiCorp has identified several interim conservation measures that are intended to address potential sources of incidental take identified in the USFWS BiOp (USFWS 2008). These selected measures include:

- Shutting down the East Side and West Side developments within 30 days of issuance of the incidental take permit (ITP) to eliminate entrainment and take of listed suckers at these facilities. These facilities will remain substantially shutdown until eventual decommissioning of the facilities.
- Supporting activities to enhance the survival and recovery of listed sucker species by funding additional sucker recovery initiatives during the period extending from shut down of the East Side and West Side developments until the end of the Permit Term.
- Developing and implementing a flow monitoring program to evaluate potential take of suckers at Project facilities,

Detailed descriptions of the above mitigation and conservation measures are provided in Chapter VI (Conservation Program) of this HCP.

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[6] Reclamation released its 2010 Annual Operations Plan on May 6, 2010. The Operations Plan describes expected Project operations from April 1 through March 31 of the year based upon current and expected hydrologic conditions, and consistent with the U.S. Fish and Wildlife Service 2008-2018 Biological Opinion, dated April 2, 2008.

III. Covered Species

This section describes the status, distribution, life history, and habitat requirements of Lost River sucker and shortnose sucker – particularly in relation to the Covered Lands. Additional information on the status of the populations of these species is provided in Chapter IV. As previously defined, Covered Lands include the mainstem Klamath River and reservoirs from Link River dam at the outlet of Upper Klamath Lake down to Iron Gate Fish Hatchery below Iron Gate dam, inclusive.

Lost River and Shortnose Suckers

Legal Status

The Lost River sucker and shortnose sucker were listed as endangered on July 18, 1988 by the USFWS (53 FR 27130). A recovery plan was completed in 1993 (USFWS 1993). A draft revised recovery plan for the Lost River and shortnose suckers was released in 2011 (USFWS 2011). The two species are also on the protected species lists of the states of California and Oregon (CDFG 2004; Oregon Department of Fish and Wildlife [ODFW] 2004). In California, these species were state-listed as endangered in 1974 (CDFG 2004).

Critical habitat for the Lost River sucker and the shortnose sucker was proposed in 1994, but was not finalized (59 FR 61744). Critical habitat was reproposed on December 7, 2011 (76 FR 76337). In the reproposal, two critical habitat units were proposed including: Clear Lake and Gerber Reservoir and their major tributaries, Upper Klamath Lake and parts of the Williamson, Wood, and Sprague River, and the upper Klamath River from Link River dam to Keno dam. The Covered Lands are within the proposed habitat unit consisting of Upper Klamath Lake and the Klamath River. However, areas downstream from Keno dam were not proposed for designation as critical habitat because such areas do not contain physical or biological features essential for the recovery of the species.

Range and Distribution

The current distribution of Lost River sucker and shortnose sucker is Upper Klamath Lake and its tributaries, in one or more of the Klamath River reservoirs below Keno dam, the Lost River and the Tule Lake sumps at the terminus of the Lost River, Clear Lake, and Gerber Reservoir. New genetic information casts some doubt on whether the fish in Gerber Reservoir and Clear Lake are actually shortnose sucker (Tranah and May 2006).

Most of the Lost River sucker and shortnose sucker that occur in the HCP Area are found in Upper Klamath Lake and use the Williamson and Sprague rivers for spawning (along with some spawning in the lake itself). Some individual suckers are found in the Project reservoirs; however, the USFWS BiOp for Project relicensing (USFWS 2007a) indicates that these individual suckers are not part of a large or self-sustaining population due to lack of spawning habitat in the mainstem Klamath River. USFWS (2007a) indicated that these sucker species do not inhabit the Klamath River below Iron Gate reservoir.

In addition to the two listed sucker species, there are two other native sucker species found in the Klamath basin that are not ESA-listed species: the Klamath largescale sucker (*Catostomus snyderi*) and the Klamath smallscale sucker (*Catostomus rimiculus*). The four sucker species are difficult to identify because of similarities in their morphology, particularly in the larval and juvenile life stages. The USFWS's relicensing BiOp (USFWS 2007a) provides a detailed taxonomic description of how the two listed sucker species are differentiated from the Klamath largescale sucker and Klamath smallscale sucker.

Life History and Habitat Requirements

The two listed sucker species are part of a group of suckers that are large, long-lived (Lost River suckers and shortnose suckers have been aged to 43 and 33 years, respectively), late-maturing, and live in lakes and reservoirs but spawn primarily in streams. Collectively, this group of suckers is commonly referred to as lake suckers (National Research Council 2004). 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.

Lost River sucker and shortnose sucker grow rapidly in their first five to six years, reaching sexual maturity sometime between age four and nine for Lost River sucker and age four and six for shortnose sucker (Perkins et al. 2000a). Some females spawn every year, while others spawn only every 2 or 3 years. The majority of Lost River sucker and shortnose sucker spawning occurs in tributaries to Upper Klamath Lake from March to early-May (for Lost River sucker) and early-April to mid-May (for shortnose sucker). Preferred 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). However, some spawning does occur in Upper Klamath Lake in areas associated with springs in the lake. Water temperatures in the Williamson and Sprague Rivers have ranged from 5.5 to 19°C during the spawning period (Golden 1969, Andreasen 1975, Buettner and Scoppettone 1990).

Soon after hatching, sucker larvae move out of the gravel; larvae generally spend relatively little time upriver before passively drifting downstream. However, in 2006, the USFWS did document a large number of larvae 25 to 35 mm in length (J. Hodge, USFWS, pers. comm.) residing in the Sprague River until June. In the Williamson River, larval sucker outmigration from spawning sites begins in April and is generally completed by mid-July. Peak migration occurs in June. Downstream movement generally 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 associated with emergent aquatic vegetation, such as bulrush (Buettner and Scoppettone 1990; Cooperman and Markle 2004). After emigrating from the parental spawning sites in late spring, larval and juvenile Lost River and shortnose suckers inhabited near shore waters, primarily less than 50 cm (19.7 inches) in depth, throughout the summer months (Buettner and Scoppettone 1990). Larval and juvenile suckers were found to occur in greatest frequency at 10 to 60 cm depth (Buettner and Scoppettone 1990). Although dissolved oxygen in Upper Klamath Lake ranged from 1.3 to 20.0 mg/l in sampling during the summer of 1988, juvenile suckers were only found where concentrations were 4.5 to 12.9 mg/l (Buettner and Scoppettone 1990). Few sites with pH values of 9.0 or higher had juvenile suckers (Buettner and Scoppettone 1990).

Juvenile suckers emigrate from Upper Klamath Lake during the July through October period, with a peak in August and September (Gutermuth et al. 1998, 2000a, 2000b; Foster and Bennetts 2006; Tyler 2007). Adult Lost River suckers are generally limited to lake habitats when not spawning, and no large populations are known to occupy stream habitats (USFWS 2002). In contrast, shortnose suckers 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).

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IV. Current Conditions

This section describes the current conditions for species covered in the HCP and begins with a description of the existing facilities in the Project Area. Existing physical environmental conditions on Covered Lands, such as climate and hydrology, are described in following sections, as are the Covered Species and their habitats on Covered Lands, including each species' status and distribution, both regionally and on Covered Lands.

Existing Project Facilities

To summarize, the existing Project consists of eight developments (see Figure 1). Seven are located on the Klamath River between RM 190.1 and 254.3, consisting of (in downstream ascending order) the East Side, West Side, Keno, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate developments. The eighth development is on Fall Creek, a Klamath River tributary at RM 196.3.[7] Detailed descriptions of Project facilities are provided in Section 2.1 of the FEIS and in the USFWS BiOp (2007a, page 9). PacifiCorp's Project operations are described in detail in FERC (2007) and in the 2007 BiOp on the proposed Project relicensing prepared by USFWS (USFWS 2007a). Table 1 summarizes dam, powerhouse, and reservoir information for the seven Project developments located on the Klamath River.

East and West Side Developments

The East Side and West Side developments are located just downstream of Link River dam at the outlet of Upper Klamath Lake at RM 254.3. Link River dam is owned by Reclamation. PacifiCorp operates the dam at Reclamation's direction. Operations at this site include specified flow releases from Link River dam to comply with the 2002, 2008, and 2010 BiOps for operation of Reclamation's Klamath Irrigation Project relating to the listed sucker species in Upper Klamath Lake (USFWS 2002, USFWS 2008) and coho salmon in the Klamath River below Iron Gate dam (NMFS 2002, NMFS 2008, NMFS 2010). PacifiCorp generates electricity at the East Side and West Side facilities using water diverted at Link River Dam.

The East Side facilities consist of: (1) 670 feet of mortar and stone canal; (2) an intake structure; (3) 1,729 feet of 12-foot-diameter, wood-stave flow line; (4) 1,362 feet of 12-foot-diameter, steel flow line; (5) a surge tank; and (6) a powerhouse. Maximum diversion capacity for the East Side powerhouse is 1,200 cubic feet per second (cfs). The West Side development facilities consist of: (1) a 5,575-foot-long concrete-lined and unlined canal; (2) a spillway and discharge structure; (3) an intake; (4) 140 feet of 7-foot-diameter steel penstock; and (5) a powerhouse. The maximum diversion capacity of the West Side powerhouse is 250 cfs. Water at Link River dam either flows over the dam or is diverted to East Side or West Side developments, after which it enters the Link River and flows to Keno reservoir.

[7] There is no evidence that Fall Creek is inhabited by listed suckers or that operation of the Fall Creek facility could result in take of covered sucker species. The Fall Creek facility is described in this HCP because it is part of PacifiCorp's existing Project facilities.

TABLE 1
Dam, Powerhouse, and Reservoir Information for the Existing Klamath Hydroelectric Project Developments
(Sources: PacifiCorp 2008a, 2008b).

Item	East Side and West Side	Keno	J.C. Boyle	Copco No. 1	Copco No. 2	Iron Gate
Dam and Powerhouse Information						
Completion Year	East Side: 1924 West Side: 1908	1967	1958	1918	1925	1962
Dam Location (River Mile)	254.3	233.0	224.7	198.6	198.3	190.5
Dam Height (ft)	---	25	68	126	33	173
Powerhouse Location (River Mile)	East Side: 253.7 West Side: 253.3	None	220.4	198.5	196.8	190.4
Powerhouse (Turbines) Hydraulic Capacity (cfs)	East Side: 1200 West Side: 250	None	3,000	2,962	3,300	1,735
Reservoir Information						
Reservoir Length (miles)	---	22.5	3.6	4.6	0.3	6.2
Maximum Surface Area (acres)	---	2,475	420	1,000	40	944
Maximum Depth (ft)	---	19.5	41.7	115.5	28	162.6
Normal Annual Operating Fluctuation (ft)	---	0.5	5	6.5	NA	4.0
Total Storage Capacity (ac-ft)	---	18,500	3,495	46,867	73	58,794
Active Storage Capacity (ac-ft)	---	495	1,724	6,235	Negligible	3,790
Reservoir Retention Time (days)						
At 710 cfs	---	13	2.5	32	0.052	42
At 1,500 cfs (near average)	---	6	1.2	15	0.025	20
At 3,000 cfs	---	3	0.6	8	0.012	10

Maintenance at this facility consists of gate repairs, powerhouse maintenance, and vegetation control in and around the dam and flow lines, and dam structural repairs. The frequency of such maintenance is dependent upon the maintenance schedule for each piece of equipment and maintenance associated with equipment repairs. Maintenance is also determined by the FERC in their annual facility inspections under CFR 18, Part 12D, Annual Facility Safety Inspections.

Keno Development

The Keno development is a regulating facility owned by PacifiCorp that controls the water level of the Klamath River at Keno dam (RM 233), creating Keno reservoir, an impoundment that extends 22.5 miles upstream[8]. The normal maximum water surface of Keno reservoir is at elevation 4,086.5 feet. Keno reservoir has a surface area of 2,475 acres at elevation 4,085 feet and a total storage capacity of 18,500 acre-feet.

PacifiCorp currently operates Keno dam under an agreement with Reclamation, the execution of which was required by article 55 of PacifiCorp's existing FERC license. According to a 1968 contract between PacifiCorp and Reclamation for the operation of Keno reservoir, the reservoir must be maintained at a stable water level between elevations 4,085.0 and 4,086.5 feet. Maintenance of a stable water level in Keno reservoir facilitates consistent water delivery to dependent water users. Gravity flow from Keno reservoir provides water either directly or indirectly to about 41 percent of the lands irrigated by Reclamation's Klamath Irrigation Project and the Lower Klamath Lake National Wildlife Refuge.

The Keno Development does not include power-generating equipment. Keno dam includes a 24-pool weir and orifice-type fish ladder that gains 19 feet in elevation over a length of 350 feet. The ladder was designed originally to pass trout and other resident fish species; however, the ladder may present an impediment to passage by listed suckers (USFWS 2007a).

Maintenance at this facility consists of fish ladder repairs, gate maintenance, reservoir boom repairs, vegetation control in and around the dam and flow lines, and dam structural repairs. The frequency of such maintenance is dependent upon the maintenance schedule for each piece of equipment and maintenance associated with equipment repairs. Maintenance is also determined by the FERC in their annual facility inspections under CFR 18, Part 12D, Annual Facility Safety Inspections.

J.C. Boyle Development

The J.C. Boyle development consists of a reservoir, a combination embankment and concrete dam, a screened intake structure and water conveyance system, a fish ladder designed to pass trout, and a powerhouse on the Klamath River between about RM 228.3 and 220.4. J.C. Boyle dam impounds a narrow reservoir of 420 surface acres (J.C. Boyle reservoir) from RM 228.3 to 224.7. The reservoir contains approximately 3,495 acre-feet of total storage capacity and 1,724 acre-feet of active storage capacity.

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[8] The impounded portion of the Klamath River upstream of Keno dam also includes Lake Ewauna (the wider, 2-mile-long upstream-most portion of the impoundment).

The J.C. Boyle intake structure is a 40-foot-high reinforced concrete tower. Water at J.C. Boyle dam either flows through the intake and enters the water conveyance system and then the powerhouse or is discharged back into the Klamath River. J.C. Boyle dam includes an approximately 569 foot long pool and weir fishway for upstream fish passage. Flow into the ladder is approximately 80 cfs. A 24-inch-diameter fish screen bypass pipe provides about 20 cfs of flow below the dam.

The J.C. Boyle powerhouse is located at RM 220.4, approximately 4 miles downstream of the dam. The powerhouse contains two vertical-Francis turbines, each with a rated discharge of 1,425 cfs. The reach between the dam and powerhouse is referred to as the J.C. Boyle bypass reach. Substantial groundwater enters the J.C. Boyle bypass reach starting about 0.5 mile downstream of the dam. The average accretion in the bypass reach is between 220 and 250 cfs and is relatively constant on a seasonal basis (FERC 2007). From the powerhouse, river flows pass through a 17.3-mile-long reach referred to as the J.C. Boyle peaking reach, before entering Copco No. 1 reservoir at RM 203.1.

Maintenance at this facility consists of fish screen and ladder repairs, spill gate and intake gate maintenance, reservoir boom repairs, vegetation control in and around the dam and flow lines, dam structural repairs, water conveyance canal and flow line maintenance, and power house maintenance. The frequency of such maintenance is dependent upon the maintenance schedule for each piece of equipment and maintenance associated with equipment repairs. Annual maintenance is performed typically on the powerhouse. Its duration is limited to the breadth of the need. Maintenance is also determined by the FERC in their annual facility inspections under CFR 18, Part 12D, Annual Facility Safety Inspections. Every five years the FERC requires a full open test be performed on the dam spill gates, demonstrating the project’s ability to manually open the gates for spill in the event of an emergency condition.

Copco No. 1 Development

The Copco No. 1 development consists of a reservoir, dam, spillway, intake, and outlet works and powerhouse located on the Klamath River between RM 203.1 and 198.6 near the Oregon-California border. Copco No. 1 dam impounds a reservoir of 1,000 surface acres (Copco reservoir[9]) from RM 198.6 to 203.1. Copco reservoir contains approximately 33,724 acre-feet of total storage capacity at elevation 2,607.5 feet and approximately 6,235 acre-feet of active storage capacity. The normal maximum and minimum operating levels of the reservoir are at elevations 2,607.5 and 2,601.0 feet, respectively. The Copco No. 1 powerhouse is located at the base of the dam. The two turbines are double-runner, horizontal-Francis units, each with a rated discharge of 1,180 cfs. Water at Copco No. 1 dam passes directly into Copco No. 2 reservoir, either via the powerhouse or spillage.

Maintenance at this facility consists of gate maintenance, reservoir boom repairs, vegetation control in and around the dam and flow lines, dam structural repairs, and power house maintenance. The frequency of such maintenance is dependent upon the maintenance schedule for each piece of equipment and maintenance associated with equipment repairs.

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[9] The Copco No. 1 reservoir is also commonly known as “Copco reservoir”, and is distinct from the relatively small Copco No. 2 reservoir further downstream.

Annual maintenance is performed typically on the powerhouse. Its duration is limited to the breadth of the need. Maintenance is also determined by the FERC in their annual facility inspections under CFR 18, Part 12D, Annual Facility Safety Inspections. Every five years the FERC requires a full gate open test performed, demonstrating the project's ability to manually open the gates for spill in the event of an emergency condition.

Copco No. 2 Development

The Copco No. 2 development consists of a relatively short diversion dam and small impoundment just downstream of Copco No. 1 dam, a water conveyance system, and a powerhouse located on the Klamath River between RM 198.6 and 196.9. The reservoir is about 0.25 miles long and has a relatively small storage capacity of 73 acre-feet.

The Copco No. 2 powerhouse is located approximately 1.4 miles downstream of the diversion dam at RM 196.9. The powerhouse is a reinforced concrete structure that houses two vertical-Francis turbines. Each turbine has a rated discharge of 1,338 cfs. The reach between the diversion dam and powerhouse is referred to as the Copco No. 2 bypass reach. Water at Copco No. 2 dam either enters the flow conduit to the Copco No. 2 powerhouse or the Copco No. 2 bypassed reach, after which it enters Iron Gate Reservoir.

Maintenance at this facility consists of gate facility maintenance, boom repairs, vegetation control in and around the dam, dam structural repairs, and power house maintenance. The frequency of such maintenance is dependent upon the maintenance schedule for each piece of equipment and maintenance associated with equipment repairs. Annual maintenance is performed typically on the powerhouse. Its duration is limited to the breadth of the need. Maintenance is also determined by the FERC in their annual facility inspections under CFR 18, Part 12D, Annual Facility Inspections.

Fall Creek Development

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 the mouth of Fall Creek in the upper end of Iron Gate reservoir.

Maintenance at this facility consists of vegetation control in and around the dam, dam structural repairs, and power house maintenance. The frequency of such maintenance is dependent upon the maintenance schedule for each piece of equipment and maintenance associated with equipment repairs. Annual maintenance is performed typically on the powerhouse. Its duration is limited to the breadth of the need. Maintenance is also determined by the FERC in their annual facility inspections under CFR 18, Part 12D, Annual Facility Safety Inspections.

Iron Gate Development

The Iron Gate development consists of a reservoir, an earth embankment dam, spillway, intake, and outlet works and powerhouse located on the Klamath River between RM 196.9 and 190.1, approximately 20 miles northeast of Yreka, California. Iron Gate dam impounds a reservoir of 944 surface acres (Iron Gate reservoir) from RM 190.1 to 196.9 that contains about 50,941 acre-feet of total storage capacity (at elevation 2,328.0 feet) and 3,790 acre-feet of active storage capacity. The Iron Gate powerhouse is located at the base of the dam. The Iron Gate powerhouse consists of a single vertical Francis turbine. The turbine has a rated discharge capacity of 1,735 cfs.

Maintenance at this facility consists of gate and tunnel repairs, powerhouse maintenance, vegetation control in and around the dam and flow lines, and dam structural repairs. The frequency of such maintenance is dependent upon the maintenance schedule for each piece of equipment and maintenance associated with equipment repairs. Maintenance is also determined by the FERC in their annual facility inspections under CFR 18, Part 12D, Annual Facility Safety Inspections.

Climate

The Klamath River runs a course approximately 260 miles in length from Upper Klamath Lake in Oregon to the mouth of the river at the Pacific Ocean near Requa, California. The Klamath River Basin lies in the transition zone between the Modoc Plateau and Cascade Range physiographic provinces, with the Klamath River cutting west through the Klamath Mountain province and then the Coast Range province. The high elevation, semi-arid desert environment of the Modoc Plateau in the upper part of the Basin receives an average of about 15 inches of precipitation annually. With its porous volcanic geology and relatively moderate topography, runoff is slow, and there are relatively few streams compared to downstream provinces.

The transition from the Modoc Plateau to the Cascade Range province is subtle; the Klamath River enters the Cascade Range province roughly in the area below Keno dam. The portion of the Cascade Range province included in the Klamath River watershed is largely in the rain shadow of Mt. Shasta and the Klamath Mountains; precipitation is highly variable by elevation and location.

Temperatures in the Project area range from below freezing during the winter to over 100 degrees Fahrenheit (°F) during the summer. The higher elevation, upstream parts of the Project area, including the East Side, West Side, Keno, and J.C. Boyle developments, are generally cooler than the downstream Iron Gate and Copco development areas.

Precipitation occurs mostly during the late fall, winter, and spring and is mostly in the form of snow above elevations of 5,000 feet. Average yearly precipitation varies greatly with elevation and location and ranges from about 10 to more than 50 inches. Annual precipitation in Klamath Falls at the upper end of the Klamath River is 13.3 inches. Average annual precipitation is 18.2 inches at Copco No. 1 reservoir. Precipitation occurs primarily as rain, mostly during the fall and winter, with occasional afternoon thunderstorms occurring in the summer. Snow often occurs during winter, particularly in the higher elevations (i.e., above the canyon rim and east to Klamath Falls)

Historically, annual precipitation patterns define distinct dry and wet cycles that are closely related to runoff in the Klamath River. Stream flows normally peak during the late spring and/or early summer from snowmelt runoff. Low flows within this watershed typically occur during the late summer or early fall, after the snowmelt and before the runoff from the fall storms moving in from the Pacific Ocean.

Hydrology and River Flow Management

Natural Hydrology

The Klamath Basin's hydrologic system consists of a complex of inter-connected rivers, lakes, marshes, reservoirs, diversions, and canals. Upper Klamath Lake is the dominant feature of the upper part of the Klamath River Basin. Upper Klamath Lake receives most of its water from the Williamson and Wood rivers (NRC 2004). The Williamson River watershed consists of two subbasins drained by the Williamson and Sprague rivers, which together provide about 75 percent of the drainage area to Upper Klamath Lake. The Sycan River, a major tributary to the Sprague, drains much of the northeastern portion of the watershed. The Wood River drains an area northeast of Upper Klamath Lake extending from the southern base of the eastern slopes of the Cascade Mountains near Crater Lake to its confluence with the northern arm of Upper Klamath Lake, which is often referred to as Agency Lake. The balance of the water reaching Upper Klamath Lake is derived from direct precipitation and groundwater that flows from springs, small streams, irrigation canals, and agricultural returns. In addition, a relatively large set of springs discharges about 220 to 250 cfs into the Klamath River beginning about 0.5 miles downstream from J.C. Boyle dam.

Alterations to the Basin's natural hydrologic character began in the late 1800s, accelerating in the early 1900s, including construction and operation of Reclamation's Klamath Irrigation Project. The Klamath Irrigation Project includes facilities to divert, store, and distribute water for irrigation, National Wildlife Refuges, and control of floods in the basin. The Klamath Irrigation Project's diversion of stored water occurs year-round, but primarily occurs from early April through mid-October in support of irrigated crop lands. Water is diverted from Upper Klamath Lake at Link River dam through "A" Canal, and also is diverted from the Klamath River through the North Canal, Ady Canal, and the Lost River Diversion Channel. A portion of the diverted water is returned to the Klamath River through Reclamation's Lost River Diversion Channel and the Klamath Straits Drain (see Figure 1).

Reclamation is responsible for management of flow volumes in the upper Klamath River, including flows that both enter (from Upper Klamath Lake at Link River dam at RM 254) and exit (from Iron Gate dam at RM 190.5) the area occupied by PacifiCorp's Project developments. Reclamation also manages Upper Klamath Lake elevations to meet ESA requirements and contractual irrigation demands of the Klamath Irrigation Project. Upper Klamath Lake has a total storage capacity of 873,000 acre feet and an active storage capacity of 465,000 acre feet. Thus, PacifiCorp's reservoirs on the mainstem of the Klamath River provide about 17 percent of the total water storage of the Klamath River, and about 3 percent of active storage.

Downstream of Link River dam, surface water volumes are largely controlled by Reclamation operations. Because Reclamation's flow release requirements are met at Iron Gate dam, accretions from tributaries and naturally-occurring springs upstream of Iron Gate are generally managed and included within Reclamation's minimum flow requirements at Iron Gate. Operation of PacifiCorp's Project facilities therefore does not generally affect flow volumes in the Klamath River, but can affect rates of change in flows on a short-term basis (i.e., hourly, daily) due to flow ramping during powerhouse start-up or shut-off and seasonal spillway use.

Reservoir and Lake Elevations

Keno Reservoir

Keno reservoir is relatively shallow (average depth of 7.5 feet) and long (22.5 miles), and receives most of its water from Upper Klamath Lake via Link River. Substantial quantities of water are also diverted from, and discharged to, Keno reservoir from four facilities managed by Reclamation, including the Lost River diversion channel, North Canal, Klamath Straits Drain, and the Ady Canal. In addition to these four Reclamation facilities, there are numerous smaller water permits and claims along Keno reservoir, mostly for irrigation on adjacent privately owned agricultural lands (FERC 2007).

An agreement between PacifiCorp and Reclamation specifies that the maximum water surface elevation of Keno reservoir remains relatively constant most of the year. However, about every one or two years, aside from the agreement with Reclamation and 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.

J.C. Boyle Reservoir

J.C. Boyle reservoir is a relatively small mainstem reservoir in terms of area (420 acres) and volume (3,495 acre-feet of total storage capacity). As such, inflow has a comparatively short residence time in J.C. Boyle reservoir; that is, on the order of 1 to 2 days during average flow conditions (FERC 2007). The normal range between maximum and minimum elevations of J.C. Boyle Reservoir is 5 feet. Under typical peaking operations, the reservoir fluctuates about 3.5 feet, while average daily fluctuations are approximately 1 to 2 feet.

Copco Reservoirs

Copco No. 1 reservoir is substantially larger than the two upstream reservoirs (Keno and J.C. Boyle) with much greater total storage capacity (33,724 acre-feet) and active storage volume (6,235 acre-feet). Water levels in Copco No. 1 reservoir are normally maintained within 6.5 feet of full pool (elevation 2,607.5 feet) and daily fluctuations in reservoir water levels of about 0.5 foot are due to peaking operation of the Copco No. 1 powerhouse and variance in the inflow from the J.C. Boyle peaking reach (PacifiCorp 2004b; FERC 2006). Maximum daily fluctuations up to 3.0 feet can occur, but on rare occasions.

Copco No. 2 reservoir has virtually no storage. The Copco No. 2 powerhouse (maximum hydraulic capacity of the flow line is 3,200 cfs) acts as a virtual slave to discharges from Copco No. 1 and the water level within Copco No. 2 reservoir rarely fluctuates more than several inches.

Iron Gate Reservoir

Water levels in Iron Gate reservoir are normally maintained within 4 feet of the full pond (elevation 2,328.0 feet) resulting in an active storage volume of 3,790 acre-feet. Daily water level fluctuations within Iron Gate reservoir due to upstream peaking operations are about 0.5 foot.

Release Flows

Link River Dam

Water flows out of Upper Klamath Lake either through Reclamation's A Canal, PacifiCorp's East and West Side development canals, or through Link River dam. Flows from the East and West Side powerhouses are released back into the Link River at the powerhouse locations 0.6 and 1.0 miles, respectively, downstream of Link River dam. PacifiCorp's operation of the East Side and West Side developments enables some degree of control over discharges from Link River dam because a shutdown of one or both developments results in an increase in flow released at the dam through the spillway.

Target minimum flows at the Link River dam are outlined in Reclamation (2011). Adhering to the minimum flows (and ramping rates as discussed later in this chapter) as monitored at the Link River gauge (USGS 11507500) reduces the risk of fish stranding. The target minimum flows are 200 cfs from December 1 through February 14, 250 cfs from February 15 through end of February, and 300 cfs from March 1 through November 30. Reclamation routinely coordinates with USFWS, ODFW, and PacifiCorp on flow monitoring, and plans and procedures for Link River fish stranding prevention and response (Reclamation 2011).

Keno Dam

The minimum flow requirement below Keno dam is 200 cfs per a cooperative agreement with ODFW, and PacifiCorp must notify ODFW if flow is expected to be less than 250 cfs (PacifiCorp 2004b). However, minimum flows below Keno dam have generally been considerably higher than 250 cfs since 2002 due to minimum flow requirements placed on Reclamation at Iron Gate dam for threatened coho salmon (NMFS 2002, 2008).

J.C. Boyle Dam

PacifiCorp's current FERC-required minimum flow release from J.C. Boyle dam to the J.C. Boyle bypass reach (i.e., the reach of the Klamath River between J.C. Boyle dam and powerhouse) is 100 cfs, consisting of 80 cfs from the fish ladder and 20 cfs from the juvenile fish bypass system. This flow combines with 220 to 250 cfs of continuous spring flow to create a minimum flow of 320 to 350 cfs in the J.C. Boyle bypass reach. Spillage at the dam typically occurs only when river flows exceed the capacity of the J.C. Boyle powerhouse and the instream flow requirements. Spillage at the dam, if it occurs, would happen during the higher flow months of January through May.

Under current operations, the J.C. Boyle powerhouse is run in a power peaking mode when inflow to J.C. Boyle reservoir is below 2,500 cfs. In this mode, inflowing water to the reservoir is typically stored at night and then diverted to the powerhouse to operate the turbines for a portion of the following day to meet peak daytime energy demand. When inflow to J.C. Boyle reservoir is above 2,450 cfs, the powerhouse typically operates continuously. Spill also occurs from the dam as inflowing water to the reservoir climbs above 2,450 cfs. Studies conducted on instream flows and ramp rates in the J.C. Boyle bypass reach during the relicensing process were based on J.C. Boyle powerhouse flows of up to 3,000 cfs, with corresponding continuous operation and spill at approximately 2,950 cfs. Studies were conducted analyzing this powerhouse flow in anticipation of authorization to increase hydraulic flow at J.C. Boyle from 2,500 cfs to 3,000 cfs, as a result of planned powerhouse upgrades that were completed in 2006. The environmental effects of bypass flows and ramp rates based on 3,000 cfs powerhouse flows at J.C. Boyle were analyzed in the FEIS for proposed project relicensing (FERC 2007).

The flows that are released to the Klamath River from J.C. Boyle powerhouse during peaking operations are ramped up to either one turbine operation (up to 1,500 cfs) or two turbines operation (up to 2,500 cfs). When generation is not occurring at the J.C. Boyle powerhouse (and J.C. Boyle dam is not spilling), typical non-generation base flows in the J.C. Boyle peaking reach (i.e., the reach of the Klamath River between J.C. Boyle powerhouse and Copco reservoir) are about 320 to 350 cfs, consisting of the 100 cfs minimum flow release from J.C. Boyle dam and the accretion of 220 to 250 cfs of spring flow in the upstream J.C. Boyle bypass reach.

Copco No. 2

There is currently no minimum flow requirement in the Copco No. 2 bypass reach, but PacifiCorp maintains a constant release to the 1.4-mile-long reach of 5 to 10 cfs via a 24-inch-diameter pipe at the dam. Discharge from Copco No. 2 powerhouse enters the upper reaches of the Iron Gate reservoir.

Fall Creek

PacifiCorp operates a small diversion dam on Spring Creek that diverts up to 16.5 cfs into Fall Creek, and another dam on Fall Creek that diverts flow into a canal and penstock system leading to the Fall Creek powerhouse. The diversion dam on Fall Creek diverts up to 50 cfs of flow that bypasses 1.2 miles of a very steep gradient section of Fall Creek, leading to the Fall Creek powerhouse. The Project's current FERC license requires minimum flows of 0.5 cfs below the Fall Creek diversion and 15 cfs (or natural stream flow, whichever is less) downstream of the powerhouse.

Ramping Rates

Hydroelectric facilities typically have the capability of increasing and decreasing flow levels downstream of the facilities. In general, the rate at which these changes occur is called the "ramp rate" or "ramping." "Upramping" occurs when flows are increased and "downramping" occurs when flows are decreased.

Link River Dam

Target ramp rates at the Link River dam are outlined in Reclamation (2011). Adhering to the ramp rates (and minimum flows as discussed above) as monitored at the Link River gauge (USGS 11507500) reduces the risk of fish stranding. The target ramp rates are 20 cfs per 5 minute for flow releases up to 300 cfs, 50 cfs per 5 minute for flow releases from 301 to 500 cfs, and 100 cfs per 5 minute for flow releases from 501 to 1500 cfs. There are no ramping rates for Link River dam when flows exceed 1500 cfs. Reclamation routinely coordinates with USFWS, ODFW, and PacifiCorp on ramp rate monitoring, and plans and procedures for Link River fish stranding prevention and response (Reclamation 2011).

If circumstances were to occur that result in flows below minimums and flow reductions outside of the prescribed ramping rates, Reclamation would conduct a fish stranding assessment as soon as practical as described in Reclamation (2011). The stranding assessment would include, at minimum, deployment of a field crew to conduct an on-site survey of the margins of the Link River. If stranded fish are observed during the assessment, then the field crew may salvage the stranded fish, or determine if additional effort is necessary to salvage stranded fish. If additional fish salvage effort is necessary, Reclamation will notify the USFWS, ODFW, and PacifiCorp to assist in salvage operations. Salvage will consist of capturing fish from disconnected pools and channels using electrofishers, seines, or dip nets, and returning fish to either the main channel of the Link River when sufficient water is present or to Upper Klamath Lake.

If stranding incidents occur, an incident report would be prepared by Reclamation. A draft incident report would be provided to the USFWS, ODFW, and PacifiCorp within two weeks of the incident, and a final incident report within four weeks. In addition, prior to April 1 each year, Reclamation will coordinate an annual meeting with USFWS, ODFW, and PacifiCorp to discuss any needed changes and updates to the Link River fish stranding prevention and salvage plan (Reclamation 2011).

PacifiCorp operations account for a small portion of the potential impacts during the rare ramping of the Link River that may occur during the start up or shut down of East and West Side powerhouses (East Side and West Side powerhouses start up and shut down about four times per year), or when power load at these two facilities change as a result of rare and unplanned outages that occur, on average, less than once per year. Implementation of the Link River fish stranding prevention and salvage plan (Reclamation 2011) relative to ramp rates at Link River dam will help insure more consistent coordination between PacifiCorp and Reclamation, and it will avoid conflicting operational requirements that make compliance and Project management difficult to maintain.

Keno Dam

As noted above, areas downstream from Keno dam were not proposed for designation as critical habitat because such areas do not contain physical or biological features essential for the recovery of sucker species.

PacifiCorp has implemented a voluntary ramp rate below Keno dam to minimize potential stranding (PacifiCorp 2004b). The ramping rate below Keno dam is set at no more than 9 inches per hour.

J.C. Boyle Bypass and Peaking Reaches

Although ramp rates in the J.C. Boyle bypass reach are not a specific condition of the existing FERC license, PacifiCorp follows a ramp rate of approximately 9 inches per hour based on incremental flow changes made at J.C. Boyle dam of 135 cfs per 10 minutes (PacifiCorp 2004c). Down-ramping in the J.C. Boyle bypass reach typically does not occur for power production purposes. Therefore, down-ramping is done primarily when coming off of spill mode or a maintenance event. Although spill occurs about 16 percent of the time during the year (mostly winter and early spring), down-ramping in the bypass reach occurs about 10 percent of the time of spill (PacifiCorp 2004c). Therefore, down-ramping in the bypass reach occurs only 1.6 percent of the total time in a year on average. The FERC ramp rate requirement in the J.C. Boyle peaking reach (between J.C. Boyle powerhouse and Copco No. 1 reservoir) is 9 inches per hour for both up-ramping and down-ramping (as measured at USGS gauging station 11510700 located approximately 0.6 mile downstream of J.C. Boyle powerhouse). Sudden down-ramping in excess of 9 inches per hour in the peaking reach can occur infrequently (2 to 5 times per year) as a result of unit trips at the J.C. Boyle powerhouse caused by transmission line disturbances due to storms or other unforeseen events beyond PacifiCorp's operational control.

Copco No. 1 and Copco No. 2

There are no required instream flows or ramp rates below Copco No. 1 or for the 1.5-mile-long Copco No. 2 bypass reach (between Copco No. 2 dam and powerhouse). However, PacifiCorp currently releases a constant minimum flow of 5 to 10 cfs to the Copco No. 2 bypass reach as a standard operational practice. Because water levels between Copco No. 1 and Copco No. 2 rarely fluctuate more than a few inches, ramping of flows in the Copco No. 2 bypass 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. Because Copco No. 2 powerhouse discharges into the head of Iron Gate reservoir, there are no ramp rates for the Copco No. 2 powerhouse.

Water Quality

Water quality conditions in the Klamath River vary substantially along the approximately 250 river miles from Upper Klamath Lake to the estuary at the Pacific Ocean. The Klamath River's water quality is also unique in that impairment is greatest near the river's source – Upper Klamath Lake – and generally improves as water flows downstream towards the estuary. In most river systems, water quality is best at the source and tends to degrade as water flows downstream. The primary reason for this unique condition is that Upper Klamath Lake has excessive concentrations of nutrients such as nitrogen and phosphorous (i.e., is "hypereutrophic"), which result in periods when very large algal blooms form and subsequently collapse (particularly from May through September), causing large reductions in dissolved oxygen and high pH (Walker 2001). The large quantities of nutrients, algae, and organic matter discharged from the lake have a dramatic effect on conditions in downstream river reaches, including impairments related to algal production, dissolved oxygen, and pH. As a result, the quality of the water flowing from Upper Klamath Lake is the key "driver" that dictates water quality throughout the Klamath River. Additional information on water quality conditions in Upper Klamath Lake is provided in the section that follows.

The six dams on the Klamath River downstream of Upper Klamath Lake – Link River, Keno, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate (the latter five which are owned and operated by PacifiCorp) – directly affect how long it takes for water to travel from Upper Klamath Lake to the estuary (except for Copco No. 2 dam, which has a small reservoir and does not appreciably affect water travel time). The transit time of waters released from Upper Klamath Lake to the estuary (as well as water released from the Klamath Irrigation Project to the river between Upper Klamath Lake and Keno dam) is about 1 to 2 months or more, except during high winter flow conditions when the transit time may be reduced to as little as 2 weeks. If no dams were in place, transit time from Upper Klamath Lake (Link

River dam) to the estuary would be about a week during summer periods and less during winter high flow events. The dams increase the time it takes water to travel through the upper 65 miles of the river between Link River and Iron Gate, which allows settling and retention of nutrients and organic matter and processing of impaired quality water from Upper Klamath Lake. For example, Asarian et al. (2010) concluded that nutrient retention in Copco and Iron Gate reservoirs reduces total phosphorus (TP) concentrations by approximately 2–12 percent for the June–October period, and total nitrogen (TN) concentrations by 37–42 percent for June–October period, compared to concentrations that would be expected in the absence of these reservoirs. The dams also create quiescent water conditions in impounded reservoirs, which can promote seasonal algae production.

The following is a summary of current water quality conditions of the Klamath River system from Upper Klamath Lake to Iron Gate reservoir, within which the Covered Activities and Covered Species addressed in this HCP occur. Water quality constituents discussed include water temperature, nutrients and algae production, dissolved oxygen, and pH, because these constituents may be affected by Project activities and are most directly related to effects on biological resources, including suckers. Other constituents such as toxics (metals and pesticides), sediment oxygen demand, and water clarity, which are unlikely to be affected by PacifiCorp's covered activities, are not discussed here. The following sections are organized by discrete reaches that are defined by existing facilities (e.g., reservoirs, river reaches) and physical conditions. Although Upper Klamath Lake is upstream of PacifiCorp's Project facilities and is not affected by the Project's operations, the lake's water quality is discussed here because of its importance as inflow or "boundary" conditions to water quality within and downstream of the Project.

Upper Klamath Lake

Upper Klamath Lake is a large (121 mi^2), shallow (mean depth about 7.8 feet) lake that is geologically old (Johnson et al. 1985). Sediment core studies indicate that Upper Klamath Lake was a naturally productive lake historically as indicated by high nutrient concentrations (particularly phosphorus) for the last thousand years (Eilers et al. 2001). Additional analysis of sediment cores suggests that Upper Klamath Lake water quality has changed substantially over the past 100 years as consumptive water use practices (e.g., irrigation, municipal uses, wetland diking and draining [i.e., conversion of wetlands to agricultural land]) and accompanying changes in land use practices throughout the upper Klamath and Lost River watersheds have increased (Walker 2001). Specifically, it appears that mobilization of phosphorus from agriculture and other nonpoint sources has pushed the lake from a naturally eutrophic state into its current hypereutrophic state, allowing algal blooms to reach or approach their theoretical maximum (Walker 2001).

Low dissolved oxygen and high pH values have been linked to high algal productivity in Upper Klamath Lake (Kann and Walker 2001; Walker 2001). Chlorophyll *a* concentrations exceeding 200 µg/L are frequently observed in the summer months (Kann and Smith, 1993). Algal blooms are accompanied by violations of Oregon's water quality standards for dissolved oxygen, pH, and free ammonia. The very large algae blooms in Upper Klamath Lake are strongly dominated by the single blue-green algal species *Aphanizomenon flos-aquae* (cyanobacteria) rather than taxa that apparently dominated blooms before increased nutrient enrichment (Kann 1998; Eilers et al. 2001).

Some blue-green algal species (cyanobacteria), particularly *Microcystis*, are capable of producing toxins. In 2007, VanderKooi et al. (2010) detected microcystin, a hepatotoxin (liver toxin), both in samples of the particulate material from Upper Klamath Lake and dissolved in lake water. VanderKooi et al. (2010) also found evidence of exposure of juvenile suckers in Upper Klamath Lake to microcystin. Gut analysis on juvenile sucker specimens showed that the specimens had ingested chironomid larvae, and that these chironomid larvae in turn had colonies of *Microcystis* in their digestive tracts. Gastro-intestinal lesions were observed that were consistent with potential exposure to microcystin. VanderKooi et al. (2010) indicated that the likely route of exposure to microcystin was an oral route through the food chain, rather than exposure to dissolved toxins at the gills.

Link River

The Link River reach is approximately 1.2 miles in length between Link River dam (the outlet of Upper Klamath Lake at RM 254.6) and the headwaters of Keno reservoir (Lake Ewauna). Link River is very short and water travels through the reach in a short time. The reach passes material from Upper Klamath Lake to Keno reservoir with little or no change.

Water temperatures in Link River are determined by the temperature conditions in Upper Klamath Lake. Over the course of a year, releases at Link River dam range in temperature from near zero degrees Celsius in winter periods to over 25° C in summer periods. Because Upper Klamath Lake is shallow, the release temperatures generally reflect variations in local meteorological conditions.

Levels of nitrogen and phosphorous in Link River also are determined by conditions in Upper Klamath Lake. Overall, the nutrient load from Upper Klamath Lake remains largely unchanged through the short Link River reach. The organic matter (both living [e.g., algae] and dead) represents a considerable nutrient pool. During the warmer periods of the year, nutrient availability varies with the standing crop of phytoplankton in Upper Klamath Lake. During bloom conditions, inorganic nutrient concentrations (e.g., NH_4, NO_3, PO_4) may be low, while post-bloom conditions may result in higher inorganic nutrient concentrations. During the late fall through early spring, short days, limited light, and cold water temperatures result in low levels of primary production. Although nutrients are available, demand is low.

Dissolved oxygen conditions in the Upper Klamath Lake outflow at Link River dam vary throughout the year. During winter months when temperatures and primary production are low, the dissolved oxygen levels remain close to saturation.[10] During the warmer period of the year, when primary production plays a determinative role, the diurnal range and short-term variation is considerable. Dissolved oxygen concentrations range from less than 2 milligrams per liter (mg/L) to more than 14 mg/L (PacifiCorp 2008a). Because the Link River includes several riffles, there is the opportunity for natural physical reaeration (mechanical reaeration) to occur within this reach.

[10] Saturation dissolved oxygen concentration is the theoretical value where concentration of dissolved oxygen in the water column is in equilibrium with the partial pressure of oxygen in the atmosphere. It is temperature and elevation dependent (Bowie et al. 1985).

Generally, the alkalinity of Upper Klamath Lake at Link River dam is between 40 and 60 mg/L, indicating a weak buffering capacity (EPA 1987). A weakly buffered system is predisposed to fluctuations in pH if sufficient primary production occurs (Horne and Goldman 1994). At Link River dam, pH values range from 7.0 to 8.0 during winter periods, while during periods when significant primary production occurs, pH values typically range from 8.0 to 10.0. Alkalinity and pH are generally unchanged from the upstream end to the downstream end of this reach. Values above 8.5 to 9.0 can lead to ammonia toxicity if sufficient levels of ammonia are present (Colt et al. 1979; EPA 1984).

Keno Reservoir

Upstream from Keno dam, Keno reservoir has been proposed as critical habitat for sucker species. Keno reservoir extends from the headwaters of Lake Ewauna (RM 253.4) to Keno dam (RM 233.3). The impoundment is generally a broad, shallow body of water. The width of the reach ranges from several hundred to over 1,000 feet, with maximum depths along its length ranging from less than 6 feet to approximately 20 feet (see Table 1). Municipal, industrial, and agricultural activities are located along this reach (ODEQ 1995; Reclamation 1992).

Annual water temperatures in Keno reservoir range from near zero degrees Celsius to more than 25°C and are at or near equilibrium temperatures,[11] reflecting local meteorological conditions and the fact that Upper Klamath Lake is generally at or near equilibrium. The reservoir freezes in some winters. Water temperatures of reservoir inflows are similar to water temperatures of reservoir outflows. Keno reservoir does not experience seasonal thermal stratification, but exhibits weak, intermittent temperature gradients during summer periods. The net effect of Keno reservoir on water temperature is minimal, with inflow temperatures similar to outflow temperatures.

Dissolved oxygen conditions vary seasonally in Keno reservoir. Conditions during winter and early spring result in near saturation values for dissolved oxygen, while during the rest of the year dissolved oxygen values typically remain well under saturation. In fact, a particularly notable aspect of the water quality conditions in Keno reservoir is persistent anoxia during summer and early fall. This severe impairment has lead to extensive fish die-offs, such as in 2005 (PacifiCorp 2008a). Although the impacts of anthropogenic inputs are notable, and legacy impacts are present, the primary source of this anoxia is the very large organic matter influx from Upper Klamath Lake. This creates substantial oxygen demand, which combines with other sources of oxygen demand (in-reservoir phytoplankton mortality; influent from municipal, industrial, and agricultural sources; nitrogenous biochemical processes; and organic matter in reservoir sediments) to produce persistent anoxic conditions in the reservoir during summer and into fall. Low dissolved oxygen concentrations persist well into October and may extend into November. Figure 2 shows dissolved oxygen isopleths in Keno reservoir for example dates in May, July, and October 2005, which depict the timing and magnitude of the reservoir's low dissolved oxygen conditions.

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[11] Equilibrium water temperature is the water temperature for a given set of meteorological conditions (Martin and McCutcheon, 1999). It is somewhat of a theoretical concept because of constantly changing meteorological conditions, but is nonetheless useful when considering water temperature conditions on a conceptual basis.

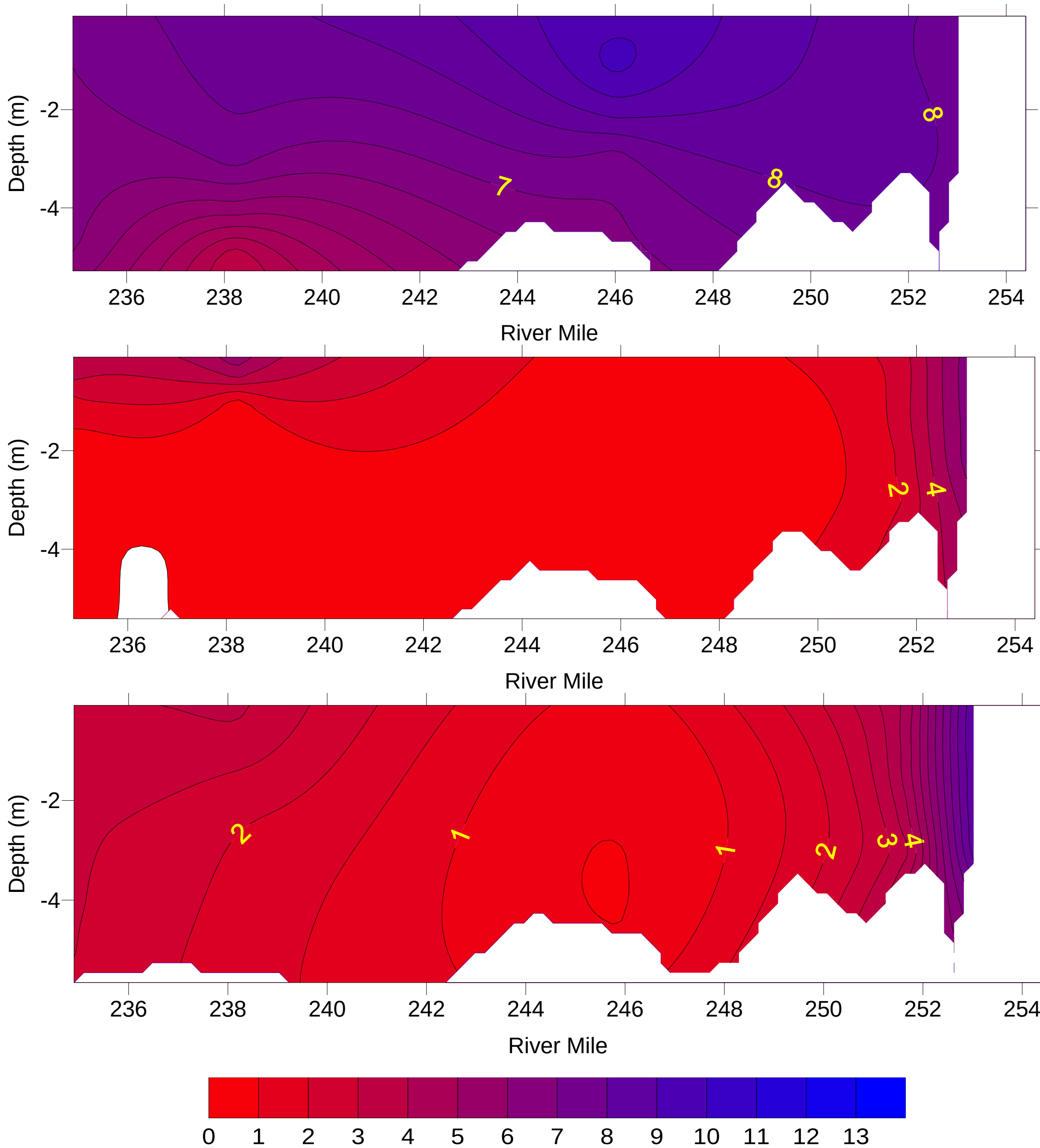

FIGURE 2
Dissolved oxygen isopleths (in mg/L) in Keno reservoir on May 3, 2005 (top plot), July 26, 2005 (middle plot), and October 18, 2005 (bottom plot). Data obtained from U.S. Bureau of Reclamation.

Alkalinity increases seasonally in this reach in response to anthropogenic inputs. Values range from 50 to over 100 mg/L. However, at these levels, the system is still considered weakly buffered (EPA 1987). The result is that pH values in the reservoir are similar to those at the Link River dam, with values ranging from 7.0 to 8.0 in winter and between 8.0 and 10.0 in summer. One deviation from this pattern is that during severe anoxia, pH values may fall to under 7.0 during summer and early fall periods where regions of low dissolved oxygen persist.

Keno Reach—Keno Dam to J.C. Boyle Reservoir

The Keno reach of the Klamath River extends from Keno dam (RM 233.3) to the headwaters of J.C. Boyle reservoir (RM 228.2). This reach is the first of significant length in the Klamath River downstream of Upper Klamath Lake that has free-flowing and turbulent river-like conditions.

Water temperatures in the Keno reach vary along its length only modestly. The exception is that releases to the Keno reach from Keno dam has only a modest diurnal range during warmer periods of the year due to the moderating effect of Upper Klamath Lake and Keno reservoir. However, by the time flows in the reach arrive at the headwaters of J.C. Boyle reservoir there is a notable diurnal cycle—in response to heat transfer across the air-water interface. As with other reaches, the thermal conditions of this reach are generally at or near equilibrium temperature.

Due to the steepness of the Keno reach and the associated natural physical aeration, dissolved oxygen concentrations generally improve in this reach, approaching equilibrium conditions with the atmosphere. However, dissolved oxygen concentrations in the river are generally not completely (100 percent) saturated during the summer period, with values around 7 mg/L. This sub-saturation condition may be associated with the large organic load from upstream sources in Upper Klamath Lake and Keno reservoir. Modest diurnal variations in dissolved oxygen concentrations above J.C. Boyle reservoir (that are in excess of that associated with diurnal temperature variations) suggest that there is some primary production occurring in this reach. However, the high velocities and variable flows, coupled with relatively high light extinction characteristic, probably limit attached algae production. Maximum chlorophyll *a* concentrations in the river above J.C. Boyle reservoir were approximately two to four times smaller than concentrations at Keno dam.

Available data suggests that nutrient concentration do not change appreciably in the Keno reach. The ability of such river reaches to process organic matter and nutrients is a function of many factors, including flow volume, flow velocity and travel time, reach morphology, light extinction characteristics, and water quality of reach inflows (upstream and tributaries) (Kalff 2002; Wetzel 2001; Horne and Goldman 1994). These factors vary in space and time. Overall, the reach appears to be providing conditions for oxidation of organic matter and ammonia (potentially other constituents as well); however, nutrient concentrations are largely unchanged within the reach.

Alkalinity does not appreciably change in this relatively short reach. pH generally shows a seasonal reduction, with values at the lower end of the reach often less than at Keno dam during the summer. These lesser values are expected given the high levels of primary production in Keno reservoir inflows to the reach and the potential for entraining carbon dioxide via natural physical aeration in the reach.

J.C. Boyle Reservoir

J.C. Boyle reservoir extends from the headwaters of the reservoir at the end of the Keno reach (RM 228.2) to J.C. Boyle dam (RM 224.6). This reservoir has a total storage capacity of approximately 3,500 acre-feet, and the maximum depth is about 40 feet (see Table 1).

Spencer Creek is a minor tributary in this reach, entering near the headwaters of the reservoir.

J.C. Boyle reservoir has a short hydraulic residence time of about 1.2 days at average annual flow and about 2.5 days at average summer flow. This short hydraulic residence time and the reservoir's modest depth prevent the development of thermal stratification such as occurs in the larger Copco and Iron Gate reservoir downstream. However, a slight temperature gradient is maintained in the reservoir as a result of the diurnal variation in the temperature of the influent river. Cooler water entering the reservoir at night tends to flow under the warmer water at the surface of the reservoir, while warmer water flowing in during the day tends to remain close to the surface. Average inflow temperatures are similar to average outflow temperatures because the inflow temperatures are at or near equilibrium temperature.

J.C. Boyle reservoir experiences dissolved oxygen concentrations that deviate from saturation—falling to about 3 mg/L at certain times of the year. The lowest dissolved oxygen levels are restricted to a relatively small volume of water in the deeper portion of the reservoir. Although primary production occurs in the reservoir surface waters, the organic matter input from upstream sources appears to be the primary source of low dissolved oxygen. Dissolved oxygen concentrations in water released from the reservoir are often similar to inflow concentrations.

J.C. Boyle reservoir is eutrophic because of the large nutrient load from upstream sources. Due to the lack of thermal stratification, inflowing waters are distributed throughout the depth of the reservoir, which distributes nutrients and organic matter vertically in the reservoir. Because the reservoir's hydraulic residence time is short and the photic zone is restricted to the near-surface waters, a potentially significant portion of the nutrients that flow into the reservoir pass through the reservoir. There is probably some settling of organic matter from upstream sources (Upper Klamath Lake, Keno reservoir), but it is likely limited by the reservoir's short hydraulic residence time. In general, J.C. Boyle reservoir is not appreciably retaining (reducing) nutrient levels under typical conditions. This is in contrast to the larger downstream Copco and Iron Gate reservoirs, which have much longer hydraulic residence times (e.g., on the order of 32 and 42 days, respectively, in Copco and Iron Gate reservoirs during average summer flow conditions) and retain (reduce) significant amounts of the annual load of nutrients that flow into those reservoirs.

Average phytoplankton biovolume and chlorophyll *a* concentrations in J.C. Boyle reservoir show a general pattern typical of the Klamath River system. Values are typically high in March, decrease in April into June, and increase to a peak in August. Biovolume and chlorophyll *a* values typically decrease considerably in the fall with the onset of cold temperatures and decreased light. These patterns and levels of primary production vary from year to year, with meteorological conditions, hydrology, and upstream water quality conditions playing important roles in the species timing, magnitude, and persistence, and in the duration of standing crop. Generally, algal concentrations as represented by chlorophyll *a* are similar to or lower below J.C. Boyle reservoir than upstream of the reservoir, suggesting that although primary production is present, it is not nearly of the same magnitude as in upstream areas such as Upper Klamath Lake and Keno reservoir.

pH values are generally equal to or lower below J.C. Boyle dam than upstream of the reservoir. An exception is that during summer periods, pH is occasionally higher below J.C. Boyle dam than above J.C. Boyle reservoir. These occasional high pH levels are expected given that primary production (phytoplankton) in J.C. Boyle reservoir can occur during these periods.

Bypass Reach—J.C. Boyle Dam to J.C. Boyle Powerhouse

The J.C. Boyle bypass reach extends from J.C. Boyle dam (RM 224.6) to J.C. Boyle powerhouse (RM 220.4)—a distance of approximately 4 miles. The bypass reach is characterized by reduced in-channel flows owing to the diversion of flows from the dam to the powerhouse. There is a minimum 100 cfs required release from J.C. Boyle dam to meet instream flow requirements. Large groundwater springs discharge about 250 cfs into the bypass reach approximately 0.75 miles below the dam. This groundwater discharge dominates the flows in the bypass reach, with the exception of occasional periods in winter or spring when river flows are high enough (greater than about 3,000 cfs) that J.C. Boyle dam is spilling. If the spills are sufficiently large (on the order of 600 to 800 cfs), the river dominates the spring inputs.

The portion of the bypass reach immediately downstream of J.C. Boyle dam is similar in quality to the waters of J.C. Boyle reservoir. However, the springs that enter in this reach have a notable impact on conditions within this reach down to the J.C. Boyle powerhouse. The springs discharge water at a roughly constant 11°C temperature year round. As a result, during summer, the springs provide cool water to a river that otherwise may exceed 25°C. During winter, the springs provide warmer water to a river that otherwise may be less than 2°C. Flows out of the bypass reach range in temperature from greater than 15°C in summer to less than 10°C in winter. There are periods in the spring and fall when the springs have little impact on water temperature due to the similarity of river and spring temperatures.

PacifiCorp notes that the existing instream flow release of 100 cfs from J.C. Boyle dam provides a balance of preferred water temperature conditions and available physical habitat for fish in the reach (PacifiCorp 2004b, 2004d, 2005a, 2005c). Modeling by PacifiCorp indicates that higher instream flows would impair water quality in the J.C. Boyle bypass reach by degrading the beneficial cooling effects of the 250 cfs of springs that discharge into the reach. Modeling results demonstrates that as bypass release flows are incrementally increased above 100 cfs, water temperatures in the bypass reach are incrementally warmed to unsuitable levels (> 21°C), particularly at flow releases of 400 cfs or greater.

Dissolved oxygen conditions of the spring inputs are apparently at or near saturation. Direct field measurements are not available because the springs emanate from beneath extensive talus slopes. Large volume springs with high elevation source water, such as the springs located in the bypass reach, tend to have relatively rapid transit times (in relation to typical groundwater movement) from source to discharge location. Because the source water is at or near saturation and there is little organic matter in the source water or rock matrix, the spring inputs are presumed to have oxygen levels at or near saturation.

Nutrient concentrations are generally reduced within this reach by dilution from spring inflows. The ratio of release from J.C. Boyle dam to spring inflows is approximately 1:2. Comparisons of nutrient concentrations at the top and bottom of the reach indicate that in almost all instances concentrations are reduced consistently with this ratio, i.e., they are reduced by approximately two-thirds. Estimating concentrations of the spring inflow with a simple mass balance using available field data suggests that a modest amount of background nutrients occur in the springs, with only small or zero concentrations of organic forms. The general physical aspects of this reach are not conducive to phytoplankton growth and limit attached algae forms (Wetzel 2001; Borchardt 1996; Reynolds and Descy 1996; Reynolds 1994). These features include bedrock or large substrate channel forms; steep, high velocity reaches; and topographic shading.

The spring inflows apparently have a lower alkalinity than the river water—at least seasonally—and downstream concentrations are generally lower than those below J.C. Boyle dam. pH values are generally similar at the top and bottom of the reach, although the values tend to be somewhat higher at the bottom than at the top.

Peaking Reach—J.C. Boyle Powerhouse to Copco Reservoir

The J.C. Boyle peaking reach extends from J.C. Boyle powerhouse (RM 220.4) to the California border at RM 209 and beyond to the headwaters of Copco reservoir (RM 203.1). Noteworthy features of the reach include the powerhouse penstock return and the influence of the bypass reach flows. There are few small streams entering the reach, the most significant being Shovel Creek, which enters the California portion of the reach at RM 206.4. Water quality conditions vary considerably from low flow conditions that are dominated by spring accretions flowing out of the bypass reach, to high flow conditions where powerhouse releases (equivalent to J.C. Boyle reservoir release water quality) dominate the downstream water quality.

Inflow temperatures to the peaking reach from the bypass reach and the powerhouse can differ considerably during the summer and winter periods due to the groundwater inputs from springs in the bypass reach. The two flows are generally well mixed within a short distance downstream due to the configuration of the powerhouse discharge and downstream river reach, and the powerhouse discharge flow rates. During winter months, the combined flow below the powerhouse is often above equilibrium temperature due to bypass reach contributions, and waters may cool in the downstream direction. During summer periods the combined flow is often less than equilibrium and waters may warm en route to Copco reservoir.

Due to the free-flowing and turbulent nature of the peaking reach, dissolved oxygen concentrations generally are at or near equilibrium conditions with the atmosphere. In the upper portion of this reach, the river is steep and punctuated by large rapids, providing natural physical reaeration for dissolved oxygen conditions at or near saturation (Chapra 1997; Thomann and Mueller 1987). During the summer months, dissolved oxygen values can at times run under 100 percent saturation. This condition may be associated with the appreciable organic load imparted on the reach from upstream sources.

Only modest changes in nutrients occur within the peaking reach. Phytoplankton generally perform poorly in river conditions, and increased depths, high velocities, significant light extinction, and boulder/bedrock substrate limit benthic algae, thus limiting the ability of nutrients to be acquired by aquatic plants. Conditions within the peaking reach probably lead to only a limited capacity for algal biomass to utilize available nutrients due to scour, light limitations due to colored water and suspended matter, the inability of phytoplankton to persist in the riverine environment, and short residence time (Reynolds 1994; Stevenson 1996). Field observations indicate that the standing crop of attached algae is modest, with some filamentous algae on the channel margins and among partially submerged boulders, and limited periphyton growth (PacifiCorp 2008b).

Alkalinity concentration does not change appreciably within this peaking reach. The system remains well under 100 mg/L, indicating the system is still weakly buffered (EPA 1987). Even with modest primary production the pH in the reach downstream of the powerhouse can range from approximately 8.0 to over 8.7 during the summer. During the late fall through early spring, the pH is generally at or under 8.0.

Copco Reservoir Complex

The Copco reservoir complex includes Copco reservoir and both Copco No. 1 and Copco No. 2 developments. Because the reach below Copco No. 2 dam is relatively short and transit time is likewise short, discussion will focus on Copco reservoir. Copco reservoir extends 4.6 miles from Copco dam at RM 198.6 to the reservoir headwaters at RM 203.2. There are no major tributaries in this reach. The reservoir has a storage capacity of approximately 40,000 acre-feet and its maximum depth is approximately 115 feet (see Table 1).

Copco reservoir is the first relatively large, deep reservoir on the Klamath River mainstem below Upper Klamath Lake. As such, it bears the burden of accepting and processing the large loads of nutrients and organic matter from upstream sources, most notably Upper Klamath Lake. As a result of these substantial upstream loads, Copco reservoir is eutrophic, and can produce large blue-green algae blooms during summer months. Copco reservoir acts as a significant net sink for nutrients as a result of reservoir retention (Asarian et al. 2010).

Copco reservoir undergoes seasonal thermal stratification during the period from about March through October. Meteorological warming during spring acts to warm river flows, which can subsequently ride over the colder waters and create the stratification. The minimum temperatures at the bottom of this reservoir during mid-summer and early fall are typically in the range of 12°C to 14°C, although the cool pool of water during this time is a relatively small portion of the overall reservoir volume (less than about 2,000 acre-feet out of a storage capacity of approximately 40,000 acre-feet). Fall cooling (e.g., cold fronts) acts to cool river flows, which can subsequently "plunge" to deeper levels in the reservoir and contribute to destratification.

The large thermal mass of the reservoir results in release temperatures that are "lagged" in relation to inflow river temperatures. During late spring and mid-summer, the reservoir releases are generally below temperatures of the Klamath River upstream. In the fall, reservoir release temperatures tend to be above the Klamath River upstream. The reservoir's volume also tends to moderate and minimize the range in daily and seasonal temperatures of the inflowing river, i.e., the relatively deep water release moderates short term response in water temperature to deviations in meteorological conditions ("hot" or "cold" spells).

Dissolved oxygen conditions in Copco reservoir vary seasonally as a result of thermal stratification, seasonal water temperature variations in inflowing waters, and seasonal nutrient loading and organic matter from upstream sources. Under stratified conditions, dissolved oxygen concentrations in surface waters during the growth season are typically at, or even above, saturation, while the bottom waters of the reservoir can have low dissolved oxygen concentrations, including concentration of less than 1.0 mg/L in mid-summer. Releases from Copco dam from mid-summer through mid-fall are typically below saturation, with minimum values in late September to early October reflecting the subsaturated conditions within deeper portions of the reservoir.

Copco reservoir acts as an annual net sink for both total nitrogen and total phosphorous (Kann and Asarian 2005, Asarian et al. 2010). Reservoirs can act as traps, reducing organic matter, nutrient, and particulate matter (Thornton 1990; Ward and Stanford 1983). There are periods during the growth season when the reservoir may act as a source of nutrients. The fate of inflowing nutrients (organic and inorganic), subsequent decay of organic forms to inorganic forms, uptake of inorganic nutrients by algae, and other processes may play a role in reservoir processes (Horne and Goldman 1994, Kalff 2002; Wetzel 2001). Nonetheless, field observations suggest that Copco reservoir water quality responds strongly to variations in the quantity and quality of the inflow from upstream sources, i.e., Upper Klamath Lake. Transit time from Upper Klamath Lake at Link River dam to Copco reservoir is approximately 10 days and on the order of 2 to 3 days from Keno dam under typical summer flows. Thus, nutrients and organic matter associated with algal blooms from Upper Klamath Lake and Keno reservoir can reach Copco reservoir in a matter of days.

Blue-green algae, such as *Aphanizomenon* and *Microcystis,* have been observed to form large blooms in the reservoir during summer. *Aphanizomenon* is usually the dominant bloom-forming species, although large blooms of *Microcystis* have been observed since 2005, particularly in late summer (Prendergast and Foster 2010). Certain conditions favor *Microcystis* over *Aphanizomenon*. For example, an abundance of ammonia gives a competitive edge to *Microcystis*. Sustained *Microcystis* blooms in Copco reservoirs are consistent with the potentially elevated levels of inorganic nitrogen (ammonia) and organic matter in influent waters.

Some forms of *Microcystis* found in Copco reservoir are capable of producing the toxin microcystin (Moisander et al. 2009; Bozarth et al. 2010). Potential toxicity effects from microcystin on suckers, if present, in the reservoir are not known. Yellow perch (*Perca flavescens*) from Copco reservoir were sampled during 2007, 2008, and 2009 for possible accumulation of microcystin in tissues. Detection occurred in some samples in 2007, but non-detection occurred in all samples from 2008 and 2009 (Prendergast and Foster 2010). These varying results illustrate that the presence of microcystin within waters of the reservoir does not correlate to microcystin concentrations in fish tissue. Reasons for this lack of correlation may include the patchy distribution of algal blooms within waters of the reservoir, the mobility of fish to move in and out of cyanobacteria bloom areas where microcystin occurs, and the fact that uptake of toxins into fish tissue is through the food chain and not directly from the water (Prendergast and Foster 2010).

Iron Gate Reservoir

Iron Gate reservoir reach extends from Iron Gate dam at RM 190.5 to the reservoir's headwaters at RM 196.7. The reservoir has a storage capacity of approximately 50,000 acre-feet, and a maximum depth of 162 feet (see Table 1).

Iron Gate reservoir is located approximately 1.5 miles below Copco reservoir, and the two reservoirs essentially act in series because the Copco No. 2 powerhouse discharges waters directly into Iron Gate reservoir headwaters. In many ways, Iron Gate reservoir is similar to Copco reservoir in thermal stratification, dissolved oxygen conditions, and water quality response. However, the implications of receiving discharge from an upstream reservoir versus a river reach play an important role in this eutrophic reservoir, as do processes within the reservoir.

Like Copco reservoir, Iron Gate reservoir undergoes seasonal thermal stratification, but Iron Gate's stratification is generally longer (lasting into November) and stronger (bottom waters are colder) than in Copco reservoir. Fall turnover (i.e., cessation of thermal stratification) in Iron Gate reservoir occurs approximately 3 to 4 weeks after Copco reservoir. The minimum temperatures at the bottom of Iron Gate reservoir during mid-summer and early fall are typically in the range of 7°C to 8°C. These conditions create a fairly isolated hypolimnion (approximate annual minimum 5,000 acre-feet) and minimize mixing into the deeper portions of Iron Gate reservoir. The Iron Gate fish hatchery also draws on this cold water volume in Iron Gate reservoir.

As with Copco reservoir, the large thermal mass of Iron Gate reservoir results in release temperatures that are "lagged" in relation to upstream river temperatures. During late spring and mid-summer, the reservoir releases are generally below temperatures of the Klamath River upstream. In the fall, reservoir release temperatures tend to be above the Klamath River upstream. Throughout the year, the diurnal range of release temperatures from Iron Gate reservoir is moderated by the volume of the reservoir. Owing to the mass of Iron Gate and Copco reservoirs (and the resulting thermal lag effect), release waters from Iron Gate dam are sometimes warmer and sometimes cooler than the inflows from the Copco No. 2 powerhouse. However, temperatures below Iron Gate dam are mostly cooler than the inflows from the Copco No. 2 powerhouse because of contributions from deeper cooler waters in Iron Gate reservoir.

Dissolved oxygen conditions in Iron Gate reservoir vary seasonally due to thermal stratification, seasonal water temperature variations in inflowing waters, and seasonal nutrient loading and organic matter from upstream sources. Under stratified conditions, dissolved oxygen concentrations in surface waters during the growth season are typically at, or even above, saturation, while the bottom waters of the reservoir can have low dissolved oxygen concentrations, including concentration of less than 1.0 mg/L in mid-summer. Iron Gate reservoir releases from mid-summer through mid-fall are typically below saturation, with minimum values in late September to early October reflecting the subsaturated conditions within deeper portions of the reservoir.

Iron Gate reservoir is eutrophic largely due to nutrient inputs (organic and inorganic) from upstream sources; tributary inputs are insignificant in comparison to Klamath River inflows. Iron Gate reservoir acts as an annual net sink for both total nitrogen and total phosphorous

(Kann and Asarian 2005, Asarian et al. 2010). There are periods during the year when the reservoir may act as a source of nutrients. However, as with Copco reservoir, careful consideration of upstream fluxes and residence time are critical. At times, these upstream conditions may produce large quantities of organic matter and can increase the nutrient fluxes into Iron Gate reservoir substantially. However, the subsequent impact on Iron Gate reservoir water quality does not occur instantly, but rather over several days or weeks due to both the duration of the upstream conditions and the residence time of the reservoir. Because of this time lag, it is expected that the reservoir will occasionally experience nutrient fluxes in release waters greater than that in inflowing waters.

Average phytoplankton biovolume and chlorophyll concentrations in Iron Gate reservoir show a general succession typical of the Klamath River system. Values are typically high in March, decrease in April into June and increase to a peak in August. Biovolume and chlorophyll *a* values typically decrease considerably in September, but might show a modest rebound in October and then decrease after the end of the growing season with the onset of cold temperatures and decreased light. These patterns and levels of primary production can vary from year to year, with meteorological conditions, hydrology, and upstream water quality conditions playing important roles in the species timing, and magnitude, persistence, and duration of algal standing crop.

Total Maximum Daily Loads (TMDLs)

As described above, high algal productivity in Upper Klamath Lake are accompanied by violations of Oregon's water quality standards for dissolved oxygen, pH, and free ammonia. Such water quality violations led to 303(d) listing of Upper Klamath Lake in 1998 by the Oregon Department of Environmental Quality (ODEQ). ODEQ subsequently established Total Maximum Daily Loads (TMDLs) for Upper Klamath Lake in May 2002 (ODEQ 2002). TMDLs are developed to: (1) estimate the water body's capacity to assimilate pollutants without exceeding water quality standards; and, (2) set limits on the amount of pollutants that can be discharged into a water body while still protecting identified beneficial uses.

In 2002, ODEQ issued the Upper Klamath Lake Drainage TMDL that includes the northern portion of the Upper Klamath Basin upstream of the Project, comprising three sub-basins (i.e., Upper Klamath Lake, Williamson River, and Sprague River). TMDL targets were developed for: (1) total phosphorous (TP) loading as the primary method of improving pH and dissolved oxygen conditions in Upper Klamath and Agency lakes; (2) heat loads for anthropogenic and background nonpoint sources throughout the basin; (3) dissolved oxygen in the Sprague River (USEPA 1987); and, (4) pH in the Sprague River. PacifiCorp has no assigned allocations under the Upper Klamath Lake Drainage TMDL, and has no specific responsibilities or involvement in implementation actions under this TMDL (ODEQ 2002).

In 2010, ODEQ issued the Upper Klamath River and Lost River Draft TMDLs that cover the southern portion of the Upper Klamath Basin including (1) the Klamath River from Upper Klamath Lake to the Oregon-California state line; and (2) the Lost River from the state line downstream of the Malone Dam to the state line upstream of Tule Lake, including the Klamath Straits Drain from the state line to the confluence with the Klamath River (ODEQ 2010). The TMDLs require reductions in phosphorus, nitrogen, and biochemical oxygen demand (BOD) loading from both point sources and nonpoint sources in the Upper

Klamath River, as well as augmentation of dissolved oxygen in the reservoirs. There are no permitted point sources of elevated water temperatures for these TMDLs. The heat load allocation for nonpoint sources is equivalent to 0.2°C (0.4°F) above applicable criteria. Specific implementation actions, including designated BMPs, will be developed by DMAs. PacifiCorp will assist on implementation actions under the Upper Klamath River TMDL related to DO and water temperature allocations assigned to waters in the Project area (ODEQ 2010).

In 2010, NCRWQCB issued the Klamath River TMDL that includes the river from state line to the Pacific Ocean (NCRWQCB 2010). The TMDLs assign three types of load allocations to the waters in the Project area in California: (1) sufficient DO to create a "compliance lens" of water temperature and dissolved oxygen conditions in Copco and Iron Gate Reservoirs that are suitable for cold water fish during summer; (2) nutrient (TP and TN) loading reductions upstream of Copco reservoir to offset the reduced nutrient assimilative capacity in the reservoirs (as compared to a free-flowing river condition); and (3) daily average (and daily maximum) increase in water temperatures relative to inflow temperatures for reservoir tailrace waters (0.1°C [0.18°F] for Iron Gate and 0.5°C [0.9°F] for Copco 1 and 2). PacifiCorp will assist on implementation actions, including reservoir management measures, to achieve the TMDL targets under the Klamath River TMDL related to these allocations (NCRWQCB 2010).

Covered Species and Habitats

The Covered Species' legal status and a general description of their distribution, life history, and habitat requirement were presented in Chapter III. This section builds upon that information by further describing the species' regional status and distribution, as well as aquatic habitat elements on Covered Lands. The current conditions are relevant to analyzing the effects of the Covered Activities and conservation strategies on the Covered Species.

Lost River and Shortnose Sucker

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

Although Tule Lake once supported a large population of suckers, habitat conditions there are currently degraded and the lake now supports only a few hundred suckers. Upper Klamath Lake currently supports the largest remaining population of both species (USFWS 2002). Recent sampling conducted in the J.C. Boyle, Copco, and Iron Gate reservoirs indicate that the populations in these reservoirs are not large nor are they self-sustaining; they appear to be supported by downstream movement of fish from Upper Klamath Lake (Desjardins and Markle 2000).

Status of Lost River and Shortnose Sucker within Their Historical Range

Both species of suckers were listed as endangered by USFWS on July 18, 1988 (53 FR 27,130-27,134) and a recovery plan for the listed suckers was issued in 1993 (USFWS 1993). Information gathered since the listing indicates that there may be several tens of thousands of adult Lost River and shortnose suckers in Upper Klamath Lake (Independent Scientific Review Panel [ISRP] 2005). Gerber Reservoir and Clear Lake also have shortnose sucker populations numbering in the thousands of adults (ISRP 2005). Clear Lake has a population of Lost River suckers numbering in the thousands of adults. In addition, a small population of about one thousand adult Lost River and shortnose suckers occurs in the Tule Lake sumps at the terminus of the Lost River (USFWS 2007a). Small populations of adult shortnose sucker also occur in the Lost River, Keno reservoir, J.C. Boyle reservoir, Copco No. 1 reservoir, and Iron Gate reservoir (Buettner 1993, Desjardins and Markle 2000, Kyger and Wilkens 2010, Piaskowski 2003, USGS 2000, Reclamation 1993, Ziller and Buettner 1987).

The USFWS (2007a) reported that population trends in Upper Klamath Lake have been evaluated by comparing an adult abundance index or catch-per-unit-effort in the Williamson River. These data indicate that sucker populations in Upper Klamath Lake 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). Sampling of larval suckers in upper Klamath Lake since 1995 has indicated that recruitment failure was an important problem and indicated the number of survivors in a year class can differ greatly (Simon et al. 2009).

In 1995, the adult abundance index for Lost River and shortnose sucker populations spawning in the Williamson River system were the highest observed between 1995 and 2005 (ISRP 2005, USGS 2003). The index was reduced by 90 percent between 1995 and 1997 due to die-offs in Upper Klamath Lake. Although recruitment increased for both species in 2000 and 2001, it was greater for Lost River sucker than shortnose sucker (USGS 2007). In 2003, another die-off occurred that was much smaller in magnitude than those from 1995 to 1997. From 2003 to 2005, the Lost River sucker index increased gradually, but was still only about 40 percent of the 1995 index value. The shortnose sucker index has remained low, less than 10 percent of the 1995 level (ISRP 2005, USGS 2007).

Although the Clear Lake Lost River and shortnose sucker populations appear to number in the thousands of individuals, a substantial reduction in mean body size has occurred over the last decade. Between 1996 and 2000 there was a reduction of over 30 percent in mean size of adult Lost River and shortnose sucker (Barry et al. 2007). In 2005 and 2006, adult suckers were represented by mostly smaller size classes. The Gerber Reservoir shortnose sucker 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, USFWS 2007a).

Populations of Listed Suckers in the Project Area

Information on the status of Lost River and shortnose sucker in the Project Area from Link River dam to Iron Gate dam is less extensive than that for sucker populations upstream of the Project in Upper Klamath Lake, 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 lake habitats, was expanded by the construction of Project reservoirs.

Adult populations of shortnose suckers may number over 1,000 individuals in Keno, J.C. Boyle, and Copco reservoirs. Shortnose suckers are uncommon in Iron Gate reservoir. Lost River suckers are very uncommon except in Keno reservoir where there appears to be about 100 individuals that are restricted to the upper portion of the reservoir. Based on entrainment studies at Link River dam and fish distribution studies in the Project reservoirs, USFWS (2007a) concluded that substantial numbers of larval and juvenile suckers disperse downstream from Upper Klamath Lake to reside in the downstream reservoirs. There is no evidence that self-sustaining populations exist in any of the reservoirs. USFWS has stated that shortnose sucker spawning and larval production occurs in Copco No. 1 reservoir; however, there is little recruitment into the adult population (USFWS 2007a). The following description of fish populations in Project reaches is summarized from the FEIS (FERC 2007) and updated with current information where relevant.

Link River. All life stages of listed suckers have been found in the Link River in recent years, based on monitoring below Upper Klamath Lake and the Link River dam. This habitat is primarily a migration corridor for large numbers of larval and juvenile suckers dispersing downstream from Upper Klamath Lake to Keno reservoir (Gutermuth et al. 2000b, Reclamation 2006). 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 DO in Keno reservoir (USFWS 2007a).

Fish sampling conducted by PacifiCorp in 2001 and 2002 indicates that the fish population in this reach is dominated by blue chub (*Gila coerulea*), Klamath tui chub (*Siphateles bicolor bicolor*), and fathead minnows (*Pimephales promelas).* A small number of Lost River suckers were collected in the spring of 2002, and none were collected in the other three sampling periods. Shortnose suckers were collected in both years, and they were the third most abundant species collected in the spring of 2002 (PacifiCorp 2004d).

Keno Reservoir. Sampling conducted by PacifiCorp in 2001 and 2002 indicates that fish populations in Keno reservoir are very similar to those in the Link River, and are dominated by the same pollution-tolerant fish species: blue chub, Klamath tui chub, and fathead minnows. Small numbers of the endangered shortnose and Lost River suckers were collected in Keno reservoir in both 2001 and 2002 (PacifiCorp 2004d). Several other fish distribution studies have been conducted in Keno reservoir. Hummel (1993) and ODFW (1996) captured only a few juvenile and adult Lost River and shortnose sucker during their limited sampling. Oregon State University conducted more rigorous sampling in 2002 and 2003. Larvae and age-0 suckers were most abundant in Keno reservoir; juvenile and adult suckers were rare (Terwilliger 2004). In recent years, Reclamation has captured and tagged a total of 1,136 shortnose suckers and 285 Lost River suckers during ongoing sampling for suckers in Keno reservoir since 2008 (C. Kyger [Reclamation] email communication to R. Larson [USFWS] on May 23, 2011).

Keno Reach. The Keno reach, a canyon area with a relatively high gradient, is primarily a migration corridor for listed suckers dispersing downstream from Upper Klamath Lake and Keno reservoir, and a few adult suckers migrating upstream from J.C. Boyle reservoir to spawn. Fish 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. Of the federally listed sucker species, only the Lost River sucker was represented, and it was only collected in the lower part of the reach in 1 out of the 2 years that were sampled (PacifiCorp 2004d). It is estimated that about 20 percent of the populations in J.C. Boyle reservoir will migrate up to Keno dam during the spring spawning period each year (Perkins et al. 2000b). However, it is unlikely that spawning by Lost River and shortnose sucker occurs in the Keno reach because of the high gradient and lack of spawning gravel (Fortune et al. 1966).

J.C. Boyle Reservoir. Fish collections by Oregon State University in the J.C. Boyle reservoir during 1998 and 1999 indicate that the fish community is dominated by chub species, fathead minnows, and bullheads (*Ameiurus* spp.) (PacifiCorp 2004d). Rainbow trout (*Oncorhynchus mykiss*) were also collected during sampling. Of the two federally listed sucker species, a total of 44 shortnose suckers and 2 Lost River suckers were collected. The investigators reported that this was the only one of the three project reservoirs sampled where they collected all three life stages of suckers (larvae, juvenile, and adult), and they speculated that the reservoir may be seeded with larval suckers emigrating from Upper Klamath Lake (Desjardins and Markle, 2000).

J.C. Boyle Bypass Reach. Fish sampling conducted by PacifiCorp in 2001 and 2002 indicates that the fish population in the J.C. Boyle bypass reach is dominated by rainbow trout, speckled dace (*Rhinichthys osculus*), and marbled sculpin (*Cottus klamathensis*) (PacifiCorp 2004d). The shortnose sucker was the least common of the five species that were collected in 2001, and none were collected in 2002. No Lost River suckers were collected in either year.

J.C. Boyle Peaking Reach. Fish sampling conducted by PacifiCorp in 2001 and 2002 indicates that the fish population in the J.C. Boyle peaking reach is composed primarily of speckled dace, marbled sculpin, and rainbow trout (PacifiCorp 2004d). Shortnose sucker was the least common of the four species that were collected in 2001, and no shortnose suckers were captured in 2002 sampling. No Lost River suckers were captured in either year. Henriksen et al. (2002) reported that use of the Klamath River between J.C. Boyle dam and Copco No. 1 reservoir by the listed sucker species likely is limited to downstream emigration of juveniles and adults from areas upstream. Shortnose sucker from Copco No. 1 reservoir may spawn in the lower section of this reach (Beak Consultants Inc. 1987).

Copco No. 1 Reservoir. Fish collections by Oregon State University in Copco No. 1 reservoir during 1998 and 1999 surveys were dominated by yellow perch, unidentified larval suckers, and golden shiners (*Notemigonus crysoleucas*), which collectively comprised 95 percent of the catch (PacifiCorp 2004d). Approximately 13 percent of the adult fish that were collected in Copco No. 1 reservoir were federally listed sucker species, nearly all of which were shortnose suckers. Since 1976, only five Lost River sucker have been captured in Copco No.

1 reservoir (Desjardins and Markle 2000). Few juvenile suckers were collected in the reservoir, which may reflect predation by non-native species such as yellow perch, largemouth bass (*Micropterus salmoides*), and crappie (*Pomoxis* spp.) (Desjardins and Markle 2000). The investigators speculated that adult suckers that occur in all three project reservoirs may have been produced in Upper Klamath Lake.

Copco No. 2 Reservoir and Bypass Reach. Fish sampling conducted by PacifiCorp in 2001 and 2002 indicate that the fish population in the Copco No. 2 bypass reach is composed primarily of marbled sculpin and speckled dace, with much smaller numbers of Klamath tui chub, rainbow trout, yellow perch, black crappie (*Pomoxis nigromaculatus*), largemouth bass, and blue chubs (PacifiCorp 2004d). 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.

Spring, Fall, and Jenny Creeks. The Jenny Creek watershed supports several native fish species including the Jenny Creek sucker (*Catostomus rimiculus*), rainbow trout, and Klamath speckled dace. PacifiCorp (2005b) concluded that the upstream migration of suckers from Jenny Creek is probably precluded by high stream gradient in the lower portion of Spring Creek. A falls located less than 0.2 miles upstream of the confluence of the Fall Creek powerhouse tailrace is another likely barrier to fish passage.

Iron Gate Reservoir. Fish collected in Iron Gate reservoir during Oregon State University's 1998 and 1999 surveys were dominated by golden shiners, tui chub, pumpkinseed (*Lepomis gibbosus*), unidentified chubs, yellow perch, unidentified larval suckers, and largemouth bass, which collectively comprised 95.1 percent of all fish collected (Desjardins and Markle 2000). Shortnose sucker made up only 1 percent of the total catch of adult fish, and no Lost River suckers were collected in Iron Gate reservoir. Although 1,180 sucker larvae were collected in the reservoir, no juvenile suckers were collected, which may reflect predation by non-native species such as yellow perch, largemouth bass, and crappie (Desjardins and Markle 2000).

Current Habitat Conditions in the Klamath River Above Iron Gate Dam

The facilities associated with the existing project are located over a 64-mile reach of the Klamath River, extending from Link River dam at RM 254.3 to Iron Gate dam at RM 190.1. The following description of current habitat conditions is organized by river reach and is taken from the FEIS on PacifiCorp's application for a new license (FERC 2007) and the USFWS BiOp (USFWS 2007a).

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 of the river is mostly bedrock, and at lower flows the river breaks into smaller braided channels. The Link River downstream of Link River dam 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; Reclamation 2000).

As described above, water quality conditions in Link River are similar to those that occur in Upper Klamath Lake, and include periods of high water temperatures, high pH levels, and low DO levels, although DO levels can be higher in the river because of aeration as water flows over cascades. Fish populations in the Link River are limited primarily to species that are able to tolerate these poor water quality conditions. Link River, because of its high gradient and numerous cascades, has substantial potential for oxygenation of water prior to entry into Keno Reservoir, where there is a high biochemical oxygen demand. In addition, a number of small springs along and in the channel add fresh, high quality water to the river (USFWS 2007a).

Keno Reservoir. Keno reservoir is narrow and riverine in character, and is confined within a diked channel that was once part of Lower Klamath Lake. Due to past diking and draining of wetlands for agriculture above Keno Dam and water management operations resulting in stable water levels, there is very little wetland habitat for larval and juvenile rearing (USFWS 2007a). As described above, water quality conditions in Keno reservoir are heavily influenced by the high nutrient content of inflowing water from Upper Klamath Lake, but they are exacerbated by wastewater effluent from the city of Klamath Falls, Reclamation irrigation return water, and accumulated wood waste from lumber mill operations. Summer water quality is generally poor, with heavy algae growth, high temperatures and pH, and low DO. Respiration demands from abundant algal populations combined with decomposition of organic matter (biological oxygen demand) can result in near-complete anoxia during certain time periods, and fish kills are sometimes observed in and downstream of Keno reservoir, as they are in the upstream Upper Klamath Lake.

Keno Reach. Downstream of Keno dam, the Klamath River flows freely for 4.7 miles until it enters J.C. Boyle reservoir. This section runs through a canyon area with a relatively high gradient of 50 feet/mile (1 percent) (PacifiCorp 2000). The channel is generally broad, with rapids, riffles, and pocket water among rubble and boulders. Water quality in the Keno reach is influenced by water quality in Keno Reservoir. As described above, summer water quality in Keno Reservoir is generally poor. The combination of warm water, abundant nutrients, and organic materials from upstream sources, and adequate DO resulting from the river's turbulence, create a productive environment in the Keno Reach (ODFW 1997).

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. Like the upstream Keno reservoir, water quality is heavily influenced by Upper Klamath Lake.

J.C. Boyle Bypass Reach. The J.C. Boyle bypass 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 and runs, with few pools among large boulders with some large cobbles interspersed. Gravel is scarce, in part because recruitment from upstream areas is blocked by the presence of J.C. Boyle dam.

J.C. Boyle Peaking Reach. The J.C. Boyle peaking reach is 17.3 miles long, extending from the J.C. Boyle powerhouse at RM 220.4 to the upper end of Copco No. 1 reservoir. The upstream 11.1 miles of this reach are in Oregon, and the downstream 6.2 miles are in California. 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.

Copco No. 1 Reservoir. Copco No. 1 reservoir is located in a canyon area, and is 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 shorelines, and only very small isolated pockets of wetland vegetation exist. As discussed above, 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 blue-green algae *Aphanizomenon*. Since 2005, Copco No. 1 reservoir has experienced elevated levels of the cyanobacteria *Microcystis* (Prendergast and Foster 2010). Some forms of *Microcystis* found in the reservoir are capable of producing the toxin microcystin (Moisander et al. 2009; Bozarth et al. 2010). In 2008, the Environmental Protection Agency (EPA) added microcystin toxins to California's section 303(d) list as an additional cause of impairment for the Klamath River.

Copco No. 2 Reservoir and Bypass Reach. The Copco No. 2 bypass 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. Because of its small size and high rate of water exchange, Copco No. 2 reservoir probably does not support listed suckers.

Spring, Fall, and Jenny Creeks. The Jenny Creek watershed supports several native fish species including the Jenny Creek sucker, rainbow trout, and Klamath speckled dace. PacifiCorp (2005b) concluded that the upstream migration of suckers from Jenny Creek is probably precluded by high stream gradient in the lower portion of Spring Creek. A falls located less than 0.2 miles upstream of the confluence of the Fall Creek powerhouse tailrace is another barrier to fish passage. Downstream of the tailrace confluence, Fall Creek is fairly low in gradient, is well shaded with trees, and enters a wetland area at its confluence with Iron Gate reservoir.

Iron Gate Reservoir. The reservoir is similar to Copco No. 1 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, except at the mouths of Jenny and

Camp creeks, where well developed riparian habitat occurs. Due to the cliff-like nature of shorelines, only very small isolated pockets of wetland vegetation exist around the perimeter of the reservoir. As in Copco No. 1 reservoir described above, water quality in the reservoir during the summer supports large blooms of the *Aphanizomenon* and *Microcystis*.

V. Effects of Covered Activities on Covered Species

Effects on Listed Sucker Species

Covered Activities include continued operation and maintenance of Project facilities over the interim period. The USFWS in its 2007 BiOp (USFWS 2007a) identified the following potential impacts on listed sucker species as a result of PacifiCorp's Klamath Hydroelectric Project:

- Injury/Mortality due to:
  - Entrainment of suckers at Project diversions or spillways
  - False attraction and harm at Project tailraces
  - Stranding and ramp rate effects
  - Reservoir fluctuations
- Migration barriers
- Degradation and loss of habitat due to:
  - Instream flows
  - Wetlands loss
- Water quality (in Keno reservoir)

The following section, including Table 2, focuses on the effects of interim operations and describes in more detail the potential forms of impact to listed suckers that might occur as described by USFWS. Included in these descriptions are the extent and type of impacts identified by USFWS in its 2007 BiOp. These descriptions represent the potential effects of continued operations without implementation of the conservation measures identified later in this HCP. This section also describes the anticipated impact on the sucker population that could result in the absence of the conservation measures.

TABLE 2
Summary of Covered Activities That Could Potentially Result in Incidental Take[a] of Listed Suckers, the Type of Take, Impacts of the Taking, and Whether Take Can Be Avoided[b], Minimized[c], or Mitigated[d]

Mechanism for Potential Take	Type of Take	Effect on Listed Sucker	Life Stage(s) Affected	Populations Impacted	Extent and Impact of Potential Take	Potential Take Avoidance	Impact Minimization	Impact Mitigation	Methods for Monitoring Compliance and Effectiveness
Turbine Entrainment	Direct[a]	Potential mortality or injury as suckers pass through the turbines at Project facilities with generation capability.	All	Upper Klamath Lake, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate	Generally proportional to the amount of flow diverted through the turbines. USFWS (2012) estimates that turbine mortality could result in the loss of over 1,000,000 larvae, about 450 juveniles, and 13 adults at Project facilities (see Table A1 in Appendix A). These facilities could also result in the harassment of larval, juvenile, and adult suckers (see Table 4). The impact associated with mortality or injury from turbine entrainment may be a reduction in sucker abundance.	Take avoidance at the East Side and West Side facilities would require complete shutdown of the facilities during time periods when suckers are present. Avoidance of take during interim operations would not be practicable at other Project facilities because of the very low proportion of the sucker population affected and the need to construct facilities (fish screens) that would be removed during dam removal actions under the Settlement Agreement.	Restricted operations at the East Side and West Side facilities minimize the impact associated with mortality or injury resulting from entrainment	Mitigation under interim operations can be achieved through site-specific habitat improvements that benefit the sucker population.	The effectiveness of implementing additional curtailment of operations at East Side and West Side can be monitored by reporting the periods of non-operation. Monitoring the effectiveness of habitat improvements can be conducted as part of specific enhancement projects.
Spillway Entrainment	Direct[a]	Potential mortality or injuries as suckers pass through Project spillways.	All	Keno, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate	Generally proportional to the amount of flow diverted through spillways. USFWS (2012) estimates that routing water through spillways at Project facilities (except Link River dam, which is attributable to Reclamation) could result in the loss of about 11,350 larvae, 670 juveniles, and 3 adults (see Table A1 in Appendix A). These facilities could also result in the harassment of larval, juvenile, and adult suckers (see Table 4). The impact associated with mortality or injury from spillway entrainment may be a reduction in sucker abundance.	Avoidance of take during interim operations would not be practicable because of the very low proportion of the sucker population affected and the low estimates mortality (2 percent) associated with spillways.	Minimization of take during interim operations would not be practicable because of the very low proportion of the sucker population affected and the low estimates of mortality (2 percent) associated with spillways.	Mitigation under interim operations can be achieved through site-specific habitat improvements that benefit the sucker population.	Monitoring the effectiveness of habitat improvements can be conducted as part of specific enhancement projects.
False Attraction	Indirect Harm	USFWS believes suckers may be falsely attracted to turbine discharges each year, delaying their ability to reach suitable spawning habitat at a time when they are ready to spawn or conditions are optimal for survival. Harm may also occur through contact with powerhouse structures.	Adult	Link River	USFWS (2007a) estimated that up to 20 adult suckers (10 percent) may be falsely attracted to turbine discharges each year and that two fish (1 percent) may be injured annually in the East Side and West Side power diversions. Migration delays associated with false attraction or injury may reduce spawning success, resulting in a reduction in sucker abundance.	Take avoidance would require curtailment of power generation during the entire spawning migration.	The impact of potential take can be minimized by curtailing power generation during portions of the spawning migration.	Mitigation under interim operations can be achieved through site-specific habitat improvements that benefit the sucker population.	Monitoring the effectiveness of habitat improvements can be conducted as part of specific enhancement projects.

TABLE 2
Summary of Covered Activities That Could Potentially Result in Incidental Take[a] of Listed Suckers, the Type of Take, Impacts of the Taking, and Whether Take Can Be Avoided[b], Minimized[c], or Mitigated[d]

Mechanism for Potential Take	Type of Take	Effect on Listed Sucker	Life Stage(s) Affected	Populations Impacted	Extent and Impact of Potential Take	Potential Take Avoidance	Impact Minimization	Impact Mitigation	Methods for Monitoring Compliance and Effectiveness
Ramping	Direct	USFWS contends that rapid flow reductions can adversely affect fish populations by dewatering spawning, rearing, or foraging habitat and may strand fish.	Eggs, larvae, and juveniles	Link River, Keno reach, J.C. Boyle bypass and peaking reaches, and Copco No. 2 bypass reach	USFWS (2012) estimates that up to 100,000 sucker eggs could be dewatered in the J.C. Boyle peaking reach. About 14,800 larval and 360 juvenile suckers may be stranded, primarily in the Link River, Keno reach, and J.C. Boyle peaking reach (see Table A2 in Appendix A). The impact of any direct mortality resulting from ramping could be manifested as a reduction in sucker abundance. However, because of the minimal impacts on Lost River and shortnose suckers within the context of their overall population size the impact of the taking may be low. In addition, the reservoir reaches occupied by these species, particularly downstream of Keno dam, are not part of the original habitat complex of these sucker species and probably are inherently unsuitable for completion of their life cycles.	Avoiding all potential take associated with ramping would require release of constant flow. Constant flow releases may not be practical because of the need to meet Reclamation's minimum flow requirements at Iron Gate dam. Constant flow releases also may not be desirable because variable flows have beneficial hydrologic, geomorphic, and biological effects.	The number of suckers potentially impacted as a result of ramping can be minimized through implementation of appropriate ramping rates.	Mitigation under interim operations can be achieved through site-specific habitat improvements that benefit the sucker population.	Monitoring the effectiveness of habitat improvements can be included in enhancement projects.
Reservoir Fluctuation	Direct and Indirect Harm	Although reservoir fluctuation at the Project is limited, USFWS believes fluctuating reservoir levels have the potential to affect fish species directly if stranding of fish occurs along the shoreline, and indirectly if a "dewatered zone" occurs around the edges of the reservoir that decreases habitat availability and leads to increased predation.	Larvae and juveniles	Keno, J.C. Boyle, Copco No. 1, and Iron Gate reservoirs	USFWS (2012) estimates that over 11,000 larval and 1,000 juvenile suckers may be affected, primarily in J.C. Boyle reservoir (see Table A2 in Appendix A). The impact of any direct mortality and indirect harm as a result of fluctuating reservoir levels could be manifested as a reduction in sucker abundance. However, because of the minimal impacts on Lost River and shortnose suckers within the context of their overall population size the impact of the taking may be low. In addition, the reservoir reaches occupied by these species, particularly downstream of Keno dam, are not part of the original habitat complex of these sucker species and probably are inherently unsuitable for completion of their life cycles.	Avoidance of potential take resulting from fluctuating reservoir levels by maintaining stable water surface elevations may not be practicable because of the need to manipulate water surface levels to meet irrigation demand and to facilitate maintenance activities.	The minimization of the impact of potential take resulting from reservoir fluctuations may not be practicable because of the need to manipulate water surface levels to meet irrigation demand and to facilitate maintenance activities.	Mitigation under interim operations can be achieved through site-specific habitat improvements that benefit the sucker population.	Monitoring the effectiveness of habitat improvements can be included in enhancement projects.

TABLE 2

Summary of Covered Activities That Could Potentially Result in Incidental Take[a] of Listed Suckers, the Type of Take, Impacts of the Taking, and Whether Take Can Be Avoided[b], Minimized[c], or Mitigated[d]

Mechanism for Potential Take	Type of Take	Effect on Listed Sucker	Life Stage(s) Affected	Populations Impacted	Extent and Impact of Potential Take	Potential Take Avoidance	Impact Minimization	Impact Mitigation	Methods for Monitoring Compliance and Effectiveness
Migration Barriers	Indirect Harm	USFWS believes that current ladders at Keno and J.C. Boyle dams potentially impede the upstream migration of suckers in the system. Upstream fishways do not exist at Copco No. 1, Copco No. 2, and Iron Gate dams	Adult	Keno dam, J.C. Boyle dam, and Copco No. 1 dam	USFWS (2007a) found that the effectiveness of the existing Keno ladder or need for a new ladder at Keno dam is unknown; suckers do not appear to be attempting to migrate upstream of J.C. Boyle to spawn or return to upstream rearing areas. Interim operations will have no effect on upstream sucker spawning migrations at facilities without ladders because listed adult suckers are rare or absent in Copco No. 2, uncommon in Iron Gate reservoir, and absent in the Klamath River below Iron Gate dam (USFWS 2007a). There likely would be minimal impacts on Lost River and shortnose suckers within the context of their overall population size and geographic range because the river and reservoir reaches occupied by these species, particularly downstream of Keno dam, are not part of the original habitat complex of these sucker species and probably are inherently unsuitable for completion of their life cycles.	Avoidance of potential take resulting from migration barriers may not be practicable because it would require construction of fish passage facilities or removal of the existing facilities, both of which would be outcomes of the Settlement Agreement or a new FERC license.	Minimization of the impact of potential take resulting from migration barriers may not be practicable because it would require construction of fish passage facilities or removal of the existing facilities, both of which would be outcomes of the Settlement Agreement or a new FERC license.	Mitigation under interim operations can be achieved through site-specific habitat improvements that benefit the sucker population.	Monitoring the effectiveness of habitat improvements can be included in enhancement projects.
Degradation or Loss of Habitat	Indirect Harm	USFWS believes that reduced instream flows in the Link River as a result of agricultural diversions from the Reclamation project and water diversions for hydropower production may affect the amount and availability of rearing habitat. USFWS also believes the loss of historical wetlands that connected with the Klamath River above the present location of Keno dam has reduced the historically available habitat for larval and juvenile suckers.	Larvae and Juveniles	Link River, Upper Klamath Lake	USFWS (2007a) estimates that construction and operations of Keno reservoir has resulted in the loss or degradation of an estimated 230 acres of wetlands. The impact associated with the increment of habitat loss associated with interim operations is not certain. However, USFWS believes the reduced availability of habitat for larval and juvenile suckers may contribute to low survival in Keno reservoir.	Avoidance of this impact may be achieved by ceasing water diversions for hydropower production at Link River dam, thereby eliminating impacts to instream flows in the Link River related to Project operations. Avoidance of impacts related to loss of wetlands may not be practicable under interim operations. These existing project-related habitat effects are the result of the presence of the facilities.	Minimizing the impact of the take potentially resulting from loss or degradation of habitat in the Link River is possible by minimizing water diversions for hydropower production that may have impacts to habitat suitability and availability. Additional minimization is not practicable given the systemic nature of this effect. The loss of habitat is a product of the system of dams and reservoirs in place.	Mitigation under interim operations can be achieved through site-specific habitat improvements that benefit the sucker population.	Monitoring the effectiveness of habitat improvements can be included in enhancement projects.
Water Quality	Indirect Harm	USFWS believes that impaired water quality in Keno reservoir is largely responsible for the mortality of suckers dispersing	Larvae, Juveniles, and Adults	Upper Klamath Lake, Keno Reservoir	USFWS (2007a) estimates that about 80 percent of the 6 million larvae, 100,000 juveniles, and 100 sub-adult/adult suckers that disperse	The poor water quality in Keno reservoir is a product of the poor water quality originating Upper Klamath Lake, and the	Minimizing the impact of the take potentially resulting from poor water quality is not practicable given the systemic	Existing water quality is the result of factors outside PacifiCorp's control. Site-specific habitat improvements	Monitoring the effectiveness of habitat improvements can be included in enhancement

TABLE 2

Summary of Covered Activities That Could Potentially Result in Incidental Take[a] of Listed Suckers, the Type of Take, Impacts of the Taking, and Whether Take Can Be Avoided[b], Minimized[c], or Mitigated[d]

Mechanism for Potential Take	Type of Take	Effect on Listed Sucker	Life Stage(s) Affected	Populations Impacted	Extent and Impact of Potential Take	Potential Take Avoidance	Impact Minimization	Impact Mitigation	Methods for Monitoring Compliance and Effectiveness
		downstream into the reservoir from Upper Klamath Lake. PacifiCorp does not directly affect water quality in Upper Klamath Lake or Keno reservoir; however, USFWS believes the presence of Keno reservoir may influence the exposure of suckers to stressors associated with water quality. Interim operation of Keno facilities likely has little effect on the vulnerability of suckers to water quality stressors.			annually into Keno reservoir perish due to the impaired water quality conditions in Keno reservoir (USFWS 2007a). However, the influence of continued operation over the interim period has little influence on water quality and likely does not contribute significantly to the number of fish lost. Sucker mortality resulting from poor water quality in Keno reservoir may contribute to continued low sucker abundance.	presence of Keno dam has not significantly altered historic hydraulic conditions in this river reach given the hydraulic control provided by the Keno reef prior to construction of Keno dam. . Existing water quality is the result of the long-term operation of the facilities in place and factors outside PacifiCorp's control. Avoidance of this impact may not be practicable under interim operations	nature of this effect and PacifiCorp's inability to control water quality loading from Upper Klamath Lake.	that benefit the sucker population would help offset any water quality-related impact associated with PacifiCorp's continued operation of Keno reservoir over the period of interim operations.	projects.

[a] As defined in the ESA, the term "take" includes harm. This indirect type of take may result in the death or injury of individual suckers, but it is not the proximal cause. It is assumed that all suckers entrained and exposed to the turbines will be harmed under this definition. For the purpose if this analysis, the quantification of potential mortality associated with turbines includes all turbine mortality, whether direct or non-direct.

[b] For the purpose of this HCP, the term "avoid" refers to actions that prevent the potential take from occurring (e.g., ceasing power generation activities to avoid larval sucker entrainment and exposure to turbines).

[c] For the purpose of this HCP, the term "minimize" refers to actions that reduce the numbers of individuals potentially taken (e.g., reducing the number of days that hydroelectric facilities are in operation to reduce entrainment).

[d] For the purpose of this HCP, the term mitigate refers to actions that offset the potential take of individuals by creating or enhancing conditions such that fish survival is improved or production increased, thereby resulting in a neutral or positive effect on the population (e.g., improving production by transporting adult suckers in downstream reaches to areas where they can spawn successfully and contribute to the population).

Entrainment at Project Diversions

Entrainment of listed suckers can occur from the downstream movement of fish into Project diversions or spillways by drift, dispersion, and volitional migration. Effects to fish associated with entrainment may include injury and mortality as fish pass through turbines or over spillways. Turbine mortality can take place as a result of pressure changes, shear stress, cavitation, turbulence, strike, and grinding (Cada 2001). Spillway mortality of entrained fish can occur from 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). Spillway operation at Link River dam can also result in take of suckers; however, those impacts are the responsibility of Reclamation (USFWS 2007a, page 86). Water not diverted as a result of curtailment of operations at PacifiCorp's East Side and West Side facilities implemented to eliminate turbine mortality would remain in Upper Klamath Lake, and release of that water would be subject to operational decisions at Link River dam by Reclamation. Water spilled by Reclamation at Link River dam increases when the East Side and West Side facilities are not in operation. Although this increases spill mortality (as described further in Chapter VI), the net result is an overall substantial reduction in the potential mortality of listed suckers entering Lake Ewauna.

There are currently no downstream fishways (screen and bypass facilities) to prevent entrainment at the East Side, West Side, Copco No. 1, Copco No. 2, and Iron Gate dam developments. The J.C. Boyle development does have screen and bypass facilities. Turbine entrainment studies were completed at the East Side and West Side developments from 1997 to 1999 (Gutermuth et al. 2000b).

Entrainment estimates using information provided by USFWS are presented in Table 3. USFWS estimates that potential annual mortality under proposed operations at Project facilities due to turbines, spillways, and flow lines could result in the potential loss of over 1,000,000 larvae, about 1,130 juveniles, and 13 adults. These numbers include those listed in Table 3 except for Link River dam, which is attributable to Reclamation.

The mortality estimates summarized in Table 3 are based on the USFWS (2012) analysis (see Appendix A). USFWS (2012) used literature reviews and extrapolations from other entrainment studies to estimate the expected turbine and spillway entrainment at the Klamath facilities, as well as the expected mortality of suckers due to this entrainment. Appendix A of this HCP contains a detailed description of methods and calculations used by USFWS to estimate entrainment. USFWS (2012) assumes: (1) entrainment is in proportion to flow; (2) 25 percent mortality for suckers entrained into the turbines; (3) 2 percent mortality for suckers entrained into spillways, bypasses, and flow lines; and (4) 90 percent of suckers entering reservoirs (except for the small Copco No. 2 reservoir) remain in those reservoirs rather than disperse downstream. The number of suckers entrained at facilities decreases progressively downstream through the system. This corresponds to the relative distribution of the suckers in the downstream reservoirs.

PacifiCorp generates electricity at J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams, and the proportion of flow that is routed through the turbines depends primarily on annual river flows, which is dependent upon variable hydrologic and meteorological conditions in the Upper Klamath basin. Based on flow data provided by PacifiCorp for the years 1995 to 2011, the USFWS (2012) analysis assumes that 94, 100, 100, and 98 percent, respectively, of the flow at the J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate facilities is routed through the turbines in June when most sucker larvae would be entrained, and the remaining percent of flow is routed through the spillways. The USFWS (2012) analysis also assumes that 97, 100, 100, and 98 percent, respectively, of the flow at these facilities is routed through the turbines in August-October, during which the potential entrainment of juveniles and adults could occur, and the remaining percent of flow is routed through the spillways.

TABLE 3
Estimates of Maximum Annual Sucker Mortality under Current Operations at Link River Dam and the Klamath River Hydroelectric Project Facilities Due to Turbines, Spillways, Flow Lines, Reservoir Fluctuations, and Stranding
Estimates are derived using the USFWS (2012) approach to estimating sucker mortality (Appendix A). All numbers are rounded to the nearest 10 except for adults. PacifiCorp does not agree that these estimates necessarily reflect take associated with its activities.

Life Stage	Facility							
	East Side & West Side[A]	Link River[B]	Keno	J.C. Boyle	Copco No. 1	Copco No. 2	Iron Gate	Total
Estimated Annual Mortality[C] Due to Turbine, Spillway, and Flow Line Operations								
Larvae	1,005,000	53,600	11,280	13,060	13,560	10,170	750	1,107,410
Juveniles	340	3,060	330	400	30	20	2	4,190
Adults	13	3	0	0	0	0	0	16
Total	1,005,350	56,660	11,620	13,460	13,590	10,190	750	1,111,620
Estimated Annual Mortality[C] Due to Reservoir Fluctuations and Stranding Effects								
Eggs	0	0	0	100,000	0	0	0	100,000
Larvae	0	2,500	2,000	20,200	1,000	100	100	25,900
Juvenile	0	250	100	1,010	0	0	0	1,360
Adult	0	0	0	0	0	0	0	0
Total	0	2,750	2,100	121,210	1,000	100	100	127,260

A. The estimates for mortality at the East Side and West Side facilities is based on passage or entrainment through the East Side and West Side turbines or flow lines. Under current operations, the East Side and West Side turbines are offline during the August – October peak entrainment period as explained in the text, but relatively small amounts of water pass (approximately 80 cfs total) through the flow lines.

B: Mortality estimates in this column are based on spill releases at Link River dam, which are attributable to Reclamation's operations.

C. Annual mortality is defined as the estimated maximum number of individuals killed from the encounters with the listed operations sources. Total mortality includes losses resulting from spill at Link River dam. Spillway mortality associated with Link River dam is attributable to Reclamation operations.

The number of larval suckers that are estimated to be lost through entrainment (Table 3) represents a small proportion of the potential fecundity of the breeding population. Each female shortnose and Lost River sucker can produce up to 72,000 and 236,000 eggs per year, respectively (Perkins et al. 2000), and there are thousands of reproductively active females in the population (Janney et al. 2008). The USFWS (2007a) indicated that an estimated 73 million larvae enter Upper Klamath Lake annually from the Williamson River based on data from the Klamath Tribes (Klamath Tribes 1996). Furthermore, it is uncertain how the number of larval suckers produced affects recruitment to the adult populations. While recruitment to the adult populations has been low in recent years (Janney and Shively 2007), Janney et al. (2008) suggest that management strategies that emphasize the production of young fish may be ineffective because population growth for suckers is probably sensitive to adult survival and less sensitive to vital rates associated with reproduction.

As explained in Section VI, PacifiCorp proposes to shut down operations at the East Side and West Side facilities. However, during the term of the ITP, PacifiCorp will continue to maintain water conveyance and other structures associated with these facilities. During the course of ongoing maintenance of these facilities, it is possible that adult or juvenile sucker species may become entrained, or may be falsely attracted at these structures. For example, USFWS (2012) estimates an annual mortality of 340 juveniles from potential entrainment and passage through the East Side flow line (Table 3). The amount and impact of take will otherwise be limited to a few individuals, given the limited operations at the facilities, and the lack of species presence during most periods of time. Any potential take associated with these activities would fall within the overall amount of take estimated for Covered Activities, and would not otherwise result in significant, additional impacts. Finally, potential future operations at East Side and West Side would occur outside periods of time that take of Covered Species is reasonably certain to occur.

The Independent Scientific Review Panel document (ISRP 2005), USFWS (2007a) indicated that available information suggests that several tens of thousands of adult Lost River and shortnose suckers reside in Upper Klamath Lake. The estimated annual loss of 16 adult suckers as a result of entrainment through the turbines and spillways conservatively represents less than 0.4 percent of the adult sucker population. The impact of the loss of these individuals is uncertain, but it is likely that the impact on the population as a whole is low.

Project facilities may cause harassment of larval, juvenile, and adult suckers under current operations due to false attraction, turbines, spillways, flow lines, reservoir fluctuations, and stranding. Estimates of harassment are summarized in Table 4. These estimates are based on the USFWS (2012) approach to estimating sucker harassment (see Appendix A). USFWS (2012) derived these estimates by assuming that all suckers that were estimated to encounter and pass through each of the Project facilities (without mortality) would be subjected to disturbance and potential injury.

TABLE 4
Estimates of Maximum Annual Sucker Harassment under Current Operations at Link River Dam and the Klamath River Hydroelectric Project Facilities Due to Turbines, Spillways, Flow Lines, Reservoir Fluctuations, and Stranding
Estimates are derived using the USFWS (2012) approach to estimating harassment (Appendix A). All numbers are rounded to the nearest 10 except for adults. PacifiCorp does not agree that these estimates necessarily reflect take associated with its activities.

Life Stage	Facility							
	East Side & West Side[A]	Link River[B]	Keno	J.C. Boyle	Copco No. 1	Copco No. 2	Iron Gate	Total
Estimated Annual Harassment[C] Due to Current Operations								
Larvae	3,015,000	2,626,400	552,860	42,230	40,670	30,500	2,300	6,309,950
Juveniles	16,670	150,000	16,330	1,240	90	70	10	184,400
Adults	38	151	19	2	0	0	0	210
Total	3,031,700	2,776,550	569,210	43,460	40,760	30,570	2,310	6,494,560

A. The estimates for harassment at the East Side and West Side facilities are based on passage or entrainment through the East Side and West Side turbines or flow lines. Under current operations, the East Side and West Side turbines are offline during the August – October peak entrainment period as explained in the text, but relatively small amounts of water passes through the flow lines.

B: Harassment estimates in this column are based on spills at Link River dam, which are attributable to Reclamation's operations.

C. Harassment is defined 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.

False Attraction at Project Tailraces

Project facilities do not presently possess tailrace barriers to prevent suckers from being potentially falsely attracted to tailrace discharges. Due to the relatively low numbers of listed suckers in the lower reservoirs, along with lack of spawning habitat, USFWS considers the effects of false attraction flows to be a potential issue only for listed suckers moving out of Keno reservoir into the Link River, and perhaps at the East Side and West Side powerhouses. False attraction could cause an upstream migration delay of listed suckers that may prevent or delay fish from reaching suitable spawning habitat when they are ready to spawn or conditions are optimal for survival.

There have been no specific studies to evaluate the effects of turbine discharges on suckers at the Project facilities. 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 discharges as a potential problem (Piaskowski 2003; Piaskowski et al. 2004). Based on the number of adult suckers Reclamation sampled in Keno reservoir from 2002 to 2005 (Piaskowski 2003; Piaskowski et al. 2004), the USFWS estimated that up to 200 listed suckers may migrate up the Link River during the spring spawning season (USFWS 2007a, page 59). The USFWS also estimated that up to two suckers may be injured annually in the East Side and West Side power diversions and that up to 20 adult suckers may be falsely attracted to turbine discharges each year, rendering them unable to reach suitable spawning habitat when they are ready to spawn or conditions are optimal for survival (USFWS 2007a, page 59).

The failure of 20 adult suckers to reach suitable spawning areas may translate into reduced reproductive output for the year. However, as USFWS has stated, this number of fish represents less than 1 percent of the total spawning population, which is estimated in the tens of thousands (USFWS 2007a). This reduced productivity likely would have little impact on the population because of the high reproductive output of the spawning population and the small number of individuals that would not contribute.

Ramp Rate Effects

Hydroelectric facilities typically have the capability of increasing and decreasing flow levels downstream of the facilities. In general, the rate at which these changes occur is called the "ramp rate" or "ramping." USFWS (2007a) indicated that rapid flow reductions can adversely affect fish populations by dewatering spawning, rearing, or foraging habitat and may strand fish. Smaller juvenile fish (less than about 50 mm long) are most vulnerable to potential stranding due to weak swimming ability and preference for shallower, near-shore habitats. River channel configuration, channel substrate type, time of day, and flow level before down-ramping (antecedent flow) are also key factors that determine stranding incidence. PacifiCorp operations may potentially alter flows in the Link River during times of East Side and West Side start up and shut down (East Side and West Side powerhouses start up and shut down about four times per year), or during a decrease of generation (flow) to the respective powerhouses as a result of unplanned outages that occur, on average, less than once per year.

No stranding vulnerability information is available specifically for suckers. Most of the research and evaluation regarding the effects of flow fluctuations on fish has occurred on salmon and steelhead (FERC 2007). "Ramping rate" is the allowable rate of change in stage or flow between regulated flow levels. In most cases, it refers to the rate of stage decline since up-ramping of flows typically is not an issue regarding fish stranding (FERC 2007). The faster the down-ramping rate, the more likely fish may become stranded. Under current operations, PacifiCorp follows established ramping rates (as described above) to control the rate of change or fluctuation in river flow levels downstream of Project facilities.

USFWS (2012) provided estimates of the number of listed suckers that could potentially be stranded at Link River dam and the other downstream Project facilities due to operations and ramping (see Table A2 in Appendix A). These estimates are summarized in Table 3.

USFWS (2008) determined that incidental take of suckers could occur as a result of Reclamation's operation of Link River dam, and has prescribed Terms and Conditions to address such take. PacifiCorp operations only account for a small portion of the potential take during the occasional ramping of the Link River during the start up or shut down of East Side and West Side powerhouses, or when power load at these two facilities change. Observations in Link River have indicated that fish stranding does not occur from down-ramp of East Side and West Side powerhouse flows. However, the USFWS 1996 BiOp (USFWS 1996) identified a concern that, if available upstream flows from Link River dam drop below 300 cfs, side channels can become dewatered, leaving only isolated pools in which potential fish stranding might occur.

USFWS (2007a) indicated that current operation of Keno dam with existing ramping rates may strand an unknown number of sucker larvae dispersing downstream during the spring and summer, and juveniles dispersing downstream throughout the year. PacifiCorp (2004b) concluded that fish stranding and mortality due to ramping are unlikely in the 4.3-mile long J.C. Boyle bypass reach due to the relatively constant flow conditions in the bypass reach. USFWS (2007a) indicated that there may be down-ramping impacts to shortnose sucker that ascend from Copco No.1 reservoir to spawn in the lower portion of the 17.3-mile long J.C. Boyle peaking reach. Because water levels between Copco No. 1 and Copco No. 2 rarely fluctuate more than a few inches, stranding potential below Copco No. 1 is minimal. Ramping of flows in the Copco No. 2 bypass 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. However, the USFWS (2007a) believes that some downstream dispersal and stranding is possible below Copco No. 2 in the bypass reach.

The impact of the potential take of suckers as a result of stranding is likely low because of the small number of individuals affected relative to the total population. The USFWS also concluded that potential ramping effects associated with Project facilities have minimal impacts on Lost River and shortnose suckers within the context of their overall population size and geographic range (USFWS 2007a, page 63). The USFWS based this conclusion on the assumption that the river and reservoir reaches occupied by these species, particularly downstream of Keno dam, are not part of the original habitat complex of these sucker species and probably are inherently unsuitable for completion of their life cycles.

Reservoir Fluctuation Effects

Fluctuating reservoir levels have the potential to affect fish species directly if stranding of fish occurs along the shoreline, and indirectly if a “dewatered zone” occurs around the edges of the reservoir that decreases habitat availability. The occurrence and severity of these depends on the magnitude and timing of the reservoir fluctuations (USFWS 2007a). USFWS (2012) provided estimates of the number of listed suckers that could potentially be stranded at Project facilities due to fluctuating reservoir elevations (see Table A2 in Appendix A). These estimates are summarized in Table 3.

About every one to two years, aside from the agreement with Reclamation and at the request of irrigators, PacifiCorp draws Keno 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 USFWS estimated that up to 1,000 sucker larvae could be stranded as a result of this operation annually (USFWS 2007a, page 63). Because juvenile and adult suckers occupy deeper water, the USFWS does not anticipate any stranding of these life stages (USFWS 2007a).

J.C. Boyle reservoir operates within an overall range of about 5 feet annually, but the reservoir generally fluctuates only 1-2 feet per day and up to 2 inches per hour (PacifiCorp 2004b, FERC 2007). At these rates, there is little opportunity for fish stranding except for larval suckers, which are poor swimmers. The USFWS estimated that up to 10,000 larvae could be stranded each year (Table 4). The USFWS also indicated that larval and juvenile suckers using the shallow shoreline habitats may be temporarily displaced on a daily basis leading to the potential for increased predation by non-native fish species. While the actual impacts of temporary displacement are unknown, the USFWS estimated that up to 5,000 larvae and 1,000 juveniles may be killed annually by predation associated with daily reservoir fluctuations (USFWS 2007a, page 64).

Copco and Iron Gate reservoir water levels are normally maintained within a few feet of full pool, and average daily fluctuations are less than 0.5 feet (less than 1 inch per hour) (PacifiCorp 2004b; FERC 2006). Maximum daily fluctuations up to 3.0 feet occur on rare occasions. Because of the small daily water level fluctuations and the lack of shallow shoreline habitat with gradual slopes, the USFWS estimated that up to 1,000 larval suckers could be stranded per year in Copco No. 1 reservoir and up to 100 larvae in Iron Gate reservoir (USFWS 2007a, page 64). The USFWS concluded that 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. The USFWS also concluded that there may be increased predation impacts due to loss or displacement of cover habitat for larval and juvenile suckers in these reservoirs caused by the small daily reservoir fluctuations (USFWS 2007a, page 64).

Because the potential effects of reservoir fluctuations are less than the potential ramping effects associated with Project facilities, it is assumed that the impact of potential take associated with reservoir fluctuations on Lost River and shortnose suckers would be minimal when considered within the context of their overall population size and geographic range. This is based on the USFWS assumption that the reservoir reaches occupied by these species, particularly downstream of Keno dam, are not part of the original habitat complex of these sucker species and probably are inherently unsuitable for completion of their life cycles (USFWS 2007a, page 69).

Migration Barriers

Within the distribution of the listed suckers in the Klamath River, there are three existing fish ladders – one on the Reclamation-owned Link River dam, and two on PacifiCorp's Project dams (Keno and J.C. Boyle). In 2005, Reclamation built a new fishway at the Link River dam that meets recommended design criteria and guidelines for upstream fish passage of federally listed suckers (ODFW 2006; USFWS 2005). The current fish ladder at the Link River dam is not considered a migration barrier, although conditions in the Link River channel might influence access to the ladder.

Since 2008, Reclamation has conducted sampling in Lake Ewauna each spring in an attempt to quantify the relative abundance and distribution of suckers and evaluate sucker use of the Link River dam fish ladder (Kyger and Wilkens 2010). Since sampling began, captured suckers have been implanted with passive integrated transponder (PIT) tags. Kyger and Wilkens (2010) indicate that most of the PIT-tagged sucker detections in the fish ladder (a total of 26 suckers) occurred in late May during 2009 and early June during 2010. Kyger and Wilkens (2010) suggest that these peaks in sucker movement through the ladder in late spring coincide with increases in temperature (approaching 18°C) and decreases in water quality that typically occur in Lake Ewauna at that time of year. Nearly all detections of PIT-tagged suckers in the fish ladder occurred during the night or early morning or late evening, suggesting the preference of suckers to move during the night or in low light conditions. Kyger and Wilkens (2010) indicated that there were no relationships between discharge from Link River dam or discharge trend and sucker use of the fish ladder.

To address fish passage conditions in the Link River below the dam, Reclamation conducted a hydraulic modeling study (Reclamation 2005). USFWS (2007a) indicated that current operation of the East Side and West Side power diversion at Link River dam likely restricts adult sucker migration at flows less than about 300 cfs in the Link River bypass reach because of the location of the turbine outlets and at flows greater than 3,000 cfs because of the flow hydraulics in the cascade reach.

The current ladders at Keno and J.C. Boyle dams potentially impede the upstream migration of suckers in the system. However, the USFWS acknowledges that the effectiveness of the existing Keno ladder or need for a new ladder at Keno dam is unknown. This is because of a lack of information or observations on suckers downstream of Keno dam or migrating upstream through the Keno ladder (USFWS 2007a). The USFWS also concluded that operation of the J.C. Boyle fish ladder has no impact to adult Lost River and shortnose suckers because none appear to be attempting to migrate upstream of the dam to spawn or return to upstream rearing areas (USFWS 2007a, page 65).

There are no upstream fishways at Copco No. 1, Copco No. 2, and Iron Gate dams. However, the USFWS concluded that there are currently no effects on upstream sucker spawning migrations at these facilities because listed adult suckers are rare or absent in Copco No. 2, uncommon in Iron Gate reservoir, and absent in the Klamath River below Iron Gate dam (USFWS 2007a, page 66).

Because the river and reservoir reaches occupied by these species, particularly downstream of Keno dam, are not part of the original habitat complex of these sucker species and probably are inherently unsuitable for completion of their life cycles, it is assumed that the impact of potential take caused by migration barriers associated with Project facilities on Lost River and shortnose suckers would be minimal when considered within the context of their overall population size and geographic range. This is consistent with the conclusions reached by the USFWS (2007a).

Degradation and Loss of Habitat

Instream Flows

The ecological structure and functioning of aquatic, wetland, and riparian ecosystems depends on the hydrologic regime, or pattern and quantity of water flowing through the system. 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 adversely affect the composition, structure, and functioning of these systems (Annear et al. 2004).

The 1.2-mile long Link River is primarily used as a migration corridor for suckers moving between Keno reservoir and Upper Klamath Lake (Reclamation 1996; USFWS 2002).

Juvenile suckers have been sampled in Link River throughout the year, suggesting that this area may provide some rearing habitat (Reclamation 1996, 2000). The minimum flow requirements below Link River dam (as described above in Chapter IV under "Release Flows") likely avoid significant losses of habitat that would result at lower flows (USFWS 2007a).

The impact of any potential take of listed suckers resulting from degradation and loss of habitat due to low instream flows on the overall population is likely low. This is consistent with USFWS' conclusions contained in the 2007 BiOp (USFWS 2007a) that indicated that while current operation of Project developments and associated minimum instream flow requirements below Keno, J.C. Boyle, and Copco No. 2 dams may affect individual suckers in the Project area, these effects are minimal within the context of the overall population size and geographic range of the Lost River and shortnose sucker because these reaches are not part of the original habitat complex of the listed suckers and are inherently unsuitable for completion of life cycles of these suckers (USFWS 2007a, page 69).

Wetlands Loss

In their 2007 BiOp, the USFWS indicated that the loss of approximately 85,000 acres of historical wetlands that connected with the Klamath River above the present location of Keno dam has greatly reduced the historically available habitat for larvae and juveniles (USFWS 2007a, page 71). The USFWS concluded that the original construction of Keno reservoir has contributed to the losses of these wetland values, including an unknown amount of wetlands loss from assumed facilitation of agricultural conversion of lands by Keno reservoir, an unknown amount of wetlands loss due to maintenance dredging of Keno reservoir, about 230 acres of wetlands loss or degradation 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 Klamath Straits Drain (USFWS 2007a, page 71).

Collectively, the impact of the historical loss of habitat, including wetlands in Upper Klamath Lake and Keno reservoir, on the listed sucker population is likely significant. Continued operations over the interim period will continue to prevent the re-establishment of former wetland habitat because operations will moderate water level fluctuations in Keno reservoir that support and maintain habitat. Given that PacifiCorp does not control Upper Klamath Lake levels, continued operations over the interim period will not affect potential habitat losses upstream of Link River dam. However, the extent of these impacts and allocation of the responsibility for these is uncertain, as is the increment of effect contributed by PacifiCorp's continued operations over the interim period. In consideration of PacifiCorp's limited discretionary ability to manipulate lake levels in Keno reservoir and the short duration of interim operations, the impacts of potential take associated with habitat loss due to operations over the interim period is likely low.

Water Quality

In general, suckers are relatively tolerant of water quality conditions unfavorable for other fishes, tolerating higher pH, temperature, and un-ionized ammonia concentrations, and lower DO concentrations than many fishes (National Research Council 2004, Saiki et al. 1999). Nevertheless, despite their relatively high tolerance for poor water quality, Lost River and shortnose suckers may be affected by impaired summer water quality in Upper Klamath Lake and Keno reservoir (National Research Council 2004, Saiki et al. 1999).

Keno dam and its impoundment affect water quality primarily by increasing surface area, hydraulic retention time, and solar exposure (USFWS 2007a). The USFWS (2007a) concluded that impaired water quality conditions, especially low DO levels, occur during the summer, restricting the listed sucker species to the upper end of Keno Reservoir, and that fish die-offs, including listed suckers, occur frequently (USFWS 2007a includes citations by Piaskowski 2003 and Tinniswood 2006 to support their conclusion). Impaired water quality in Keno reservoir is largely responsible for the mortality of juvenile suckers dispersing downstream into the reservoir from Upper Klamath Lake (USFWS 2007a, page 75).

The USFWS estimated that about 6 million larvae, 100,000 juveniles, and 100 sub-adult/adult suckers disperse annually into Keno reservoir from Upper Klamath Lake. They estimate that 80 percent of these fish perish due to the impaired water quality conditions in Keno reservoir (i.e., about 5 million larvae, 80,000 juveniles, and 80 sub-adult/adult suckers annually) (USFWS 2007a, page 94). For larval suckers, the USFWS (2007a) concluded that this equates to approximately 7 percent of the estimated 73 million larvae entering Upper Klamath Lake from the Williamson River (based on Klamath Tribes [1996] data). There are no reliable population estimates for juvenile or sub-adult/adult suckers for Upper Klamath Lake (USFWS 2007b, 2007c) against which to judge potential effects. However, the USFWS believes the impact to adult populations to be minimal, since few sub-adult and adult suckers disperse out of Upper Klamath Lake (USFWS 2002, 2007a; Gutermuth et al. 2000a, 2000b).

VI. Conservation Program

To meet the statutory requirements for approval, USFWS must find, among other things, in an incidental take permit and related HCP: (1) how PacifiCorp will minimize and mitigate the impacts of authorized incidental take of Covered Species that may result from Covered Activities to the maximum extent practicable; and (2) how PacifiCorp will ensure that any such taking will not appreciably reduce the likelihood of the survival and recovery of such species in the wild. In addition, USFWS has issued an Addendum to the HCP Handbook (called the "Five Points Policy") calling for an HCP to identify specific biological goals and objectives based on the proposed action that necessitates incidental take permit issuance and the conservation needs of the Covered Species (65 FR 35251). The biological outcome of the conservation program is considered the most important measure of the success of an HCP (64 FR 11585).

Biological goals can be either habitat-based or species-based depending on whether they are related to the amount or quality of the habitat or to the individuals or populations of the species. This Plan's goals and objectives are a mix of both habitat and species-based. Permittees are not required to achieve the HCP biological goals and objectives to comply with their permits, rather these goals and objectives guide the development of the operating conservation measures. This Plan uses a combination of (1) prescriptive-based goals and objectives that identify a set of actions to achieve a certain result and (2) results-based goals and objectives where PacifiCorp has the flexibility in the implementation as long as certain results are achieved. The results-based strategy will be used primarily in cases where there is greater uncertainty about which measures will be able to be implemented within the Permit Term (e.g., measures dependent on landowner cooperation).

This section identifies the biological goals and objectives of the Plan, provides a detailed rationale for the conservation program, and sets forth the conservation plan that PacifiCorp will undertake on Covered Lands and within the Permit Area to achieve these goals and objectives. The following presents the goals and objectives of the Sucker Conservation Strategy and the conservation measures, monitoring, and adaptive management measures that PacifiCorp will undertake to address these goals and objectives. It also describes the anticipated effects of the Sucker Conservation Strategy on listed sucker species.

Sucker Conservation Strategy

The Sucker Conservation Strategy identifies take minimization and mitigation measures that respond directly to the sources of potential take that may occur as a result of PacifiCorp's Covered Activities during interim operations (see Table 3 above). The approach of the strategy focuses on two substantive conservation components for listed sucker species. First, PacifiCorp will avoid potential take associated with its Covered Activities by shutting down operations at its East Side and West Side hydroelectric facilities within 30 days after issuance of the ITP. Further operations, if any, of the East Side and West Side facilities prior to decommissioning of these facilities will occur only during periods of time when take of listed suckers is unlikely to occur. Second, PacifiCorp will improve habitat conditions for listed suckers by facilitating the implementation of specific enhancement projects consistent with the Recovery Plan and supporting The Nature Conservancy's (TNC) Williamson River Delta Restoration Project.

This strategy takes into consideration the complexity of system operation, including Reclamation's substantive role in influencing many of the factors/stressors addressed, and the uncertainty regarding quantification of take, the impact of the take, and the increment of this take that is attributable to PacifiCorp's operation over the interim period covered by this HCP. This strategy also acknowledges that several of the mechanisms that may result in the take of listed suckers (e.g., false attraction and passage) are currently addressed by a parallel process that will either result in removal of the lowermost four dams (in accordance with the terms the KHSA) or operation under a new FERC license.

This strategy also acknowledges and takes into consideration the following:

- Factors affecting listed suckers in the Klamath River system are complex, including a number of causes and sources over which PacifiCorp's Project activities have little or no influence or control.
- The uncertainty regarding quantification of take, the impact of the take, and the increment of take that is attributable to PacifiCorp's operations over the interim period covered by this HCP.

The conservation strategy described below is intended to minimize and mitigate the potential for take of listed suckers resulting from continued operations over the Permit Term.

Sucker Biological Goals and Objectives

The overarching biological goal of this HCP is to contribute to the conservation of Lost River and shortnose suckers on Covered Lands during the interim period. This goal will be achieved through implementation of measures that avoid or minimize the direct effects of PacifiCorp's operation (e.g., entrainment) on individual suckers and by funding enhancement efforts that will translate into benefits for listed suckers. While these goals are not quantitative, they are measurable as described below. More specific goals and objectives of the strategy, and measures to address the objectives, include the following:

Goal I: Minimize take associated with interim operations of the Project facilities

<u>Objective A</u>: Minimize entrainment at the East Side and West Side hydroelectric facilities. Minimization of take resulting from shutdown of these facilities will enhance juvenile sucker populations in the Klamath River.

The majority of estimated potential take of listed suckers associated with Project operations (see Tables 3 and 4) is related to operation of the East Side and West Side facilities. With reduced operations at the East Side and West Side facilities, potential Project impacts on listed suckers will be reduced, and the residual sources of potential take would be restricted to the downstream reservoirs where suckers contribute less to the overall population.

Measure Undertaken to Achieve Objective

To address Objective I.A, PacifiCorp will shut down operations at the East Side and West Side facilities within 30 days of the date of issuance of the ITP by USFWS. The facilities would remain in place until they are decommissioned through the FERC licensing process. Decommissioning is not a Covered Activity under this HCP. PacifiCorp will continue to maintain the facilities such that limited operations for testing or maintenance purposes are possible prior to decommissioning of the facilities. Further operations of these facilities, if any, would take place only during periods when take of listed suckers is unlikely to occur, such as during periods of low species presence. PacifiCorp will contact the Service no later than 30 days before any such operations for testing or maintenance purposes to provide information on the planned operations and allow the Service to recommend possible modifications of the planned operations to avoid take of listed suckers.

Shutdown of the East Side and West Side developments prior to decommissioning will reduce potential adverse effects to listed suckers identified in Chapter V. Specifically, the shutdown will result in additional benefits to listed suckers by reducing possible entrainment, ramping events, and false attraction to powerhouse tailraces.

The success of this goal and objective to minimize take associated with interim operations of the Project facilities is measureable by calculating the increased sucker survival attributable to discontinuation of operations of East Side and West Side facilities (as discussed in the section below entitled “Effects of the Sucker Conservation Strategy – Shutdown of the East Side and West Side Developments”).

Implementation of Measures

The measure will be implemented by ceasing diversion of water into the East Side and West Side powerhouses.

Goal II. Improve the viability of the listed sucker populations

Objective A: Increase the amount of available sucker habitat.

This objective is important because the amount of available sucker habitat is presently limited due to existing habitat conditions in the Project area. Increasing the availability of key sucker habitats will help improve spawning and rearing conditions prior to Project removal.

This goal and objective to improve the viability of the listed sucker populations by offsetting the impact of the potential take of individuals is measureable by demonstrating the effectiveness of improvements conducted under the Sucker Conservation Fund and support of the Williamson River Delta Restoration program. This could be accomplished by quantifying the units of habitat created or restored (e.g., acres of habitat or linear feet) or by demonstrating use of those restored sites by suckers.

Measures Undertaken to Achieve Objectives

To address Objective II.A, PacifiCorp will facilitate activities that enhance sucker habitat or otherwise promote the survival and recovery of listed sucker species. PacifiCorp will accomplish this by establishing a fund to support sucker recovery actions and providing continued support of the Williamson River Delta Restoration Project for the duration of the Permit Term.

Sucker Recovery Initiatives

Within 90 days following issuance of the ITP, PacifiCorp will make an initial contribution of $40,000 to a fund (the Sucker Conservation Fund) to support initiatives that promote sucker recovery. PacifiCorp will also support recovery initiatives by contributing an additional $30,000 to the fund on the fourth anniversary of the ITP and another $30,000 on the seventh anniversary. The total fund contribution over the Permit Term will be $100,000. This funding will be used to support and implement actions that increase the viability of the sucker populations consistent with the Recovery Plan (USFWS 2011a). The funding schedule outlined above will ensure that mitigation funding is available prior to potential incidental take occurring from Project operations during the Permit Term and will allow sucker recovery initiatives to be adequately planned and implemented to mitigate potential incidental take.

Recommendations for projects to be funded by the Sucker Conservation Fund will be provided by the Klamath Sucker Recovery Program. The draft revised Recovery Plan for the Lost River sucker and shortnose sucker (USFWS 2011a) calls for the establishment of a program comprised of interested parties and entities to coordinate implementation of recovery actions identified in the plan as necessary for recovery of these species. This Recovery Program will consist of federal and state agencies, nongovernmental organizations, tribal partners, and private stakeholders. Because it is comprised of experts within the fields relevant to sucker recovery and is generally responsible for the implementation of the Recovery Plan including prioritization and coordination of activities, the Klamath Sucker Recovery Program will be in a position to provide recommendations to PacifiCorp for use of the Sucker Conservation Fund that are based upon the best available scientific information.. Examples of potential sucker recovery actions that could be implemented with the Sucker Conservation Fund include the following: (1) restoration/enhancement of spawning areas in Upper Klamath Lake or in its tributaries; (2) capture of adult suckers in Keno reservoir and relocation to Upper Klamath Lake; and (3) off-lake rearing of wild-caught sucker larvae. Any of these three potential projects listed above could increase sucker reproduction in Upper Klamath Lake and thus promote their recovery.

The Sucker Conservation Fund will initially be administered by the National Fish and Wildlife Foundation (NFWF)[12]. If, for any reason, a different third party administrator is required during the Permit Term, PacifiCorp and USFWS will select a new third party administrator with demonstrated capability to successfully carryout the administration of the fund. NFWF will administer the fund upon receiving a list of sucker enhancement projects specified by PacifiCorp based on recommendations from the Klamath Sucker Recovery Program as described above. Thereafter, NFWF will be responsible for overseeing contracting with parties for the projects with funds provided from the Sucker Conservation

[12] NFWF is a 501(c)(3) non-profit organization created by Congress in 1984. NFWF directs public conservation dollars to projects and activities that preserve and restore native wildlife species and habitats, and matches those investments with private funds. NFWF works with a variety of individuals, foundations, government agencies, nonprofits, and corporations to identify and fund important conservation projects and activities throughout the U.S.

Fund. Certain projects funded by this account may qualify for matching grants or money from NFWF or other parties. Benefits anticipated from actions funded by the Sucker Conservation Fund are described below under "Effects of the Sucker Conservation Strategy."

Extended Funding of the Williamson River Delta Restoration Project

To specifically mitigate the impact of take of listed suckers during the Permit Term, PacifiCorp also will extend its significant funding support of TNC's Williamson River Delta Restoration project, which is one of the basin's most important sucker recovery and habitat restoration actions. PacifiCorp will extend its funding for this project for the duration of the Permit Term, resulting in total contributions of about $200,000, depending on the farm income. From these contributions, an average of $4,000 per year ($40,000 over the Permit Term) will be used directly to implement additional projects to increase sucker habitat through riparian and wetland plantings along the Williamson River and the shoreline of Upper Klamath Lake, and other sucker habitat enhancement projects at the Williamson River Delta Restoration project. The remainder of funds will be used for supporting ongoing sucker recovery and land management actions by TNC at the restoration project, such as creating and maintaining wetlands that improve water quality and providing rearing habitat for larval and juvenile suckers. Activities funded by PacifiCorp are expected to directly or indirectly improve survival of listed suckers and increase the likelihood of recruitment to the adult population.

With PacifiCorp's mitigation funding, TNC will also, with input from the USFWS and subject to the approval of the Natural Resources Conservation Service, make land available for the development and use of off-channel rearing ponds for larval suckers. Under a management agreement, TNC would provide the land as well as access to water and power.

These contributions will provide the support needed to continue to realize the conservation benefits of Williamson River Delta Restoration project (described below) , for which PacifiCorp has already provided significant funding as mitigation for Project operations. This funding will provide benefits to listed suckers and contribute to meeting the goals and objectives defined in the revised sucker recovery plan (USFWS 2011), while mitigating the impact of take during the Permit Term.

Planning and Selection of Measures

Sucker Conservation Fund

Funding to support sucker recovery initiatives undertaken through the Sucker Conservation Fund will be handled initially by NFWF. In evaluating proposed sucker recovery initiatives for selection and implementation, USFWS and PacifiCorp will consider the goals and objectives in the revised sucker recovery plan (USFWS 2011) and the following guidelines:

1. Whether the proposed project substantially reduces the threats to suckers, and how the project reduces these threats;
2. The recovery objectives of the proposed project and the anticipated dates for achieving them;
3. The estimated costs to complete the proposed project, along with a description of construction and permitting requirements, and the ability of the party undertaking the project to successfully and safely complete the project;
4. Whether the proposed project incorporates quantifiable, scientifically valid standards that will demonstrate achievement of recovery objectives;

5. Whether the proposed project includes provisions for monitoring and reporting progress on project implementation and effectiveness; and
6. The extent to which the proposed project is consistent with sucker recovery plans or other pertinent scientific literature applicable to the Klamath River Basin.

Williamson River Delta Restoration Project

As described above, PacifiCorp, in partnership with TNC, will continue contributing to the restoration of riparian and wetland habitats in the Williamson River Delta on Upper Klamath Lake to assist in the recovery of listed suckers over the Permit Term. PacifiCorp leases 1,100 acres of farmland (Tulana Farms) from TNC at the Conservancy's Williamson River Delta Preserve and uses its share of the income from the property to contribute to funding restoration actions at The Conservancy's Preserve. In October 2007, approximately 600 acres of this farmland was returned to wetlands, and the current farm operation is approximately 500 acres.

In 2006, after several successful pilot projects and the completion of environmental planning documents, TNC and Federal partners, including the Service, implemented a $9 million effort to restore 5,500 acres of wetlands at the Williamson River delta by removing approximately 2 million cubic yards of material from 22 miles of levees (Erdman and Hendrixson 2009). In support of this project, PacifiCorp voluntarily contributed $1.6 million towards the purchase of the Williamson River delta property in 1996, provided $750,000 in funding towards the restoration effort, and dedicated $100,000 from its share of the 2006 and 2007 farm lease income. This $100,000 contribution also fulfilled the requirement of a private match that helped TNC successfully compete for a $1 million grant from the North American Wetlands Conservation Council for this restoration work. This phase of the restoration project, one of the most significant projects initiated to restore habitat and advance the recovery of the endangered Lost River and shortnose suckers, was completed in October of 2008 (Erdman and Hendrixson 2009, 2010a, b). Subsequently, PacifiCorp also contributed an additional $67,000 from its share of farm revenue in 2007, 2008, and 2009 that was used to further extend and deepen the breaches along the lake and the river, work that was supported and guided by staff from both TNC and the Service.

Subsequently, the applicant also contributed an additional $97,000 from its share of Tulana Farms revenue since 2007 to support additional restoration activities that benefit listed suckers. These contributions supported actions to further extend and deepen the breaches along the lake and the river, work that was guided by staff from both TNC and USFWS. These efforts also included preparation of plans by TNC to implement additional riparian and wetland restoration actions in the Williamson River Delta Preserve to benefit recovery of the endangered suckers.

Throughout the Permit Term the applicant will continue to contribute net revenue from its share of the annual farm revenue at Tulana Farms (about $20,000 annually depending on farm revenue) to support restoration and recovery efforts for listed suckers for the duration of the Permit Term. Of this amount, about $4,000 per year will be used directly for additional sucker habitat enhancement projects at the Williamson River Delta project to restore and improve juvenile sucker rearing habitat with the remainder used to support and maintain existing restoration projects and operations at the Preserve to ensure the continued benefit of restoration projects that have been previously undertaken.

Effects of the Sucker Conservation Strategy

Shutdown of the East Side and West Side Developments

Potential take associated with operation of the East Side and West Side facilities will be eliminated upon shutdown within 30 days of ITP issuance. This will substantially enhance the benefits of the HCP by eliminating mortality at these facilities. Elimination of mortality caused by entrainment and ramping associated with East Side and West Side operations may reduce the overall potential take of larvae and juveniles (see Table 3) by as much as 90 percent and result in the elimination of potential adult mortality at these facilities. The projected reduction in potential entrainment mortality is presented in Table 5. Positive numbers for the change in mortality indicate increases in mortality; negative numbers indicate a decrease in mortality.

As described above, the East Side facilities include 1,729 feet of 12-foot-diameter, woodstave flow line and 1,362 feet of 12-foot-diameter, steel flow line. Prior to decommissioning, PacifiCorp will continue to provide flow through the flow line to maintain its structural integrity by allowing the woodstave portion of the flow line to remain wetted. Flow through the flow line also will continue to supply 0.21 cfs of irrigation water rights claims from the flow line by adjacent landowners, and will provide for some leakage from the woodstave portion of the flow line, which returns to the Klamath River. The maintenance flow provided to the flow line results in an approach velocity at the flow line intake of about 0.7 feet per second at a flow rate of about 80 cfs, which is typical during non-operational periods. Water leaked from the woodstave flow line returns to the Klamath River near its point of leakage or flows down the flow line alignment and returns to the Klamath River near the East Side powerhouse tailrace, where there is also an existing 8-inch-diameter drain valve on the flow line.

To avoid and minimize the amount of potential take associated with flow line maintenance, PacifiCorp will allow flow to exit the flow line by keeping open the 8-inch flow line drain valve at the East Side powerhouse. The turbine at the powerhouse will be secured and non-operational, avoiding turbine entrainment mortality. Flow through the open flow line drain valve will reenter the Klamath River at the powerhouse tailrace and will provide for passage of juveniles, eggs, and larvae that may be present in the flow line. Much of the leakage from the flow line also returns to the river at this location.

Take (mortality) associated with flow line maintenance should be limited to juveniles and larvae present in the water column at the intake structure. Due to the low approach velocities at the intake, adult and sub-adult suckers should be able to avoid entering the flow line or exit the flow line should they enter. Eggs and larvae entering the intake structure will be conveyed down the flow line in the water column and then through the open flow line drain valve.

TABLE 5
Estimates of Maximum Annual Sucker Mortality at Link River Dam and Project Facilities under the Conservation Strategy
Estimates are derived from USFWS (2012) (see Appendix A). All numbers are rounded to the nearest 10 except for adults. PacifiCorp does not agree that these estimates necessarily reflect take associated with its activities.

Life Stage/ Facility	**Estimated Mortality with HCP**			**Estimated Change in Mortality with HCP**		
	Turbine	Spillway and Flow Line[A]	Fluctuation & Stranding	Total with HCP	Total Current	Change in Mortality
Eggs						
J.C. Boyle	0	0	100,000	100,000	100,000	0
Larvae						
Link River Dam	0	111,220	0	111,220	56,100	55,120
East Side/West Side	0	22,780	0	22,780	1,005,000	-982,220
Keno	0	13,130	2,330	15,460	13,280	2,180
J.C. Boyle	15,120	80	23,510	38,710	33,260	5,450
Copco No. 1	13,730	0	1,160	14,890	14,560	340
Copco No. 2	10,300	0	100	10,400	10,270	130
Iron Gate	760	0	100	860	850	10
Total	*39,900*	*147,210*	*27,210*	*214,320*	*1,133,310*	*-918,990*
Juvenile						
Link River Dam	0	3,060	0	3,060	3,310	-250
East Side/West Side	0	340	0	340	340	0
Keno	0	330	110	430	430	0
J.C. Boyle	400	0	1,010	1,410	1,410	0
Copco No. 1	30	0	0	30	30	0
Copco No. 2	30	0	0	30	30	0
Iron Gate	0	0	0	0	0	0
Total	*450*	*3,740*	*1,110*	*5,300*	*5,550*	*-250*
Adult						
Link River Dam	0	4	0	4	3	1
East Side/West Side	0	1	0	1	13	-12
Keno	0	0	0	0	0	0
Total	*0*	*5*	*0*	*5*	*16*	*-11*

A: Spillway mortality at Link River Dam is attributable to Reclamation's operations.

Some amount of mortality of juveniles or larvae present in the flow line could occur as a result of leakage through the closed wicket gates in the powerhouse or as a result of discharge from leaks in the flow line. Take will be minimized by enabling fish to pass through the flow line structure unharmed through the open flow line drain valve. Mortality associated with water moving through the flow line, discharges through wicket gates, and flow line leakage is likely to be similar to that experienced at spillways (2 percent) given that any individuals within the flow line would not be exposed to a rotating turbine.

When the decommissioning process for the East Side facilities begins, as is anticipated to occur during the Permit Term, flow to the East Side flow line would be discontinued and the East Side flow line would be dismantled, eliminating take associated with this facility.

Shutdown of the East Side and West Side facilities could increase the number of suckers entering Lake Ewauna. This increase in the number of suckers entering Lake Ewauna translates to more suckers encountering the dams downstream of Keno dam and a minor increase in the estimated mortality associated with entrainment of those additional fish. Nonetheless, the shutdown of the East Side and West Side facilities is estimated to result in the survival of about a million additional larval suckers throughout the system. An overall reduction in mortality is also anticipated for juvenile and adult suckers.

Aside from entrainment, the USFWS has indicated that the remaining potential take associated with Project operations downstream of the East Side and West Side facilities does not have a significant effect on the overall populations of listed suckers (USFWS 2007a). Upstream from Keno dam, Keno reservoir has been proposed as critical habitat for sucker species. As described previously in chapter V (*Effects of Covered Activities on Covered Species*), the effects on habitat in Keno reservoir over the interim period will be low due to PacifiCorp's limited discretionary ability to manipulate lake levels in Keno reservoir and the short duration of interim operations. USFWS (2012) provided estimates of the number of listed suckers that could potentially be stranded at Project facilities due to fluctuating reservoir elevations, including Keno reservoir. These estimates are summarized in Table 4.

Potential Project-related effects to listed suckers that may occur at facilities downstream of the historic Keno Reef occur to individuals that are not contributing to the population. Areas downstream from Keno dam were not proposed for designation as critical habitat because such areas do not contain physical or biological features essential for the recovery of the species. However, PacifiCorp believes the presence of its Project reservoirs downstream of Keno dam create habitat conditions in which suckers may reside as compared to riverine conditions that would not otherwise support suckers. The populations in downstream reservoirs are minimal, but represent a reserve population that could be available to supplement populations should there be a catastrophic event affecting these species.

Sucker Recovery Initiatives

The actions undertaken through the Sucker Conservation Fund will mitigate the potential impacts of the taking caused by entrainment at Project dams downstream of Link River dam that cannot be avoided. These actions also will contribute to meeting the biological goals and objectives of the revised sucker recovery plan (USFWS 2011) by mitigating the impacts of take associated with false attraction, instream flows and habitat availability, stranding (reservoir fluctuations), and migration barriers. As previously described in Chapter V, the impact of the potential take reasonably attributable to Project operations is low because very few fish relative to the population as a whole would be taken, and all take would occur downstream of Keno dam where individual suckers do not contribute to the population.

Actions undertaken using funding provided by the Sucker Conservation Fund would be selected by the Klamath Sucker Recovery Program to support the conservation goals and objectives. PacifiCorp would verify project selections to ensure that selected projects are consistent with HCP goals and ITP requirements. Various projects described in, or defined from the sucker recovery plan could be done with these funds and provide substantial conservation benefits, such as (1) restoration/enhancement of spawning areas in Upper Klamath Lake or in its tributaries; (2) capture of adult suckers in Keno reservoir and relocation to Upper Klamath Lake; and (3) off-lake rearing of wild-caught sucker larvae. Also, these funds may be combined with funds from other sources to be used for larger and more expensive projects that would have greater benefits. The Sucker Conservation Fund provides the flexibility to focus the mitigation on actions that create the greatest benefit for suckers, regardless of the proximal cause. Therefore, this measure is expected to mitigate the impact of the take resulting from these sources by making habitat improvements or otherwise increasing survival and recruitment to the adult population (e.g., trapping and transporting adults from reservoirs downstream of Keno dam to the Upper Klamath Lake where they can contribute to the population).

Williamson River Delta Restoration Program

Continued funding of TNC's Williamson River Delta Restoration Project will further mitigate the impact of the residual take associated with the operation of downstream facilities by contributing to the restoration of the historic form and function of the riparian corridor in the Williamson River Delta and improving habitat complexity by increasing the variety and amount of the riparian vegetation. Native riparian vegetation provides a productive medium for zooplankton on which larval suckers feed. These areas not only provide physical protection from predators, but also rich feeding grounds for young fish. Actions to increase wetland areas would contribute to reducing nutrients in the lake. Relatively high quality water from the interior western wetlands could provide refuge to larval suckers in the fringe wetland habitats, which are, in their current condition, seasonally inundated with poor quality Upper Klamath Lake water (low DO, high pH, high unionized ammonia) along the southern perimeter of the Williamson River property. Investment in improvements in the Williamson River Delta addresses habitat limitations in an important part of the suckers' range.

Given the minimal residual impacts (see Table 5) following elimination of take at East Side and West Side facilities, the amount of funding allocated for habitat improvement under this HCP should be more than sufficient to mitigate the population-level impact of the estimated take. This conclusion is based on the low level of take associated with operation during the Permit Term (e.g., non-lethal take of three adult suckers annually) and the fact that the suckers taken at Keno dam and the downstream facilities are part of a sink group of fish that are lost to the sucker population, and that therefore do not contribute to the sucker population. Thus, any increased survival and recruitment to the adult population in Upper

Klamath Lake and its tributaries that are achieved by the actions funded by PacifiCorp will represent a positive contribution to the population and will mitigate all take anticipated during the Permit Term.

In addition to the HCP measures, PacifiCorp also is taking actions as part of the Settlement under interim measures 11 and 15 to address water quality over the interim period. Under Measure 11, PacifiCorp is funding studies or pilot projects that emphasize nutrient reduction projects in the watershed, while also addressing water quality, algal and public health issues in Project reservoirs and dissolved oxygen in J.C. Boyle reservoir. If the Secretary of the Interior renders an Affirmative Determination, PacifiCorp will make substantial investments in the implementation of projects to reduce nutrients in the watershed while also seeking to improve water quality conditions in and downstream of the Project during the Interim Period. Under Measure 15, PacifiCorp is funding long-term baseline water quality monitoring to support dam removal, nutrient removal, and permitting studies. PacifiCorp is also funding blue-green algae and blue-green algae toxin monitoring as necessary to protect public health. These measures are not part of this HCP, but their implementation will improve water quality conditions in the HCP Area over the interim period and benefit listed suckers.

In summary, the conservation actions undertaken as part of this HCP will result in:

- Substantial shutdown of the East Side and West Side facilities and elimination of potential take due to turbines
- Elimination of take caused by PacifiCorp resulting from stranding in the Link River downstream of Link River dam and false attraction at the discharges from East Side and West Side facilities
- Substantial reductions in the overall potential mortality of sucker larvae, juveniles, and adults potentially resulting from operation of Project facilities (see Table 5)
- Enhancements to the survival and recovery of listed suckers facilitated by funding sucker recovery initiatives under the Sucker Conservation Fund through a partnership with NFWF, and continued funding of the Williamson River Delta Restoration Project for the duration of the Permit Term along with the opportunity for development and use of off-channel rearing ponds for larval suckers at the project to contribute to sucker recovery efforts.

With implementation of these measures, the remaining potential for take would be very low (see Table 5) relative to current operations. In addition, the take that could potentially occur would affect suckers downstream of the historic Keno Reef where individuals are not contributing to the population. Therefore, the impact of the taking on the populations of listed suckers would be minimal and implementation of these measures would minimize and mitigate the impact of taking individual listed suckers during the interim period.

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VII. Monitoring and Adaptive Management

PacifiCorp will conduct monitoring of Project facilities operations and conservation activities as described under this HCP to ensure that operation of the facilities and implementation and effectiveness of conservation activities conform to the ITP. PacifiCorp will prepare an annual monitoring report each year during the term of the ITP to document Project operations and implementation and effectiveness of activities under this HCP as authorized in the ITP. Monitoring and adaptive management activities for Project facilities, Sucker Recovery Initiatives, and the Williamson River Delta Restoration Program are described in the sections below.

PacifiCorp will submit the annual monitoring report to USFWS by May 1 of the next calendar year for review and discussion. Based upon information contained in the report, measures implemented under the HCP may be augmented or modified as determined in consultation with and approval by USFWS.

Project Facilities

The annual monitoring report will include information on the total flow in the Klamath River in the Project area and the proportion of the total flow (in percent) passing through the turbines and the spillways at East Side/West Side, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams for the purpose of determining the proportion of flow diverted through the turbines. Upon shutdown, monitoring activities at the East Side and West Side facilities will not be necessary because PacifiCorp will no longer be diverting water through the turbines and discharging water at the tailraces. All take attributable to the operation of the turbines at the East Side and West Side developments will be eliminated. However, the applicant will monitor flows in these facilities, if any occur, and provide that information to the Service in the annual monitoring report. Monitoring at the downstream facilities will be conducted using flow through the turbines as a surrogate as described below in Section VIII, Compliance with Authorized Level of Take.

Sucker Recovery Initiatives

Projects selected for implementation using the Sucker Conservation Fund will incorporate effectiveness monitoring as a part of the project design. Information obtained from effectiveness monitoring will be provided to the selected third party administrator, who in turn will produce an annual report summarizing project implementation and effectiveness. Information obtained from this annual report will be provided to USFWS and PacifiCorp for review and discussion. Based upon information obtained from monitoring results, measures implemented under the fund may be augmented, modified or discontinued.

Williamson River Delta Restoration Program

Ongoing support of the Williamson River Delta Restoration Program will be monitored as part of TNC's overall monitoring for the program. TNC will prepare and provide the

USFWS and PacifiCorp an annual report that documents program progress, accomplishments of the prior year, and future restoration plans and schedule. The annual report also will document contribution of PacifiCorp's entire share of the proceeds from farming operations to support the Williamson River Delta Restoration Program.

VIII. Compliance with Authorized Level of Take

PacifiCorp seeks an ITP authorizing the level of potential take of listed suckers identified in Table 3 and Table 5[13], as adjusted by the elimination of potential take resulting from shutdown of the East Side and West Side facilities. As summarized in Table 5, PacifiCorp estimates an annual lethal take (based on mortality estimates) of up to 100,000 eggs, 103,100 larvae, 2,240 juveniles, and 1 adult at the Eastside/Westside, J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate facilities under the proposed operational strategy. It is not practicable or feasible to directly measure the number of suckers taken at the Project hydroelectric facilities, and the monitoring (e.g., trapping suckers in spillways) would likely in itself lead to take or mortality of the species. Therefore, PacifiCorp will monitor the proportion of river flows passing through the Project hydroelectric facilities as a surrogate for take of listed suckers. This flow monitoring will also serve as the basis for demonstrating compliance with the authorized level of take.

The rationale for this approach is based on the assumptions used by USFWS (2012) to estimate annual mortality of suckers associated with Project operations (Appendix A). As described above in Chapter V, USFWS (2012) estimated 25 percent mortality for suckers entrained into hydroelectric turbines and 2 percent mortality for suckers entrained into spillways, flow lines, and bypasses. USFWS (2012) further assumed that suckers are entrained in proportion to flow through these features. Because the mortality associated with entrainment into the turbines (25 percent) is higher relative to the mortality associated with entrainment into the spillways, flow lines, and bypasses (2 percent), PacifiCorp's operations could result in an increased level of potential take beyond the estimates in Table 5 only if they increase the proportion of flow entering the turbines above the proportions of flow listed in Table 6, which are the flow proportions reasonably certain to occur during the 10-year Permit Term as explained below.

The USFWS (2012) entrainment estimates for sucker larvae, juvenile, and adult (used as the basis of estimates presented in Tables 3 and 5) assume percentages of flow through the turbines at Link River dam and the other Project dams as previously described in Chapter V. The entrainment estimates for sucker larvae were derived based on flow routed through the turbines at these facilities in the month of June. The entrainment estimates for sucker juveniles were based on the flow routed through the turbines during the period August through September, and for sucker adults were based on the period August through October. These respective periods correspond to the periods of most potential entrainment of these life stages (Gutermuth et al. 2000a, USFWS 2007).

Table 6 lists the reasonably foreseeable flow proportions (in percent) to be passed through the turbines at the Project facilities in June, August-September, and August-October periods

[13] As PacifiCorp has noted in its comments on the 2007 BiOp, no evidence of sucker take exists that has not otherwise already been addressed (PacifiCorp, 2007b). Nonetheless, PacifiCorp proposes to quantify and monitor sucker impacts similar to the approach contained in USFWS' 2007 BiOp (USFWS 2007a) as a part of its overall conservation strategy.

during the 10-year Permit Term. The June, August-September, and August-October periods correspond to times of most potential entrainment of sucker larvae, juveniles, and adults, respectively, as noted above and previously described in Chapter V.

Because PacifiCorp's Project facilities make use of the available water in the river for generation purposes after minimum instream flow requirements have been met, the proportion of flow diverted to Project turbines on an annual basis varies depending on the water year type, with higher proportions of the overall flow being diverted into Project turbines during dry years and lower proportions diverted during wet years. It is not possible to forecast what water year types will be experienced during the 10-year Permit Term. However, the Permit Term is a long enough period that a dry water year type is likely to occur. The flow proportions as listed in Table 6 are based on flows routed through the turbines at Project facilities during recent operations in dry years (over the period 1994 to 2011). PacifiCorp plans to operate the turbines at these Project facilities in similar fashion during the 10-year Permit Term. Thus, the flow proportions (as listed in Table 6) for the Keno, J.C. Boyle, Copco No. 1, Copco No. 2 and Iron Gate facilities are reasonably foreseeable to occur during the Permit Term.

For the East Side/West Side facilities, the flow proportion values in Table 6 are listed at zero. As discussed in Chapter VI, substantial shutdown of the East Side/West Side facilities will occur under the Conservation Strategy, with only very limited operations for maintenance purposes prior to decommissioning. Furthermore, any limited operations for maintenance purposes would only occur outside the June-October period of concern for potential entrainment of sucker larvae, juveniles, and adults (as noted above and previously described in Chapter V). Shutdown of the East Side/West Side facilities will result in a significant reduction in the overall amount of estimated take, including an estimated reduction of about 1 million larvae (Table 5).

TABLE 6
Reasonably Foreseeable Proportions of River Flows to be Passed Through Turbines at Klamath Hydroelectric Project Facilities During the Permit Term

Period	East Side + West Side	J.C. Boyle	Copco No. 1	Copco No. 2	Iron Gate
June (Larvae)	0	94	100	100[1]	98
August-September (Juveniles)	0	97	100	100[1]	98
August-September (Adults)	0	97	100	100[1]	98

Notes: 1 – Although there is no instream flow requirement in the Copco No. 2 bypass reach, PacifiCorp's practice is to maintain an instream flow of approximately 5 cfs in this reach. The flow proportion in the table reflects a continuation of this practice, although the flow proportion has been rounded to 100.

The procedures for monitoring the flow-based surrogate are as follows:

1. PacifiCorp will monitor the total flow in the Klamath River in the Project area and the proportion (in percent) of the river flow entering the East Side/West Side, J.C.

Boyle, Copco No. 1, Copco No. 2, and Iron Gate facilities that passes through the turbines at these facilities. There are no turbines at Keno dam; all water passing Keno dam is through the spillway and bypass features. PacifiCorp does not control the amount of water that passes through Keno dam, and therefore does not have the ability to influence the level of take associated with entrainment or spillway mortality at that facility.

2. Monitoring of flows at Project facilities by PacifiCorp occurs throughout the year, but for purposes of monitoring the surrogate PacifiCorp will focus on the June, August-September, and August-October periods, which correspond to times of most potential entrainment of sucker larvae, juveniles, and adults, respectively, as assumed in USFWS (2012) entrainment estimates (as presented in Table 3). Proportional flow values for these periods will be compared against the flow values contained in Table 6 to account for reductions in flow at East Side/West Side facilities, and corresponding changes in operational conditions at other project facilities. Compliance with the authorized level of take will be demonstrated if the actual proportional flow values for these periods are equal to or less than the flow values contained in Table 6.
3. As previously described in Chapter VII, PacifiCorp will prepare and file an annual monitoring report by May 1 of each year during the term of the ITP to document implementation and effectiveness of activities under this HCP as authorized in the ITP. This annual report will also provide monitoring results obtained for the June, August-September, and August-October periods of the previous year, and describe conformance to the flow values in Table 6 as determined above. If monitoring results indicate that the values in Table 6 have been exceeded, or have the potential to be exceeded in the upcoming year of the ITP term, PacifiCorp will then confer with USFWS to evaluate further if estimates of potential take in fact exceed authorized take levels. PacifiCorp, in consultation with USFWS, will:
    - Assess whether and how exceedances of the flow-based surrogate may be related to Project operations that were atypical and unlikely to reoccur.
    - Using the USFWS (2012) entrainment estimation method, calculate estimates of potential mortality of suckers based on the monitored flow proportion values at the Project facilities. Compare these calculated estimates with the USFWS (2012) estimates to determine if, and to what extent, the estimates of potential mortality of suckers are greater than identified in Table 5, as adjusted by the reduction of potential take resulting from substantial shutdown of the East Side and West Side facilities.
4. To the extent that the flow-based surrogate is exceeded as determined by the steps outlined above, PacifiCorp will confer with USFWS on potential actions to be implemented, including reducing the volume of water diverted through turbines, or increasing the amount of spill over project facilities.

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IX. Changed and Unforeseen Circumstances

Changed Circumstances are defined in the ESA implementing regulations as changes in circumstances affecting a species or geographic area covered by a conservation plan or agreement that can reasonably be anticipated by plan or agreement developers and the Service and that can be planned for (e.g., the listing of new species, or a fire or other natural catastrophic event in areas prone to such events). The regulations also provide that if additional conservation and mitigation measures are deemed necessary to respond to changed circumstances, and are provided for in the HCP's operating conservation program, the permittee will implement the conservation measures specified in the HCP.

Unforeseen circumstances are defined in the ESA implementing regulations as changes in circumstances affecting a species or geographic area covered by a conservation plan or agreement that could not reasonably have been anticipated by plan or agreement developers and USFWS at the time of the conservation plan's or agreement's negotiation and development, and that result in a substantial and adverse change in the status of the covered species. Should unforeseen circumstances occur, modifications to the Plan will be made only in accordance with the procedures set forth in the IA.

Changed Circumstances Identified in the Plan

Changed circumstances that could typically affect the implementation of the HCP include fire, windstorms, and other environmental events, such as climate change. Events such as fire and windstorms are unlikely to impact project operations or HCP implementation in a manner that can be reasonably planned for, and as a result, no specific measures have been identified to respond to these events.

Climate change has the potential to influence the status of listed suckers over the long term. However, climate change will not likely produce a discernible change on Covered Lands during the term of the ITP because of the short duration of the plan and the broad variation in inter-annual flows and temperatures. Any potential climate change-related effects on river flow (extreme drought or flood) can be addressed as described below.

Events such as severe drought, extreme flood events, significant fish disease outbreaks, and the listing of new species or a change in the status of a covered species can be reasonably anticipated during the Permit Term. These events could influence listed suckers in different ways:

- Severe drought and a reduction in flow have the potential to adversely influence the availability and quality of habitat for listed suckers. Reduced flows could contribute to the deterioration of water quality and incidence of fish disease in Project reservoirs. Severe droughts could also reduce or eliminate access to spawning and rearing areas due to dewatered stream reaches.

- Significant flood events, although likely providing habitat benefits for listed suckers, may damage or destroy certain habitat enhancement projects implemented under the Sucker Conservation Fund.
- Significant disease outbreaks, which may or may not be associated with drought, also could substantially influence the status of populations of listed suckers.
- Listing of additional species could influence the effectiveness of the HCP conservation strategy if the requirements of the newly listed species conflicted with the conservation actions of this HCP.

As described in Chapter IV of the HCP, PacifiCorp has limited control over water flows in the Klamath River, and thus has limited ability to respond directly to drought or flood conditions in the Klamath River. Reclamation is responsible for management of flow volumes in the upper Klamath River, including flows that both enter (from Upper Klamath Lake at Link River dam at RM 254) and exit (from Iron Gate dam at RM 190.5) the area occupied by PacifiCorp's Project developments. Reclamation also manages Upper Klamath Lake elevations to meet ESA requirements and contractual irrigation demands of the Klamath Irrigation Project. Downstream of Link River dam, surface water volumes are largely controlled by Reclamation operations.

Measures for Changed Circumstances

The HCP was developed in consideration of environmental conditions in the Klamath River and reservoirs that are reasonably certain to occur over the term of the ITP. For example, habitat conservation projects to be funded by the Sucker Conservation Fund will be recommended by the Klamath Sucker Recovery Program as described above in Chapter VI. This Recovery Program is comprised of experts within the fields relevant to sucker recovery and is generally responsible for the implementation of the Recovery Plan including prioritization and coordination of activities. Advice obtained from this group of experts will help insure that PacifiCorp continues to achieve identified goals and objectives in this HCP (as described above in Chapter VI).

Three types of changes are identified in the HCP as potential "changed circumstances" as defined in applicable federal regulations and policies:

1. Drought with a recurrence probability of 100 years as measured at Iron Gate dam,
2. Flood with a recurrence probability of 100 years as measured at Iron Gate dam,
3. Water quality degradation or significant disease outbreaks that results in fish kills of a magnitude that exceeds previously recorded events.

If a changed circumstance identified above occurs, then the following measures will be implemented:

1. If a drought or flood occurs rising to the level of a changed circumstance, USFWS may, in consultation with PacifiCorp, adjust habitat enhancement priorities under the Sucker Conservation Fund to address these changed circumstances;

2. If a water quality degradation or significant disease outbreaks occur rising to the level of a changed circumstance, USFWS may, in consultation with PacifiCorp, adjust habitat enhancement priorities under the Sucker Conservation Fund to address these changed circumstances; and
3. If a drought occurs rising to the level of a changed circumstance, PacifiCorp will meet with Reclamation and USFWS to discuss changes to flow releases entering and exiting the Project area (at Link River dam and Iron Gate dam, respectively) to address the changed circumstances.

New Listing of Species that are Not Covered Species

The preamble to the No Surprises rule states that the listing of a species as endangered or threatened could constitute a changed circumstance. Therefore, if a species is listed under the federal ESA subsequent to the effective date of the ITP, and that species (i) is not a Covered Species, and (ii) is affected by the Covered Activities, such listing will constitute a changed circumstance. Where a new listing that constitutes a changed circumstance occurs, PacifiCorp will follow the procedures set forth in the IA.

Measures for Unforeseen Circumstances

All other changes in circumstances affecting a Covered Species or its habitat on Covered Lands that are not designated changed circumstances are considered not reasonably foreseeable in the context of this Plan. For purposes of this Plan such changes are Unforeseen Circumstances. In the event that Unforeseen Circumstances occur, modifications to the Plan will be made only in accordance with the procedures set forth in the IA.

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X. Funding

The ESA implementing regulations require applicants to ensure that adequate funding will be provided to implement the HCP. Further, the USFWS must ensure that funding sources and levels proposed by the applicant are reliable and will meet the purposes of the HCP.

All of the measures identified in this HCP, including PacifiCorp's commitment to monitoring, will be funded through PacifiCorp's operating budget for the life of the permit. PacifiCorp is financially solid and derives income from wholesale and retail electricity sales to more than 1.7 million customers as a regulated, investor-owned utility doing business in six western states. PacifiCorp has sufficient revenue to cover the cost of implementing and funding the measures proposed in the HCP.

PacifiCorp estimates ongoing implementation costs for the HCP to be in excess of $300,000 over the course of the Permit Term. This does not account for the loss in generation resulting from the shutdown of the East Side and West Side facilities or the staff costs and expenses related to HCP implementation. Expected costs to implement the HCP are based upon the following elements:

- Funding of $100,000 to implement measures benefitting Lost River and shortnose suckers through the Sucker Conservation Fund.
- Annual funding of about $20,000 for the Williamson River Delta Restoration Project
- Costs to implement flow operations, monitoring and maintenance activities related to HCP implementation.
- Salary and expenses for PacifiCorp staff involved in implementing HCP measures.

Based on these elements, PacifiCorp will include the costs to implement the HCP in its 10-year business plan and operating budget. These costs will then be included in rate cases before the public utility commissions in the states where PacifiCorp provides electrical service. If the public utility commissions determine these costs to be a prudent expenditure, the commissions will set electric rates at a level that will allow PacifiCorp to recover the costs through rates for electricity sales to its customers.

As identified in Section 7.1 of the Implementing Agreement, PacifiCorp shall, by April 30 of each year during the term of the ITP, provide USFWS with a letter from PacifiCorp's general manager with authority over Covered Activities verifying that funding has been deposited with a third party administrator for the Sucker Conservation Fund in an amount adequate to ensure compliance with the Plan for the first year of the Permit Term and with TNC to support restoration efforts. PacifiCorp is also required to submit annual reports prepared by the third party administrator detailing expenditure made during the preceding calendar year and the current balance of the funds. The third party administrator and PacifiCorp shall each certify the accuracy of information contained in such reports. These reports are intended to help USFWS ensure that adequate funding will be provided to implement the

HCP and that funding sources at the required annual levels are reliable and will meet the purposes of the HCP. In addition, the funding schedule for the Sucker Conservation Fund outlined in the Sucker Conservation Strategy (Section VI) provides for mitigation funding to be available in advance of operations that have the potential to result in incidental take. This ensures that mitigation funding is available prior to potential incidental take occurring and allows for sucker recovery initiatives to be adequately planned and implemented.

XI. Other Alternative Actions Considered

The conservation measures described above were developed through lengthy discussions between PacifiCorp and USFWS, and are directly based upon findings contained in the USFWS respective BiOps on Project relicensing. Consequently, such measures are intended to address specific impacts previously identified by USFWS as potentially rising to the level of take of listed suckers.

The following two alternative permitting actions have been contemplated by the parties in addition to issuance of ITP as proposed by the Applicant. Neither of these two alternative permitting actions was considered further because they would not reduce the level of take compared to the proposed HCP and would not result in the issuance of an ITP that would provide the additional regulatory certainty sought by PacifiCorp in view of its substantial financial commitments.

No Action Alternative 1

Under No Action Alternative 1, USFWS would not issue an ITP to PacifiCorp. The conservation measures contained in the HCP would either be deferred or not implemented. The Project would continue to operate under the terms and conditions of the existing license in a manner consistent with current operations. The potential environmental effects of the No Action Alternative, based on the key issues of concern studied by FERC and USFWS include the direct, indirect, and cumulative impacts, including impacts related to the operation of the Klamath Irrigation Project and other activities described as the “Baseline Condition” by USFWS. These effects described by USFWS include:

- Entrainment of fish at various Project facilities (e.g., diversion structures), especially the entrainment of suckers at the East Side and West Side power generation facilities at Link River dam.
- Stranding of fish and their eggs due to rapid flow changes below Project facilities.
- Increased incidence of fish diseases resulting from impaired water quality and other conditions.
- Continued loss of access to habitat blocked by Project facilities.
- Secondary impacts of operations on wildlife, vegetation, recreation, cultural resources, and other resources evaluated in the FEIS.

Mitigation measures were developed by FERC and USFWS in response to these concerns but, under the No Action Alternative 1, conservation measures would not be implemented to address these concerns. No Action Alternative 1 would result in the continuation of Project impacts identified by the agencies without corresponding conservation measures.

No Action Alternative 2

Under No Action Alternative 2, PacifiCorp would continue to implement certain proposed conservation measures, but would do so in the absence of an ITP from USFWS authorizing take associated with such measures. This alternative differs from No Action Alternative 1 in that PacifiCorp would attempt to implement the conservation measures identified in this HCP to the extent possible. However, failing to obtain an ITP may prevent PacifiCorp's implementation of conservation measures deemed beneficial by USFWS. Further, PacifiCorp has justified expenditures associated with the interim conservation measures on the basis that it would obtain an ITP from USFWS in a timely manner that provides additional regulatory certainty. Consequently, it is uncertain whether PacifiCorp would continue expenditures on conservation without issuance of an ITP.

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Appendices

APPENDIX 1.

Analysis of Current Effects of Link River and Klamath River Dams On Lost River and Shortnose Suckers

The following analysis of the effects of the Link and Klamath River developments including dams, reservoirs, and power generation facilities on the Lost River suckers (LRS) and shortnose suckers (SNS) is primarily from the Service's 2007 biological opinion (BO) for relicensing of the PacifiCorp's Klamath [hydroelectric] Project developed for the Federal Energy Regulatory Commission (FERC) and the 2008 biological opinion (BO) for continued operation of the Bureau of Reclamation's Klamath [irrigation] Project (USFWS 2007, 2008). Here we describe the effects that turbines, spillways, fluctuating reservoir water levels, varying ramp rates, and other actions taken by PacifiCorp have on LRS and SNS. Because a quantification of effects to LRS and SNS based on field measurements at each facility were unavailable for most of PacifiCorp's Project (USFWS 2007), it was necessary to make assumptions, as described below. The primary assumptions used in our analysis are: (1) entrainment is directly proportional to flow, i.e.; as flow through facilities increases so does entrainment (2) turbine mortality = 25 percent of suckers passing through the turbines; (3) spillway mortality = 2 percent of suckers passing through the spillways; and (4) 90 percent of suckers entering most reservoirs (exception being Copco No. 2) remained in those reservoirs rather than dispersing downstream; other assumptions are described below.

1.0 Larval Suckers –Annual Turbine and Spillway Mortality

Link River Facilities. Facilities at the upper Link River at the outlet of Upper Klamath Lake (UKL) include the A-canal and the Link River Dam, both owned by Reclamation, and the East Side and West Side power canals and power houses owned by PacifiCorp. Based on entrainment studies at the A-canal and East Side and West Side power canals by Gutermuth et al. (1997,1998, and 2000a, b), up to 8.8 million sucker larvae could enter the Link River above the dam from UKL annually (USFWS 2007; Figure A1). Of these, we estimate that 3.3 million larvae are entrained into the A-canal headworks and of these 1.65 million larvae pass through the A-canal fish screen (assuming 50 percent pass through screen and 50 percent are by-passed back to the Link River), and 1.65 million larvae are by-passed back into the Link River (USFWS 2008). Because larval suckers are weak swimmers, we assumed 1.24 million (75 percent) of these by-passed larvae drift downstream to be entrained at the dam and associated East Side and West Side power canals, and 0.4 million (412,500) return to UKL (USFWS 2007, 2008).

Of the up to 6.7 million sucker larvae that reach the Link River Dam, we estimated that 2.7 million (2,680,000) are entrained at the spillway gates where an estimated 53,600 (or 2 percent) die from trauma (USFWS 2007, 2008). Of the up to 4 million (4,020,000) larvae that are estimated to be entrained at the East Side + West Side power canals, an estimated 1 million (1,005,000 or 25 percent) die as a result of turbine mortality, as discussed below (Table A1). Consequently, of the estimated 8.8 million larvae entering the Link River annually from UKL, approximately 0.4 million return to UKL, 1 million are estimated to die as a result of injuries from turbines and spillways, and 5.6 million larvae enter Keno Reservoir alive (Figure A1).

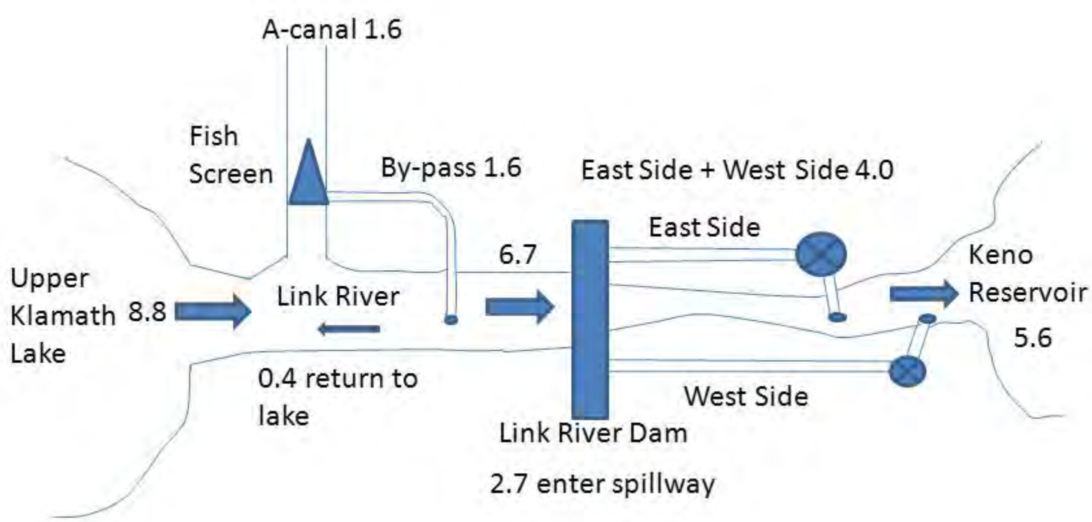


Figure A1. Diagram showing estimated larval entrainment at the A-canal fish screen, the Link River Dam, and the East Side and West Side power canals and power houses under current operations. Approximate maximum numbers of LRS and SNS larvae estimated to be annually entrained at each facility are shown in parentheses. Numbers are rounded to the nearest 1 million larvae.

Table A1. Estimated maximum annual sucker mortality at Link River dam and the Klamath River hydropower facilities under current operations due to turbines, spillways, and flowlines.

	Facility							
Life Stage	**East Side + West Side**	**Link River**	**Keno**	**J.C. Boyle**	**Copco No. 1**	**Copco No. 2**	**Iron Gate**	**Total**
	Current Operations - Turbine Mortality							
Larvae	1,005,000	0	0	12,992	13,556	10,167	747	1,042,462
Juveniles	0	0	0	396	31	23	2	452
Adults	13	0	0	0	0	0	0	13
	Current Operations - Spillway and Flowline Mortality							
Larvae	0	53,600	11,283	66	0	0	1	64,950
Juveniles	340[1]	3,061	333	1	0	0	0	3,735

	Facility							
Life Stage	**East Side + West Side**	**Link River**	**Keno**	**J.C. Boyle**	**Copco No. 1**	**Copco No. 2**	**Iron Gate**	**Total**
Adults	0	3	0	0	0	0	0	3
	Current Operations - Total Turbine and Spillway Mortality							
Total	1,005,353	56,664	11,616	13,455	13,587	10,190	750	1,111,615

1. The estimate for juvenile spillway mortality at the East Side and West Side facilities is based on estimated mortality due to passage through the East Side flowline, which is assumed to be 2 percent. Under current operations, East Side and West Side turbines are offline during the August – October peak entrainment period as explained in the text, but 80 cfs flow passes through the flowline.

Keno Facilities. We estimated that 10 percent of larval suckers entering Keno Reservoir from UKL are entrained at Keno Dam and 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 (USFWS 2007). Thus of the 5.6 million (5,641,400) sucker larvae entering Keno Reservoir alive, 564,140 would be entrained at the Keno Dam. Although Keno Dam does not have turbines, fish moving downstream must pass through the spill gates, a fish ladder, sluice conduit, or auxiliary water supply and some mortality would result. 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 larvae entrained and which equals 11,283 larvae (Table A1). Based on this, of the larval suckers passing the Keno Dam, we estimate that 552,857 larvae move downstream alive.

J.C. Boyle Facilities. We estimated that 10 percent of the sucker larvae entering J.C. Boyle Reservoir from Keno Reservoir are entrained at J.C. Boyle Dam. Based on flow data provided by PacifiCorp for the years 1994-2011, an average of 94 percent of the flow passed through the turbines in June when most larvae were entrained (Gutermuth 2000a), and 6 percent passed over the spillway. Therefore, of the 552,857 larvae entering J.C. Boyle Reservoir, we assume that 55,286 reach the J.C. Boyle Dam and are entrained, including 51,969 (or 94 percent) passing through the turbines and 3,317 (or 6 percent) going over the spillway. Although J.C. Boyle has fish screens for the turbines, we consider them ineffective at excluding small larval suckers (USFWS 2007). Mortality is estimated at 12,992 (or 25 percent) larvae from the turbines and 66 (or 2 percent) from the spillway. Of the larval suckers passing the J.C. Boyle facility, we assume that 42,227 move downstream.

Copco No. 1 Facilities. Of an estimated 42,227 larval suckers dispersing downstream of J.C. Boyle Dam, we assumed 10 percent (4,223) reach Copco No. 1 Dam (USFWS 2007). Additionally, based on evidence of SNS spawning in the Klamath River just upstream from Copco Reservoir and larval drift estimates in this reach (Beak Consultants Inc. 1987), we estimate that 500,000 larvae are produced upstream of the reservoir annually. An estimated 10 percent (50,000) of these larvae disperse through Copco Reservoir to the dam. Thus the total number of larvae reaching the dam is 54,223. Based on the data provided by PacifiCorp, 100 percent of the flow at Copco No. 1 Dam in June passes through the turbines and 0 percent through the spillway. Of the total 54,223 sucker larvae that are entrained at Copco No. 1 Dam, all go through the turbines and none pass over the spillway. Larval mortalities through the turbines is estimated at 13,556 (or 25 percent; Table A1). Of the larval suckers passing the Copco No. 1 facility, we estimate that 40,667 move downstream alive.

Copco No. 2 Facilities. Because Copco No. 2 Dam is only 0.3 miles below Copco No. 1 Dam, water residence time is less than 1 hour, therefore we assumed that all sucker larvae entering the small reservoir reach the Copco No. 2 Dam (USFWS 2007). Of the 40,667 larval suckers passing Copco No. 2 Dam annually, all are entrained through the turbines. Annual, turbine mortality estimate is 10,167 larval suckers (Table A1). Of the larval suckers passing the Copco No. 2 Dam, we estimated that 30,500 move downstream alive.

Iron Gate Facilities. Of the 30,500 larval suckers entering Iron Gate Reservoir annually, we assume 3,050 (or 10 percent) reach the dam and are entrained into turbines or spillway. Of these we assume 747 are killed by turbines and 1 from the spillway. Because there is no suitable habitat downstream of Iron Gate Dam for these larvae, we assume all of the larvae that survived will die.

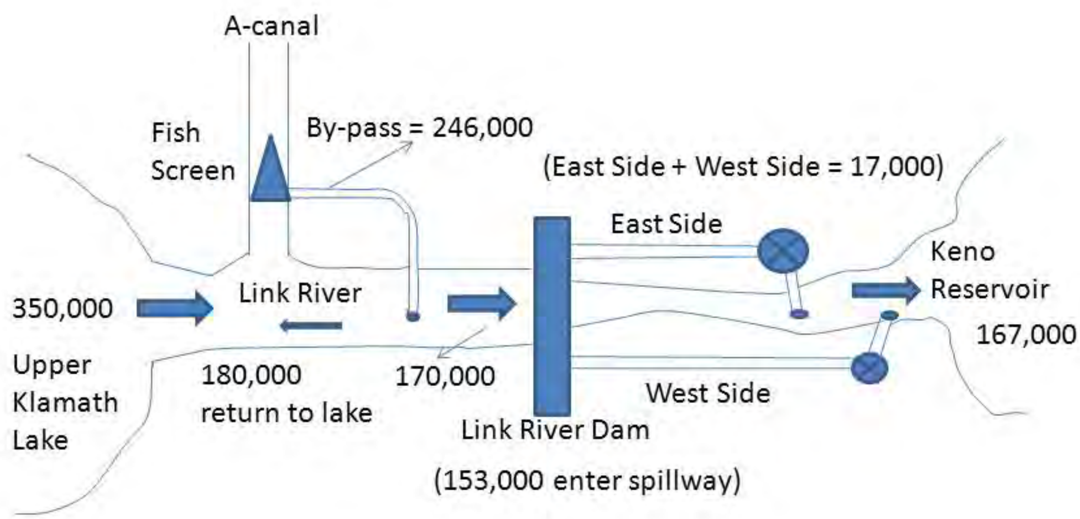
Summary of Larval Turbine and Spillway Mortality
We assume that under current operations, up to 1.1 million (1,107,412) larval suckers per year die as a result of turbine and spillway injuries at the Link River Dam, East Side and West Side facilities, and at the five Klamath River facilities owned by PacifiCorp (Table A1).

2.0 Juvenile Suckers - Annual Turbine and Spillway Mortality

Link River Facilities. Prior to the recent screening the A-canal and recent implementation of entrainment reduction operations at the East Side and West Side facilities by PacifiCorp, we assumed 349,750 juvenile suckers were entrained into the Link River above the A-canal and dam. Of this number we assume 246,000 were entrained at the A-canal, based on measurements by Gutermuth et al. (2000a), 226,750 moved downstream towards the dam and 123,000 returned back to UKL (USFWS 2007). With the installation of the A-canal fish screen we assume no juvenile suckers greater than 35 mm total length is now entrained into the A-canal.

PacifiCorp, in an effort to minimize entrainment of LRS and SNS, has not operated the turbines at the East Side and West Side facilities since 2008 during the juvenile sucker entrainment period from August through September; however approximately 80 cfs water moved through the East Side flowline. Using that information and estimates of total flow in the Link River, we determined that about 10 percent of the total Link River flow passed through the flowline in the August-September period when juvenile suckers are most likely to be entrained. We estimate that 246,000 juvenile suckers are entrained at the A-canal and are by passed back into the Link River above the dam. Thus, we estimate that of the 349,750 juvenile suckers that are entrained into the upper Link River each year, 179,688 are able to return to the lake and 170,062 move downstream to the dam (USFWS 2007). Of the 170,062 juvenile suckers that reach the dam, we assume 17,006 (10 percent) passed through the East Side flowline and 153,056 (90 percent) through the spill gates, fish ladder, and auxiliary water structures at the dam. Mortality through these facilities is assumed to be 2 percent or 3,061 at the dam and 340 at the East Side facility (Table A1). Of the juvenile suckers passing the Link River Dam spillways and the East Side and West Side hydropower facilities, we estimate that up to approximately 166,661 moved downstream alive each year (Figure A2)

Figure A2. Diagram showing estimated juvenile entrainment at the A-canal fish screen, the Link River Dam, and the East Side and West Side power canals and power houses (not shown to scale). Approximate annual maximum numbers of LRS and SNS juveniles estimated to exit UKL, and entrained at each facility, and entering the Keno Reservoir is shown. Numbers are rounded to the nearest 1,000.



Keno Facilities. We assumed that 10 percent (16,666) of the estimated 166,661 juvenile suckers entering Keno Reservoir make it downstream to the Keno Dam (USFWS 2007). We also assumed mortality equals 2 percent (333) of the juvenile suckers passing through the spill gates, fish ladder, auxiliary water supply, or sluice conduit (Table A1). Because Keno Dam lacks turbines, no turbine mortality of the juvenile suckers occurs there. Of the juvenile suckers passing the Keno Dam, we estimate that16,333 disperse downstream each year.

J.C. Boyle Facilities. We assumed 10 percent of the 16,333 juvenile suckers entering J.C. Boyle Reservoir make it to the dam (1,633) and of these 97 percent (1,584) pass through the turbines and 3 percent (49) through the spillway, based on flow data from PacifiCorp for August and September when juvenile entrainment is highest (Gutermuth et al. 2000a). With mortality rates of 25 percent and 2 percent, respectively, we assume that annual turbine and spillway mortality is 396 and 1 juvenile suckers, respectively (Table A1). Of the juvenile suckers passing the J.C. Boyle facility, we estimate that 1,236 disperse downstream each year.

Copco No.1 Facilities. Of the 1,236 juvenile suckers entering Copco I reservoir, we assume 10 percent (124) make it to the dam. Of these, 100 percent (124) pass through the turbines and 0 percent through the spillway, based on flow data provided by PacifiCorp. With an estimated turbine mortality rate of 25 percent, we estimate annual turbine mortality of 31 suckers (Table A1). Of the juvenile suckers passing the Copco No.1 facility, we estimate that 93 move downstream each year.

Copco No. 2 Facilities. We estimate that all juvenile suckers (93) entering the Copco No. 2 Reservoir make it to the Copco No. 2 Dam because of the small size of the reservoir. Of these we assume 100 percent pass through the turbines and 0 percent through the spillway. With a turbine mortality rate of 25 percent, we estimate annual turbine mortality of 23 suckers (Table A1). Of the juvenile suckers passing the Copco No. 2 facility, we estimate that 70 move downstream each year.

Iron Gate Facilities. An assumed 10 percent (7) of the 70 juvenile suckers entering Iron Gate Reservoir make it to the dam. Of these, 2 suckers are assumed to die from injuries as a result of collisions with turbines. Because there is no suitable habitat downstream of Iron Gate Dam for these larvae, we assume all of the larvae that are entrained will die.

Summary of Juvenile Turbine and Spillway Mortality

We estimated that current total juvenile sucker mortality resulting from turbine and spillway trauma at the Link River Dam and East Side and West Side facilities, plus PacifiCorp's five Klamath River facilities is up to 4,187 per year (Table A1).

3.0 Adult/Sub-adult Suckers - Annual Turbine and Spillway Mortality

Link River Facilities. Before the A-canal was screened, the highest number of sub-adult/adult LRS and SNS entrained at the East Side and West Side power diversions during a non-die-off year was 14 in 1998 (Gutermuth et al. 2000a, b). We estimate that an additional 20 percent of this amount was 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. (2000a) estimated 411 sub-adult/adult (adults) LRS and SNS were entrained at A-canal in 1998. With the screening of the A-canal, all adult suckers are bypassed back into the Link River above the dam. We assume that 50 percent of these fish go back to UKL and 50 percent are entrained at Link River Dam. Thus, an estimated 205 adult suckers move down to the Link River Dam annually. Of these we assume 50 percent would pass through the turbines and 50 percent through the spillway; however, because PacifiCorp shuts down the East Side and West Side facilities during August-October period when about one-half of the adult sucker entrainment occurred (Gutermuth et al. 2000a), we assume this operation leads to 25 percent adult suckers (51) being entrained into the East Side and West Side facilities and 75 percent (154 suckers) moving through the spill gates. We estimate annual turbine mortality at 25 percent (13 adults) and spillway mortality at 2 percent (3 adults; Table A1). Of the adult suckers passing the Link River Dam annually, we estimate that 189 adult suckers move downstream alive each year.

Keno to Iron Gate Facilities. Based on the low numbers of adult suckers estimated to have been entrained at the Link River Dam and associated hydropower facilities (205), and assuming only 10 percent move downstream, we estimate that less than 5 adult suckers were likely taken each year by the Project hydroelectric facilities between Keno Dam and Iron Gate Dam (Table A1).

Summary of Larval, Juvenile, and Adult Sucker Turbine and Spillway Mortality
Of the estimated 6.7 million sucker larvae, 170,000 juveniles, and 200 sub-adult/adults that are entrained at Link River Dam and the East Side and West Side facilities each year, we estimate that approximately 1.1 million larvae, 4,200 juveniles and less than 20 adult LRS and SNS die as a result of injuries received from turbines and spillways (Table A1). Of the suckers that enter the reservoirs and are not killed by turbines or spillways, many also likely die from other causes including stranding, as discussed below (USFWS 2007, 2008).

4.0 Effects of Stranding and Ramp Rates at Dams and Reservoirs

Hydroelectric facilities typically have the capacity to increase or decrease flows downstream of the facilities, the rate at which these changes occur are 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. Significant rapid flow reduction in bypassed, peaking, and regulated reaches affects a fish 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.

Link River Dam Facilities. Up to 2.7 million sucker larvae are estimated to pass downstream through Link River Dam spill 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 the extent of larval stranding in the Link River. Based on the large number of larvae dispersing through this reach, stranding mortality was estimated at up to 5,000 sucker larvae each year during down ramping (USFWS 2007). With up to 85,000 juvenile suckers dispersing downstream through Link River Dam spillway we estimated up to 500 could be stranded per year (USFWS 2007). We do not believe that sub-adult/adult suckers are stranded because they have not been reported in previous spillway termination salvage efforts and they tend to occupy deeper areas that are not prone to dewatering (USFWS 2007). With implementation of the new guidance for ramping operations at the Link River Dam, developed by the Bureau of Reclamation (USBR), PacifiCorp, and the Service (USBR 2011), we believe this take will be reduced by 50 percent to 2,500 larvae and 250 juveniles (Table A2).

TABLE A2. Estimates of sucker mortality due to stranding and reservoir fluctuations at the Link River Dam and operations at the five Klamath River facilities (USFWS 2007). Totals are rounded to the nearest 10.

Life Stage	Facility						Total
	Link River Dam	Keno	J.C. Boyle	Copco No. 1	Copco No. 2	Iron Gate	
Current operation – Stranding and Ramp Rate Effects							
Eggs	0	0	100,000	0	0	0	100,000
Larvae	2,500	2,000	10,200	0	100	0	14,800
Juvenile	250	100	10	0	0	0	360
Adult	0	0	0	0	0	0	0
Current operation – Reservoir Fluctuations							
Larvae	0	0	10,000	1,000	0	100	11,100
Juvenile	0	0	1,000	0	0	0	1,000
Adult	0	0	0	0	0	0	0
Total	2,750	2,100	121,210	1,000	100	100	127,260

Keno Dam. PacifiCorp has implemented a voluntary ramp rate below Keno Dam of 500 cfs or 9 inches per hour (PacifiCorp 2004). Project impacts result from periodic low flows in combination with a high down ramp rate (Tinniswood 2006). Under current conditions, the Service estimates that up to 2,000 larvae and 100 juveniles could be killed annually due to stranding below Keno Dam, based on estimates of suckers passing through the Keno Reach identified in the previous section on entrainment (USFWS 2007).

J.C. Boyle Dam. The FERC license, as continued through current annual licenses, requires PacifiCorp to ramp up and ramp down flows 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 2006). No LRS or SNS have been reported from these events; however, fish die-offs are also less obvious at this location because river reaches below J.C. Boyle Dam have more remote access.

The current FERC ramp-rate requirement for the J.C. Boyle Peaking Reach is 9 inches per hour. Current rates of stage decline are generally between 5 and 9 inches per hour

(PacifiCorp 2004). PacifiCorp conducted fish stranding observations in 2002 and 2003 in the J.C. Boyle Peaking Reach (10 study sites) and observed no fish stranded in 2002, and six fish stranded in 2003, including one juvenile sucker (PacifiCorp 2004). However, examination of isolated pools and side channels found trapped larval suckers. We estimate that 100,000 sucker eggs, 10,200 larvae, and 10 juveniles are stranded due to operational changes in flows below J.C. Boyle Dam (Table A2).

Copco No. 1 and No. 2 Dams. 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). Flows in this reach that are affected by peaking operations result in wide daily fluctuations ranging from about 350 to 3,000 cfs. Beak Consultant Inc. (1987) identified that approximately 10 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.

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. Because there are low numbers of suckers below Copco 1 Dam, only a small number of suckers are affected. We estimate that 100 sucker larvae are adversely impacted below Copco 2 Dam by stranding (Table A2).

Because endangered suckers are rare in Iron Gate Reservoir and few suckers disperse below the dam, current operation of the Iron Gate development likely results in no measurable stranding and mortality of larval, juvenile, and sub-adult/adult suckers (USFWS 2007). Furthermore, any LRS and SNS that are released into the Klamath River below the Iron Gate Dam are considered lost because there is no suitable lake habitat downstream.

5.0 Effects of Reservoir Fluctuations

Keno Reservoir. 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 4,085 feet. However, at the request of irrigators who divert water from the Keno Reservoir, PacifiCorp generally operates Keno Dam to maintain the reservoir at elevation 4,085.4 +/-0.1 feet from October 1 to May 15 and at elevation 4,085.5 +/-0.1 feet from May 16 to September 30 to allow consistent operation of irrigation canals and pumps located along the reservoir. 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 (with a 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. It is unlikely that suckers are stranded by these drawdowns because few larvae would be present at that season and juvenile and adult suckers occupy deeper water where they would not be vulnerable to stranding.

J.C. Boyle Reservoir. While the J.C. Boyle Reservoir can operate within a range of 5.5 feet, the reservoir generally fluctuates 1-2 feet per day and at a rate of elevation change of up to 2 inches per hour. At these rates there is little opportunity for fish stranding except for larval suckers that are poor swimmers. More importantly, larval and juvenile suckers using the shallow shoreline habitats may be temporarily displaced on a daily basis. Predation by non-native fish species on larval and juvenile suckers likely occurs as a result of reservoir fluctuations that displace fish from shoreline cover habitat, making them more vulnerable to predation and as a result we estimate that 10,000 sucker larvae and 1,000 juvenile are killed as a result of fluctuating water levels in J.C. Boyle reservoir.

Copco No. 1 and No. 2 Reservoirs, and Iron Gate Reservoir. 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; FERC 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 estimated that up to 1,000 larval suckers are stranded and die per year in Copco No. 1 Reservoir (Table A2; USFWS 2007).

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 small numbers of larval suckers collected by Desjardins and Markle (2000), the generally steep shorelines, and the small daily water level fluctuations, the estimated number of larval sucker stranded is 100 (Table A2), and is small compared to those affected by the hydroelectric Project upstream (USFWS 2007). 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 (USFWS 2007). Because of the small daily reservoir fluctuations and lack of emergent vegetation habitat providing cover for larval and juvenile suckers in Copco No. 1 and Iron Gate Reservoirs, we do not believe there are increased predation impacts due to habitat displacement.

Based on our analysis of effects from accidental changes in ramp rates that strand suckers and normal reservoir fluctuations that arise from daily operations, we estimated that annual mortality rates are: approximately 100,000 eggs, 26,000 larvae, and 1,300 juveniles.

6.0 Summary of Mortalities from Operations of All Dams and Hydropower Facilities

Based on the analysis presented above, the mortality of LRS and SNS life stages resulting from the current operations of all 8 dam and hydropower facilities is shown below in Table A3. We estimate that mortality of all sucker life stages at the 8 facilities is approximately 1.2 million, with over 90 percent of this being larvae.

Table A3. Estimated maximum annual sucker mortality at Link River Dam, East Side + West Side, and the five Klamath River hydropower facilities under current operations due to turbines, spillways, flow lines, ramping rate effects and reservoir fluctuations. Numbers are rounded to the nearest 10 except for adults. Rounding errors may prevent columns and rows from adding up exactly.

	Facility							
Life Stage	**Link River**	**East Side + West Side**	**Keno**	**J.C. Boyle**	**Copco No. 1**	**Copco No. 2**	**Iron Gate**	**Total**
Eggs	0	0	0	100,000	0	0	0	100,000
Larvae	56,100	1,005,000	13,280	33,260	14,560	10,270	850	1,133,310
Juveniles	3,310	340	430	1,410	30	20	0	5,550
Adults	3	13	0	0	0	0	0	16
Total	59,410	1,005,350	13,720	134,660	14,590	10,290	850	1,238,880

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