PacifiCorp Klamath Hydroelectric Project
Interim Operations Habitat Conservation Plan for Coho Salmon

February 16, 2012

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[1] 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 by the U.S. Bureau of Reclamation (Reclamation) from Upper Klamath Lake via Link River dam (RM 254.3), a facility owned by Reclamation and operated by PacifiCorp.

On February 25, 2004, PacifiCorp filed an application with the Federal Energy Regulatory Commission (FERC) for a new 50-year license for the Project. The Final License Application filed with FERC in February 2004 is available on FERC's website at www.ferc.gov, under docket number P-2082. The Project is currently operating under annual licenses from FERC pending final resolution of the licensing process as discussed further in the next section of this document.

Following the submittal of its application for a new FERC 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 to develop and enter into the Klamath Hydroelectric Settlement Agreement (KHSA), which provides a framework for possible removal of four PacifiCorp dams on the Klamath River, including Iron Gate, Copco No. 1, and Copco No. 2 dams in California, and J.C. Boyle dam in Oregon. PacifiCorp agreed to a potential dam removal path for the Project and executed the KHSA based upon an assessment that dam removal under the KHSA provided superior cost and risk protections for PacifiCorp and its customers as compared to continuing on a path of relicensing.

The potential decommissioning and removal of these dams are subject to certain contingencies including funding, the passage of federal legislation, and a determination by the Secretary of Interior that removal of the dams should proceed. Specifically, the Secretary will determine whether removal of the four PacifiCorp dams: (1) will advance restoration of the salmonid fisheries of the Klamath Basin; and (2) is in the public interest, which includes

[1] To be clear, the use of the term "Project" throughout this HCP refers specifically to PacifiCorp's Klamath Hydroelectric Project, and not to the U.S. Bureau of Reclamation's Klamath Project (which stores and diverts water to provide irrigation for approximately 200,200 irrigable acres in the Upper Klamath Basin in south-central Oregon and parts of north-central California). Reclamation's Klamath Project is referred to in this HCP as the "Klamath Irrigation Project".

but is not limited to consideration of potential impacts on affected local communities and tribes. The Secretarial Determination is now underway and scheduled to be completed by March 31, 2012.

The KHSA provides that Project operations will continue over the interim period until the dams are removed or, should dam removal not proceed, until a new FERC license is issued. The KHSA provides for the abeyance of the FERC relicensing process pending the outcome of the Secretarial Determination. Should the Secretary of the Interior determine that dam removal should not proceed, or the KHSA terminates for other reasons, the FERC relicensing process for the Project would resume. As the KHSA is closely related to this HCP, additional discussion on the KHSA process is provided in the following section of this document.

This document contains PacifiCorp's Habitat Conservation Plan (HCP; also referred to in this document as the "Plan"), which supports an application to the National Marine Fisheries Service (NMFS) for incidental take[2] authorization for interim Project operations under the Endangered Species Act (ESA). Section 10(a)(1)(B) of the ESA authorizes NMFS to issue permits to non-federal parties for the potential incidental taking of endangered and threatened species of salmon (and other marine organisms)[3]. The Southern Oregon/Northern California Coast (SONCC) Evolutionarily Significant Unit (ESU) of coho salmon (*Oncorhynchus kisutch*), which has a range that includes the Klamath River basin, is listed as Threatened under the ESA. Because NMFS' Biological Opinion (BiOp) on PacifiCorp's FERC license application (NMFS 2007) indicates a view that incidental take of coho salmon may be occurring as a result of the Project operations, PacifiCorp has elected to voluntarily pursue this conservation planning process to formalize PacifiCorp's conservation commitments, and to provide additional regulatory certainty to PacifiCorp, and thereby its customers, in view of its substantial financial commitments. The process for obtaining incidental take authorization from NMFS is described below under Regulatory Framework.

This HCP is organized generally according to suggested HCP guidelines (USFWS and NMFS 1996, 2000), as follows:

- Chapter II (*Description of Covered Activities*) describes the Project activities for which incidental take coverage is sought.
- Chapter III (*Covered Species*) describes the status, distribution, and life history of relevant coho salmon populations in the Klamath River basin.
- Chapter IV (*Current Conditions*) describes the Project facilities and associated environmental conditions in the Klamath River basin.
- Chapter V (*Effects of Covered Activities on Covered Species*) describes the effects of Project on coho salmon and their habitat.

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[2] "Incidental take" is defined as accidental killing or harming of a listed species that is incidental to, but not the purpose of, otherwise lawful activities.

[3] U.S Fish and Wildlife Service issues incidental take permits for other freshwater and terrestrial species listed under the ESA.

- Chapter VI (*Conservation Program*) describes the conservation strategy and specific measures PacifiCorp will undertake to address anticipated effects on coho salmon of Project operations during the interim period.
- Chapter VII (*Compliance with Authorized Level of Take*) describes the procedures PacifiCorp will implement to demonstrate that the authorized level of incidental take is not exceeded during the interim period.
- Chapter VIII (*Monitoring and Adaptive Management*) describes the procedures PacifiCorp will employ to demonstrate that the conservation measures implemented are effective in achieving intended biologically-based goals and objectives.
- Chapter IX (*Changed and Unforeseen Circumstances*) describes the changed and unforeseen circumstances under which modifications to the Plan would be made (in accordance with the procedures set forth in the Implementing Agreement).
- Chapter X (*Funding*) describes the funding by PacifiCorp to meet the purposes of the HCP.
- Chapter XI (*Other Alternative Actions Considered*) describes alternative permitting actions contemplated by PacifiCorp and NMFS in addition to incidental take permitting.
- Chapter XII (*References*) provides a bibliographic listing of literature cited in the HCP.

Background

In the application to FERC for a new license for the Project, PacifiCorp proposed 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 2004 and FERC 2007), the purposes of which include (but are not limited to) water quality and habitat enhancement, instream flows and ramp rates[4] 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 generating 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

[4] Hydroelectric facilities typically have the capability to control flows through the facilities. Such control can cause 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."

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 Development with FERC Staff Measures. The FERC (2007) FEIS concludes that the preferred alternative for the Project would be the FERC Staff Alternative, which incorporates most of 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, NMFS issued a BiOp under Section 7 of the ESA analyzing the effects of proposed Project operations on listed coho salmon. The NMFS BiOp was issued in December 2007 (NMFS 2007). The Proposed Action evaluated in the BiOp contains measures listed in the FERC Staff Alternative and PacifiCorp's relicensing 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 NMFS' Section 18 Fishway Prescriptions. The BiOp identifies potential Project effects that may result in incidental take of the coho salmon. 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 NMFS to develop "interim conservation measures" for listed coho salmon. PacifiCorp similarly worked with the U.S. Fish and Wildlife Service (USFWS) to develop such measures for the listed Lost River sucker (*Deltistes luxatus*) and shortnose sucker (*Chasmistes brevirostris*) These measures are to be implemented in the interim period until issuance of a new FERC license or Project dam removal as specified in the KHSA (as described above). An Interim Conservation Plan (ICP) describing the interim conservation measures was completed on November 9, 2008, through a series of technical discussions with NMFS and USFWS.

The ICP measures pertaining to coho salmon formed the starting point for development of this HCP, since it was recognized that the implementation of the ICP's conservation measures would conserve coho salmon and minimize potential Project impacts on that species. On November 10, 2008, PacifiCorp transmitted letters containing the ICP to NMFS indicating its commitment to early implementation of conservation actions identified in the ICP. On November 12, 2008, NMFS indicated its support for implementation of ICP measures, stating that implementation of such measures would reduce and help minimize potential adverse Project impacts on listed species, and provide benefits to listed aquatic species and their habitats[5].

[5] USFWS likewise indicated its support for implementation of sucker-related ICP measures to benefit the listed sucker species and their habitats. PacifiCorp has developed a separate HCP to support an application to the USFWS for incidental take authorization for interim Project operations related to the listed sucker species.

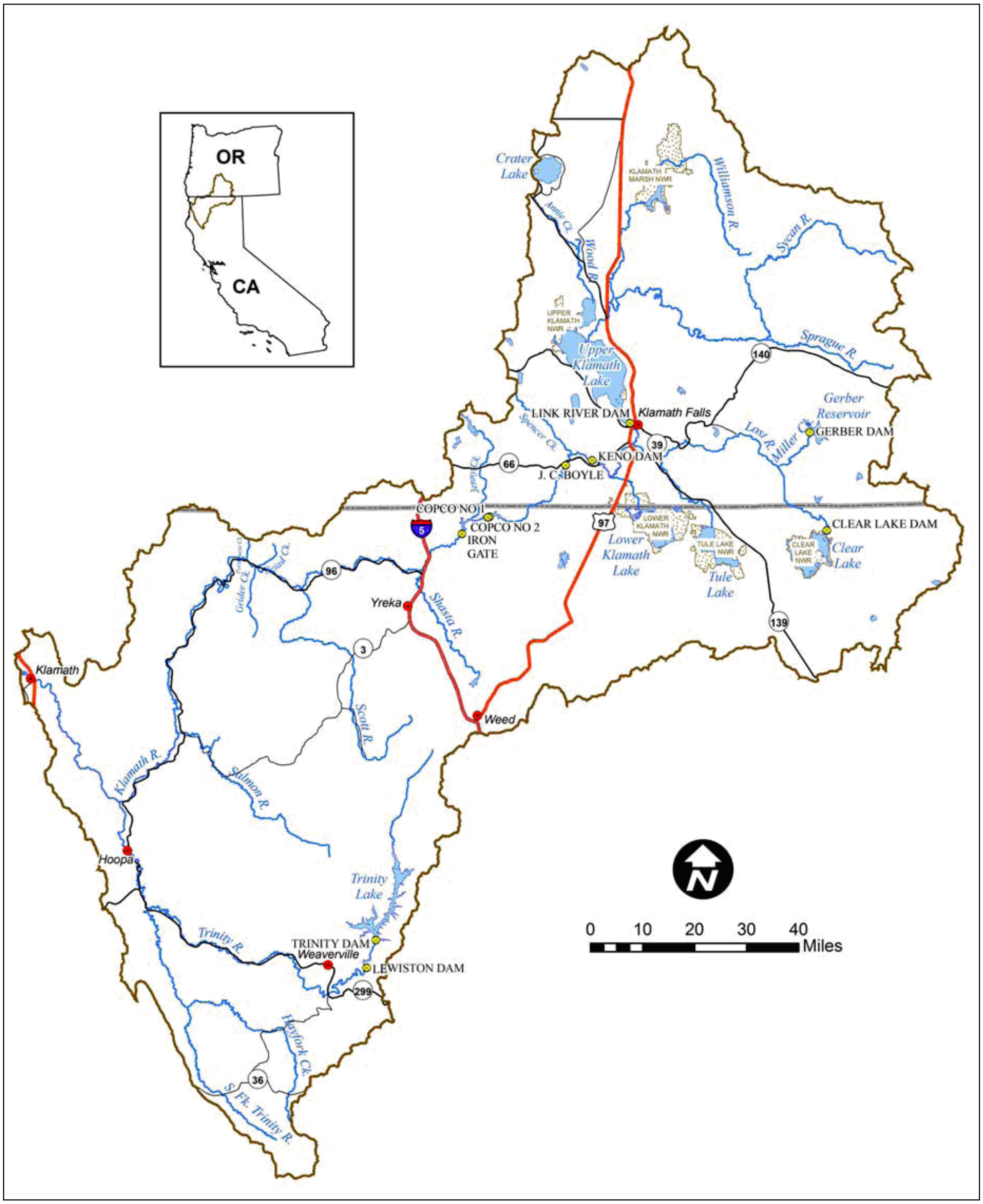

FIGURE 1
Map of Klamath River basin showing locations of rivers and lakes, and Klamath Hydroelectric Project facilities within the basin (source: NMFS 2010).

Following the submittal of its application for a new FERC license, PacifiCorp began settlement discussions with a diverse group of stakeholders to resolve issues related to relicensing of the Project. These discussions culminated in the KHSA (as described above) that was signed by the involved parties on February 18, 2010. 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 as contemplated by the KHSA. It is anticipated that the Project will continue operating under annual licenses until the dams are removed pursuant to the KHSA or a new license is issued by FERC incorporating provisions for anadromous fish passage.

The KHSA provides that Project operations will continue over the interim period until the dams are removed or, should dam removal not proceed, until a new license is issued. Should the Secretary of Interior determine that dam removal should not proceed (scheduled to be determined by March 31, 2012), or the KHSA terminates for other reasons, the FERC relicensing process for the Project would resume. 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 pending potential dam removal. The KHSA also provides for the abeyance of the FERC relicensing process pending the outcome of the Secretarial Determination and, should the Secretary render an affirmative determination, during the interim period prior to dam removal.

Permit Holder/Permit Duration

PacifiCorp is applying to NMFS for an ESA Section 10(a)(1)(B) permit authorizing the potential incidental take of SONCC coho salmon, which are listed as Threatened. The term of the proposed Incidental Take Permit (ITP) (referred to herein as “Permit Term” or “term of the ITP”) will be for ten (10) years. The initial permit term of 10 years is in anticipation of an affirmative decision on dam removal, and a target date for dam removal of December 2020. In the alternative, if the KHSA is terminated or a negative determination on dam removal is reached, it is anticipated that FERC would issue a new license for the Project including conditions for volitional fish passage, which would be in place by the end of 2020. The proposed ITP will authorize the potential incidental take of coho salmon that may occur as a result of operating the Project and implementing proposed conservation measures. 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 Project decommissioning is not reasonably certain to occur prior to the end of the initial 10-year term of the ITP, then PacifiCorp may initiate discussions with NMFS to extend the term of the ITP as described in the IA.

Covered Lands

Covered Lands include PacifiCorp’s existing Project facilities, adjacent water and land areas, and riparian zones potentially influenced by Project maintenance and operations, including the mainstem Klamath River (also containing Link River) and Project reservoirs from the outlet of Upper Klamath Lake (RM 255) down to the confluence of the Klamath River with the Shasta River (RM 176.5) (see Figure 1). Project facilities and their operation are described in Chapter IV (Current Conditions) of this HCP. The term "Covered Lands" is more specifically defined in the IA.[6]

Regulatory Framework

This HCP was prepared to comply with the existing regulatory framework that includes the following federal laws:

- Federal Endangered Species Act (ESA)
- Federal National Environmental Policy Act (NEPA)
- Magnuson-Stevens Fishery Conservation and Management Act

Summaries of the processes and requirements for each of these regulatory mechanisms are provided in the following descriptions.

Endangered Species Act

For anadromous fish such as coho salmon, the federal ESA is administered by the Secretary of Commerce through NMFS. 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 4(f)

Section 4(f) of the ESA directs NMFS to develop and implement recovery plans for threatened and endangered species of anadromous fish. According to the statute, these plans must incorporate a description of site-specific management actions necessary to achieve recovery of the species and objective, measurable criteria which, when met, would result in a determination that the species must be removed from the list. The recovery plan for SONCC coho salmon is currently being developed and is expected to be distributed for public review by fall 2011. Based on discussions with NMFS personnel, actions identified in this HCP are consistent with preliminary recovery actions being considered by NMFS as important for the recovery of SONCC coho salmon.

Section 9/Section 4(d)

Section 9 of the ESA prohibits the take of fish and wildlife species listed as endangered. Pursuant to Section 4(d) of the ESA, NMFS may, by regulation, extend the prohibition of take to species listed as threatened. NMFS has extended the prohibition of take to the listed Evolutionarily Significant Units (ESUs) and Distinct Population Segments (DPSs) pursuant to 50 Code of Federal Regulations (CFR) 223.203. 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, NMFS has defined harm as an act that actually kills

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[6] For greater clarity, the term "Covered Lands" as 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 Lands that may be directly or indirectly affected by Covered Activities.

or injures fish or wildlife, and may include significant habitat alteration that significantly impairs essential behavioral patterns, such as migrating, spawning, feeding, breeding, and sheltering.

Section 10

Section 10(a)(1)(B) of the ESA allows NMFS to authorize taking of endangered and threatened species by non-federal entities that is incidental to, but not the purpose of, otherwise lawful activities. Similar provisions are found in Section 7 for actions by federal agencies (such as Reclamation). Under Section 10(a)(1)(B), such authorizations are granted through the issuance of an incidental take permit (ITP). The Section 10 process for obtaining an incidental take permit has three primary phases: (1) the HCP development phase between an applicant and NMFS, (2) the formal ITP processing phase once NMFS has accepted an ITP application from an applicant, and (3) the post-issuance phase if NMFS has decided to issue an ITP upon satisfaction that issuance criteria have been met.

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, among other things, 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 the Services 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 if the application is found complete. NMFS 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 the incidental take permit. NMFS also prepares an Intra-Service Section 7 Biological Opinion 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 paragraph below). A Draft Environmental Assessment (EA) or Draft Environmental Impact Statement (EIS) document that has undergone a public comment period serves as NMFS' record of compliance with NEPA. After consideration of public comment, a Section 10 incidental take permit may be issued upon a determination by NMFS that all permit issuance criteria have been met.

To issue the permit, the Assistant Administrator must find that: (i) the taking will be incidental to an otherwise lawful activity; (ii) the applicant will, to the maximum extent practicable, monitor, minimize, and mitigate the impacts of such taking; (iii) the taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild; (iv) the applicant has amended the conservation plan to include any measures (not originally proposed by the applicant) that the Assistant Administrator determines are necessary or appropriate; and (v) there are adequate assurances that the conservation plan will be funded and implemented, including any measures required by the Assistant Administrator. The public is notified of permit issuance through notification in the Federal Register.

After NMFS issues an ITP, the permittee and other responsible entities implement the HCP. NMFS monitors the permittee's compliance with the HCP, as well as the long-term progress and success of the HCP.

The 'No Surprises' with Assurances regulation adopted by NMFS, 63 Federal Register (FR) 8859 (February 23, 1998), codified at 50 CFR 222.307(g), also provides that, as long as the HCP is being properly implemented, NMFS will not require additional conservation 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, NMFS may require additional measures limited to modifications within the conserved habitat area or the plan's operating conservation program, but NMFS 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, in the unlikely event that the permitted activity no longer meets the issuance criteria that the activity will not appreciably reduce the likelihood of survival and recovery of the species in the wild, and NMFS is not able to take steps to prevent that reduction, NMFS will as a last resort revoke the permit, 69 FR 71723 (December 10, 2004).

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 a permit is a federal action, NMFS must conduct an internal Section 7 consultation on the proposed issuance of the incidental take permit. The internal formal consultation is conducted after an HCP is developed by the project applicant (a nonfederal entity).

National Environmental Policy Act

The 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.

NEPA requires the analysis and public disclosure of the potential environmental impacts of a proposed federal action. The issuance of an ITP by NMFS is a federal action triggering NEPA requirements.

Magnuson-Stevens Fishery Conservation and Management Act

The 1996 Sustainable Fisheries Act amended the Magnuson-Stevens Fishery Conservation and Management Act (the Magnuson Act) to add provisions requiring NMFS and the various fishery management councils to identify and protect essential fish habitat (EFH) for fish species managed under the Magnuson Act. The Magnuson Act was again amended and reauthorized in January, 2007. EFH can include coastal areas and oceans, and it can also include rivers used by anadromous fish. The amendments require that whenever an action is authorized, funded, or undertaken by a federal agency, and the action may adversely affect EFH, a consultation similar to the consultation required under the ESA must be conducted. If it is determined that the activity would adversely affect EFH, recommendations would be made on measures that the agency can take to conserve the habitat. The Magnuson Act does not place mandatory requirements on agencies for compliance with conservation measures recommended by NMFS; however, federal agencies must provide a detailed written explanation to NMFS describing the reasons why any such recommendations are not adopted (see 16 U.S.C. § 1855(b)(4) and 50 CFR § 600.920(k)).

Roles and Responsibilities

Implementation of the HCP requires commitment on behalf of PacifiCorp and NMFS, as well as coordination with other state and federal agencies, affected Tribes, and non-profit organizations that will play a role in implementing the HCP measures with funding provided by PacifiCorp. The parties’ respective roles and responsibilities are detailed in the IA which is a companion document to the HCP.

II. Description of Covered Activities

Activities covered under the ITP ("Covered Activities") include those activities that are necessary to operate and maintain Project facilities during the Permit Term as well as certain 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. Hydroelectric 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. The majority of the operations activities were considered in the NMFS 2007 BiOp; therefore, the terms and conditions of the 2007 BiOp served as the basis for developing the measures contained in this HCP. 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, and for purposes of hydroelectric generation
- Operate and maintain the East Side and West Side canals and flowlines following shutdown of the East Side and West Side powerhouse facilities, and operate and maintain penstocks, turbines, and powerhouse facilities prior to shutdown
- 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
- 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 NMFS' BiOp on Reclamation's Klamath Project operations (NMFS 2010) which identifies instream flow and ramping rate requirements (as measured at the USGS gage located 0.5 mile downstream of Iron Gate dam).
- Regulate water levels at Keno, J.C. Boyle, Copco, and Iron Gate reservoirs

The conservation measures identified in this HCP to address the effects of Covered Activities include several categories of measures that comprise the Coho Salmon Conservation Program. These categories of conservation measures include:

- Instream flow, flow variability, and flow ramping rate measures to benefit listed coho salmon downstream of Iron Gate dam, and consistent with Reclamation's BiOp (NMFS 2010);
- Turbine venting implemented at Iron Gate dam to enhance dissolved oxygen (DO) concentrations in surface waters downstream of Iron Gate dam;
- Habitat restoration projects funded by PacifiCorp (through the Coho Enhancement Fund) and conducted by third parties to enhance the survival and recovery of listed coho salmon,
- Research studies on fish disease conditions and causal factors downstream of Iron Gate dam funded by PacifiCorp (through the Klamath River Fish Disease Research Fund) and conducted by third parties,
- Iron Gate Hatchery measures funded by PacifiCorp (and in which PacifiCorp participates) developed through an approved Hatchery and Genetic Management Plan to maximize conservation benefits of the hatchery program to coho salmon.
- Retrieval of large woody debris (LWD) trapped at or near Project dams, and release of retrieved LWD pieces on a quarterly basis to contribute to the river's habitat forming features.

Detailed descriptions of the specific measures in these categories are provided in Chapter VI (Conservation Program) of this HCP.

Covered Activities under the HCP include the implementation of the specific measures in the categories listed above that will be either be performed directly by PacifiCorp or under PacifiCorp's direct control. These include measures related to PacifiCorp's involvement in the planning and implementation of certain flow measures, turbine venting at Iron Gate dam, PacifiCorp's funding of habitat restoration and research projects, and retrieval and release of LWD.

As discussed above, the 2010 BiOp issued to Reclamation by NMFS (NMFS 2010) anticipates that PacifiCorp will coordinate with Reclamation over the flow-related actions. The 2010 BiOp also notes certain hydrologic impacts associated with Reclamation's actions are beyond the scope of this HCP, because they result from Reclamation actions and not those of PacifiCorp. NMFS has confirmed that any incidental take associated with PacifiCorp's implementation of flow variability under the 2010 BiOp is authorized under the Incidental Take Statement (ITS) associated with that BiOp. In addition, PacifiCorp's involvement in the planning and implementation of variable flows are Covered Activities under this HCP.

Habitat restoration projects and research projects undertaken through use of the Coho Enhancement Fund, while a part of the Conservation Plan, are not Covered Activities because such activities will be undertaken by third parties outside the direct control of PacifiCorp. PacifiCorp will be providing the funding for these habitat restoration and research projects, but third parties undertaking these projects are required to obtain all necessary State and federal permits and authorizations prior to conducting project activities. This includes obtaining incidental take authorization from NMFS for projects that will benefit coho salmon, but may have the potential for some form of incidental take during implementation of these projects. The environmental analysis contained in this HCP and any relevant NEPA document should help expedite future permitting processes required for such projects.

Operation and maintenance actions at the Iron Gate Hatchery by California Department of Fish and Game (CDFG) involve take of coho salmon and will be addressed though a separate ESA permitting process involving the development of a Hatchery and Genetic Management Plan (HGMP) by PacifiCorp, NMFS and CDFG as described in the KHSA. PacifiCorp has agreed to fund the development and implementation of an HGMP for the Iron Gate Hatchery for approval by NMFS in accordance with the applicable criteria and requirements of 50 CFR § 223.203(b)(5). On September 16, 2010, PacifiCorp and CDFG submitted an application for an ESA Section 10(a)(1)(A) enhancement permit incorporating the HGMP to NMFS for review and approval. When the ESA Section 10(a)(1)(A) permit is issued by NMFS, CDFG will implement the terms of the permit and related HGMP at Iron Gate Hatchery.

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III. Covered Species

This section describes the status, distribution, life history, and habitat requirements of the covered species – SONCC coho salmon – particularly in relation to the Covered Lands. As previously defined, the Covered Lands include the mainstem Klamath River and reservoirs and adjacent water and land areas, and riparian zones potentially influenced by Project maintenance and operations, from the outlet of Upper Klamath Lake (RM 255) down to the confluence of the Shasta River (RM 176.5).

Legal Status

As a result of declines in the population of coho salmon in the SONCC ESU, coho salmon within this ESU were federally listed as threatened in May 1997 (62 FR 24588). Critical habitat for this ESU was designated in May 1999 as all accessible reaches of rivers (including estuarine areas and tributaries) between Cape Blanco, Oregon and Punta Gorda, California (64 FR 24049). Excluded are: (1) areas above specific dams identified in the Federal Register notice, including areas above Iron Gate Dam on the Klamath River, Lewiston Dam on the Trinity River, and Dwinnell Dam on the Shasta River within the Klamath River basin; (2) areas above longstanding natural impassible barriers (i.e., natural waterfalls); and (3) tribal lands. Natural and human factors have been implicated in the decline of coho salmon in this ESU (62 FR 24588).

Range and Distribution

Coho salmon range in freshwater drainages from Hokkaido, Japan, and eastern Russia; around the Bering Sea and Aleutian Islands to mainland Alaska; and south along the North American coast to Monterey Bay, California (Laufel et al. 1986). Within California, the historical range of coho salmon was from the Oregon-California border (including the Winchuck River and Illinois River drainages in Oregon) south to the streams of northern Monterey Bay (Snyder 1931), including small tributaries to San Francisco Bay (Brown and Moyle 1991). Currently, the southernmost stream that contains coho salmon is Aptos Creek in Santa Cruz County (NMFS 2001). The SONCC ESU of coho salmon ranges from Cape Blanco, Oregon to Punta Gorda, California (62 FR 24588).

Williams et al. (2006) laid out the population structure of coho salmon in the SONCC ESU. According to this structure, the Klamath Basin contains nine populations of coho salmon (Upper, Middle, and Lower Klamath, Scott, Shasta, Salmon Rivers, and Upper, Lower, and South Fork Trinity) within three distinct diversity strata (Klamath, Trinity, and Central Coastal). Suitable spawning and rearing habitat exists throughout the Klamath River; however, coho spawning in the mainstem Klamath River is uncommon, and most returning adults seek out spawning habitat within large mainstem tributaries, such as the Scott and Shasta rivers, as well as smaller mainstem tributaries throughout the basin. Several mid-size tributaries, including Bluff, Red Camp, Boise, Camp, and Blue creeks, contain accessible, high quality coho salmon habitat (NMFS 2007a). Between Portuguese Creek and Iron Gate dam, coho salmon are known to spawn and rear primarily within several of the larger tributaries, namely Bogus, Horse, Beaver, and Seiad creeks (NMFS 2010). The Shasta and Scott rivers were once highly productive coho salmon watersheds, but human-caused factors have severely degraded instream habitat conditions within both basins.

Surveys by CDFG between 1979 and 1999 and 2000 to 2004 indicated coho salmon were moderately well distributed downstream of Iron Gate dam in the upper Klamath population area. Juveniles were found in 21 of the 48 tributary streams surveyed (Jong and Mills 1993, CDFG 2004a, Chesney et al. 2007). Streams with coho salmon presence in both 1979 to 1999 and 2000 to 2004 included Grider, Seiad, Horse, Walker, Beaver and West Fork Beaver, Cottonwood, Bogus and Little Bogus, and Dry creeks. Additional juvenile surveys conducted between 2002 and 2005 found fish using Tom Martin, Portuguese, Walker, Seiad, Grider, Beaver, Humbug, O'Neil, and Horse creeks (Ackerman et al. 2007). No juveniles were found in Lumgrey, Willow, Bittenbender, Barkhouse, Empire, Cottonwood, Bogus, and Kuntz creeks during these surveys.

Despite documented coho salmon preference for tributary rearing habitat, juvenile coho salmon have been observed residing within the mainstem Klamath River downstream of Iron Gate dam within the upper reaches of the Klamath River throughout the summer and early fall (Soto 2007 in NMFS 2007a). These fish are almost always closely associated with cold water refugial habitat and extensive instream cover near tributary confluences, where water temperatures are 2-6°C lower than the surrounding river environment (National Research Council 2004, Sutton et al. 2004).

Life History and Habitat Requirements

Coho salmon in the Klamath River Basin spend the first 14 to 18 months of their lives in freshwater, after which the fish live in the ocean until they return to freshwater to spawn at the age of 3 years (NAS, 2004). Adult coho salmon typically begin entering the lower Klamath River in late September, with peak migration between late October and mid-November (NRC 2004). Late arrivals continue to show within the reach between Iron Gate dam and Seiad Valley through late December (USFWS 1998). Coho salmon spawning within the Klamath River basin usually commences within a few weeks after arrival at the spawning grounds (National Research Council 2004), and is thought to occur between November and January (Leidy and Leidy 1984). Coho salmon prefer small, gravel-bottomed tributaries for spawning (Schuett-Hames and Pleus 1996), and generally do not use stream reaches with gradients greater than 3 percent (Reeves et al. 1989). Coho salmon require considerably less space for redds than either Chinook salmon or steelhead, and may spawn in streams less than 1 meter wide if suitable gravels are available. Hicks (2000) states that spawning activity in coho salmon typically occurs in the temperature range of 4.4 to 13.3°C. Bell (1991) suggested that daily average temperatures should be within the range of 50 to 55°F (10 to 13°C) for successful spawning of coho salmon. Under current conditions, daily average water temperatures in the Klamath River during the November to January spawning period are typically less than 13°C (PacifiCorp 2008b).

Coho salmon eggs typically hatch within 8 to 12 weeks following fertilization, although colder water temperatures may lengthen the process (Bjornn and Reiser 1991). Suitable water temperatures for egg incubation are similar to those for spawning. McCullough et al. (2001) and Hicks (2000) indicate that egg mortality, alevin development, and egg maturation are fully supported at daily average temperatures below approximately 14ºC. Under current conditions, daily average water temperatures in the Klamath River during the November to March incubation period are typically less than 14°C (PacifiCorp 2008b). Temperatures outside this range can increase the occurrence of abnormal fry, increase the mortality rate, and lengthen the hatching period (Spence et al. 1996). Upon hatching, coho salmon alevin (newly hatched fish with yolk sac attached) remain within the gravel for another 4-10 weeks, further developing while subsisting off their yolk sac. Once most of the yolk sac is absorbed, the 30-50 millimeter fish (then termed "fry") begin emerging from the gravel in search of shallow stream margins for foraging and safety (National Research Council 2004). Within the Klamath River, fry begin emerging in mid-February and continue through mid-May (Leidy and Leidy 1984).

Fry distribute themselves upstream and downstream following emergence while seeking favorable rearing habitat (Groot and Margolis 1991), and a further redistribution occurs following the first fall rain freshets as fish seek stream areas conducive to surviving high winter flows (Ackerman and Cramer 2006). Typical rearing habitat consists of slow moving, complex pool habitat commonly found within small, heavily forested tributary streams. In mainstem rivers, low-velocity habitats are found primarily along the river shoreline or within backwater units (Beechie et al. 2005, Lestelle 2007). Some dispersing fry can also move into off-channel habitats, such as ponds and floodplain channels, if available. Large woody debris and other instream cover are critically important to juvenile coho salmon survival, considering the relatively smaller coho salmon are often at a disadvantage during aggressive interactions with other juvenile salmonids (e.g., Chinook salmon and steelhead).

Once the initial springtime dispersal ends and fry find suitable habitats, movement to new locations slows significantly and they begin rearing within localized areas (Hillemeier et al. 2009). Subsequently, as water temperatures increase, and if reaching high enough levels, juveniles can initiate another movement in search of thermal refuge. This pattern of movement in response to high water temperatures is strongly evident in the Klamath basin (Sutton et al. 2002, Deas and Tanaka 2006, Sutton et al. 2007). Within the mainstem corridor, some juveniles find thermal relief either at sites of cold water seeps in the mainstem river or in the lower reaches of cool water tributaries.

Preferred coho salmon rearing temperatures are from 12 to 14°C (Bell, 1991), although juvenile coho salmon can, under some conditions, survive at 18 to 29°C for short periods (McCullough, 1999, Moyle, 2002). Early laboratory studies in which juvenile coho salmon were reared under constant temperatures indicated that exposure to temperatures over 25°C, even for short periods, should be lethal (Brett, 1952). In laboratory studies where temperatures were increased gradually (1°C/hr), lethal temperatures were found to range from 24 to 30°C, depending on the temperature to which the fish were originally acclimated (McCullough, 1999).

Redistribution of sub-yearling (i.e., less than 1 year old) coho salmon in the fall occurs in response to autumnal freshets and the resultant rise in streamflow, with migrating fish generally moving, or being forced by high flows, downstream in search of suitable winter habitat (Lestelle 2007). Large numbers of fish have been found moving into very small off-channel habitats adjacent to mainstem rivers. Recent sampling results at the Big Bar downstream trap, located on the mainstem Klamath River at RM 51, showed large pulses of emigrating juvenile coho salmon during the months of November and December (Soto 2007 in NMFS 2007a).

Each spring, juvenile coho salmon migrate to the sea. Outmigrating juvenile salmonids are typically referred to as smolts, in reference to the physiological transformation the fish experience in preparation for the saltwater environment (Groot and Margolis 1991). Migrating smolts are usually present within the mainstem Klamath River between February and the middle of June, with April and May representing the peak migration months (USFWS 1998). Migration rate tends to increase as fish move downstream into reaches with higher flow volumes, yet some coho salmon smolts may stop migrating entirely for short periods of time, utilizing thermal refugia and tributary habitat during this time.

Salmonid smolts may further delay downstream migration by residing in the lower river and estuary for several weeks, slowly acclimating to the saline environment before entering the ocean. Little is known about residence time or habitat use in the Klamath estuary during seaward migration. However, based on the large size of yearling coho salmon and their relatively brief occurrence in the estuary catches, Wallace (2003) surmises that coho salmon move quickly through the estuary without much rearing. Other researchers also have noted that most yearling coho salmon move through estuarine habitat fairly quickly (Miller and Sadro 2003, Myers and Horton 1982).

IV. Current Conditions

This section describes the current conditions for coho salmon in the HCP and begins with a description of the existing facilities in the Project Area. Existing physical environmental conditions on the Covered Lands, such as climate and hydrology, are described in following sections, as are coho salmon and their habitats on Covered Lands, including status and distribution, both regionally and on Covered Lands. Although Iron Gate dam blocks all upstream passage of coho salmon, areas above Iron Gate dam are described because Covered Activities in these areas have the potential to influence coho salmon downstream.

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 Detailed descriptions of Project facilities are provided in Section 2.1 of the FEIS and in the BiOps (NMFS [2007a], Section II, Subsection 2A; USFWS [2007a], page 9). PacifiCorp's Project operations are described in detail in FERC (2007) and in the 2007 BiOps on the proposed Project relicensing prepared by USFWS (USFWS 2007) and NMFS (NMFS 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 that are sufficient to provide instream flows for coho salmon in the Klamath River below Iron Gate dam in accordance with NMFS BiOps (NMFS 2002, 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 flowline; (4) 1,362 feet of 12-foot-diameter, steel flowline; (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.

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 flowlines, 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[7]. 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 designed to pass trout and other resident fish species. This fish ladder gains 19 feet in elevation over a length of 350 feet.

Maintenance at this facility consists of fish ladder repairs, gate maintenance, reservoir boom repairs, vegetation control in and around the dam and flowlines, 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 other resident fish species, 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.

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

[7] 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 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 flowlines, dam structural repairs, water conveyance canal and flowline 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[8]) 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 flowlines, 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

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8 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.

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 flowlines, 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.

Recent evaluations of trends in hydroclimatology suggest temporal changes in climate have changed the volume and timing of snowmelt runoff in the Upper Klamath watershed (NMFS 2010). Declines in precipitation, beginning in 1950, combined with a seasonal warming trend that began in 1977 both represent climatological change that has influenced water availability in the Klamath River basin (NMFS 2010). These declines in snowpack are expected to continue in the Klamath Basin and increase the demand for water by humans (Döll 2002, Hayhoe et al. 2004) and decrease water availability for salmonids (Battin et al. 2007). The overall warming trend that has been ubiquitous throughout the western U.S. (Groisman et al. 2004), particularly in winter temperatures over the last 50 years (Feng and Hu 2007), has caused a decrease in the proportion of precipitation falling as snow (Feng and Hu 2007).

Hydrology and River Flow Management

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 (upstream of Keno dam in 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 for listed suckers previously mentioned 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 much smaller reservoirs on the mainstem of the Klamath River downstream of Upper Klamath Lake provide about 15 percent of the total water storage, and about 3 percent of active storage, available in the upper Klamath River basin (upstream of Iron Gate dam).

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.

Reclamation's management of flows in the upper Klamath River is based on operational plans developed in consultations with USFWS and NMFS to protect the federally listed Lost River and shortnose suckers, and SONCC coho salmon, and their designated critical habitats. In March 2010, NMFS issued its final BiOp on Reclamation's operation of the Klamath Project for the period 2010-2018 (NMFS 2010). That BiOp contemplates PacifiCorp's interrelated operations of Link River dam and Iron Gate dam consistent with the 2010 Reclamation BiOp, and it covers PacifiCorp's coordination with Reclamation over implementation of certain Reclamation operations. The BiOp also identifies modified minimum flow releases from Iron Gate dam.

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, aside from the agreement with Reclamation and at the request of irrigators, PacifiCorp periodically 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 water 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 flowline 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.

Minimum instream flows downstream of Link River dam vary during the year according to agreements and BiOps. For the majority of the year, the minimum flow immediately below Link River dam is 90 cfs pursuant to a cooperative agreement between Oregon Department of Fish and Wildlife (ODFW) and PacifiCorp (PacifiCorp 2004b). The minimum flow immediately below Link River dam is increased to 250 cfs from mid-July through mid-October, per the 2002 Klamath Irrigation Project BiOp (USFWS 2002). Minimum flow downstream of the East Side powerhouse is 450 cfs while the unit is operating.

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. 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. J.C. Boyle powerhouse has controls capable of automatically shutting down the turbine and closing the penstock intake gate if a generating unit trips offline a result of transmission line disturbances from storms or other unforeseen events beyond PacifiCorp's operational control. As a consequence of unit trips, which occur infrequently (2 to 5 times per year), temporary flow changes can result in downramping in excess of 9 inches per hour in the peaking 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.

Iron Gate Dam

Reclamation manages flow releases to the Klamath River to ensure flows at Iron Gate dam meet or exceed specific flow releases prescribed in the applicable 1999, 2001, 2002, and 2010 BiOps from NMFS on the Reclamation consultations. These releases are considered under the "Proposed Action" in the Reclamation BiOps with the action area as the historically accessible portion of the mainstem Klamath River to Iron Gate dam (RM 190). PacifiCorp provides these required Reclamation flow releases at Iron Gate dam in coordination with Reclamation. The current NMFS modified Reasonable and Prudent Alternative (RPA) minimum flow releases from Iron Gate dam (NMFS 2010) are presented in Table 2. PacifiCorp is aware that Reclamation is developing operational procedures that may result in adjustments to how RPA flow requirements are implemented. Such adjustments or changes may require additional consultations between PacifiCorp, Reclamation and NMFS on implementation of flow requirements. PacifiCorp will coordinate with Reclamation and NMFS over the development and implementation of these potential operational changes to facilitate implementation of such measures..

Spill releases from Iron Gate dam in excess of the minimum flow requirements contained in Reclamation's BiOp generally only occur as a result of precipitation events that occur when there is insufficient available capacity in Upper Klamath Lake and Project reservoirs to store those flows. Although this is generally the rule, brief spill events can occur when operational adjustments to reduce flows at Link River dam in response to transient tributary inflows below Keno dam are determined to be impractical due to the requirement that PacifiCorp must salvage fish from the Link River when flows from Link River dam drop significantly. In addition, the lack of information on tributary contributions below Keno dam can result in spill if Project reservoirs are near maximum storage capacity and tributary contributions increase significantly as a result of localized precipitation. Finally, rain-on-snow precipitation events that occur within Reclamation's Klamath Irrigation Project can result in significant irrigation return flows to Keno reservoir. Spill has occurred at Iron Gate dam from such events on rare occasions (i.e., about once every several years) when available Project reservoir storage was not sufficient to fully absorb runoff volume. Because these spill events occur as a result of precipitation events or due to lack of information regarding tributary flow accretions, these spill events are non-discretionary in nature. Operational restrictions with regards to the operating factors discussed above and the resultant hydrology are described in the following sections.

TABLE 2
NMFS Modified RPA Monthly Instream Flow Releases (cfs) from Iron Gate Dam by Percent Flow Exceedance[9]

	Oct	Nov	Dec	Jan	Feb	March	April	May	June	Jul	Aug 1-15	Aug 16-31	Sep
95%	1000	1300	1260	1130	1300	1275	1325	1175	1025	805	880	1000	1000
90%	1000	1300	1300	1245	1300	1410	1500	1220	1080	840	895	1000	1000
85%	1000	1300	1300	1300	1300	1450	1500	1415	1160	905	910	1001	1000
80%	1000	1300	1300	1300	1300	1683	1500	1603	1320	945	935	1005	1006
75%	1000	1300	1300	1300	1300	2050	1500	1668	1455	1016	975	1008	1013
70%	1000	1300	1300	1300	1300	2350	1500	1803	1498	1029	1005	1014	1024
65%	1000	1300	1300	1300	1323	2629	1589	1876	1520	1035	1017	1017	1030
60%	1000	1300	1300	1309	1880	2890	2590	2029	1569	1050	1024	1024	1041
55%	1000	1300	1345	1656	2473	3150	2723	2115	1594	1056	1028	1028	1048
50%	1000	1300	1410	1751	2577	3177	3030	2642	1639	1070	1035	1035	1060
45%	1000	1300	1733	2018	2728	3466	3245	2815	1669	1077	1038	1038	1066
40%	1000	1300	1837	2242	3105	3685	3485	2960	1682	1082	1041	1041	1071
35%	1000	1300	2079	2549	3505	3767	3705	3115	1699	1100	1050	1050	1085
30%	1000	1434	2471	2578	3632	3940	3930	3225	1743	1118	1053	1053	1089
25%	1000	1590	2908	2627	3822	3990	4065	3390	2727	1137	1058	1058	1097
20%	1000	1831	2997	2908	3960	4160	4230	3480	2850	1152	1066	1066	1135
15%	1000	2040	3078	3498	4210	4285	4425	3615	2975	1223	1093	1093	1162
10%	1000	2415	3280	3835	4285	4355	4585	3710	3055	1370	1126	1126	1246
5%	1000	2460	3385	3990	4475	4460	4790	3845	3185	1430	1147	1147	1281

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.

Under current operations, PacifiCorp follows ramping rates below Iron Gate dam as specified in Reclamation's Operations Plan for the Klamath Irrigation Project (Reclamation 2010) in accordance with the 2010 NMFS BiOp (NMFS 2010). Ramp-down rates below 3,000 cfs are artificially set to minimize risks of stranding juvenile coho salmon (NMFS 2010). These ramping rates specify that when flows exceed 1,750 cfs, decreases in flow are limited to 300 cfs or less per 24-hour period, and no more than 125 cfs per 4-hour period (as measured at USGS gauging station 11516530 located approximately 0.6 mile downstream of

[9] "Percent flow exceedance" is the percent of time that a specified flow is equaled or exceeded during a given time period. In this instance, the values in the table were obtained from modeling a 43-year period of record (i.e., 1961 to 2004) to predict monthly average flows at Iron Gate dam under the RPA. For example, the 95% flow of 1000 cfs for October indicates that average flows equal or exceed 1000 cfs during 95% of the time in October under the RPA scenario.

Iron Gate dam). When flows are 1,750 cfs, or less, decreases in flow are limited to 150 cfs or less per 24-hour period, and no more than 50 cfs per 2-hour period.

The 2010 BiOp (NMFS 2010) does not contain specific daily or hourly ramp rates when the flow release at Iron Gate dam is greater than 3,000 cfs. The 2010 BiOp (NMFS 2010) assumes Reclamation's proposed approach that the ramp-down of flows greater than 3,000 cfs should mimic natural hydrologic conditions of the basin upstream of Iron Gate dam. PacifiCorp is currently coordinating with Reclamation to ensure that the ramp-down of flows greater than 3,000 cfs is done in a manner that is consistent with natural hydrologic conditions, and that is practicable based upon the physical limitations of the Iron Gate facilities as well as other safety considerations.

These ramp rates supersede the ramp rates managed by PacifiCorp in prior years as specified in PacifiCorp's FERC license. The ramping rates now being followed below Iron Gate dam are more restrictive than the current FERC license ramp rate of 250 cfs per hour. However, coordination between Reclamation and PacifiCorp is necessary to make sure enough water is available from upstream for release over the long ramp-down periods. PacifiCorp currently continues to implement these ramp rates to the maximum extent practicable based upon the physical limitations of the Iron Gate facilities, as well as other safety considerations[10]. In instances in which upstream flow releases, natural conditions, operational issues, or other factors have resulted in deviation from these ramp rates, PacifiCorp has coordinated with NMFS to insure such events will not adversely affect listed species (e.g., timing of ramping).

Water Quality

Water quality conditions in the Klamath River basin vary dramatically along the approximately 250 river miles from Upper Klamath Lake to the estuary at the Pacific Ocean (FERC 2007, NRC 2004, PacifiCorp 2004b). A wide range of natural and anthropogenic influences affect water quality throughout the system. Inflows to the system at Link River dam originate from hypereutrophic Upper Klamath Lake (ODEQ 2010, Wee and Herrick 2005, ODEQ 2002, Johnson et al. 1985). Diversions and return flows for agriculture, as well as municipal and industrial use, occur in the reach between Link River dam and Keno dam (ODEQ 2010). The river receives considerable inflow from major and minor tributaries between Iron Gate dam and the estuary (NRC 2004, PacifiCorp 2004b, PacifiCorp 2004c).

Not only is the Klamath River system complex, it is also unique because water quality generally improves as water flows from its headwaters towards the estuary (NCRWQCB 2010a, ODEQ 2010, PacifiCorp 2008b, FERC 2007, PacifiCorp 2006). In most river systems, water quality is best at the source and degrades as water flows downstream (Vannote et al. 1980). The water quality of Upper Klamath Lake often is impaired due to the effects of nutrient enrichment and has deteriorated at an accelerated rate over the last century as a result of anthropogenic activities, such as agricultural development and other land use changes (ODEQ 2010, Wee and Herrick 2005, Eilers et al. 2004, ODEQ 2002, Bortleson and Fretwell 1993, Johnson et al. 1985, Phinney 1959). Upper Klamath Lake is now nutrient-

[10] For example, such considerations include the potential of adjusting flows outside of established ramp rates to ensure safety and rapid response in the unlikely event of accidental equipment breakage or failure.

enriched (hypereutrophic), and experiences large, recurring algae blooms (ODEQ 2010, Wee and Herrick 2005, ODEQ 2002). The result is that the quality of the water flowing from Upper Klamath Lake is the "driver" that dictates water quality throughout the system (NCRWQCB 2010a, ODEQ 2010, PacifiCorp 2006). The influence of Upper Klamath Lake's highly variable and seasonal discharges of large quantities of algae, nutrients, and organic matter on downstream river reaches can be dramatic, especially related to algal production and associated effects on DO, pH, and alkalinity (NCRWQCB 2010a, ODEQ 2010, FERC 2007, PacifiCorp 2006, NRC 2004).

The six dams on the Klamath River – 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 some settlement of nutrients and organic matter and processing of impaired quality water from Upper Klamath Lake. 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 within the Project Area and vicinity. Information for this summary were obtained largely from PacifiCorp (2008a, 2008b, 2006, 2004b, and 2004c) and FERC (2007). Water quality constituents discussed include water temperature, nutrients and algae production, DO, and pH, because these constituents may be affected by Project activities and are most directly related to effects on biological resources. 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. The downstream effects on water quality are of particular importance because of the presence of coho salmon in the reaches of the Klamath River downstream of Iron Gate dam.

Upper Klamath Lake

Upper Klamath Lake is a large (121 mi^2), shallow (mean depth about 7.8 feet) lake that is geologically old and classified as hypereutrophic (highly enriched with nutrients and supporting high abundance of suspended algae) (ODEQ 2010, Wee and Herrick 2005, ODEQ 2002, Johnson et al. 1985). The lake is subject to wind mixing, and physical or chemical stratification is not evident. A paleolimnological study by Eilers et al. (2004) revealed that Upper Klamath Lake has been a very productive lake, with high nutrient concentrations and blue-green algae, for at least the period of record represented by the study (about 1,000 years). However, the study showed that the water quality of Upper Klamath Lake has apparently changed substantially over the past several decades. Mobilization of phosphorus from agriculture and other nonpoint sources (Walker 2001) appears to have pushed the lake into its current hypereutrophic state, which includes algal blooms reaching or approaching theoretical maximum abundance. In addition, algal populations now are strongly dominated by 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. 2004).

Low DO 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 DO, 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 TMDLs for Upper Klamath Lake in May 2002 (ODEQ 2002).

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).

Water Temperature

The quality of water of the Link River reach is dominated by Upper Klamath Lake, and thus water temperature conditions in Link River are similar to those in Upper Klamath Lake. Over the course of a year, releases at Link River dam range in temperature from near zero degrees Celsius (°C) 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.

Nutrients and Algal Production

Levels of nitrogen and phosphorous vary considerably throughout the year in the Upper Klamath Lake outflow at Link River dam, as well as over short periods, primarily in response to primary production. 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. During the warmer periods of the year, nutrient availability largely 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. The organic matter (both living [e.g., algae] and dead) represents a considerable nutrient pool. Overall, the nutrient load from Upper Klamath Lake remains largely unchanged through the short Link River reach.

Dissolved Oxygen

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 DO levels remain close to saturation.[11] During the warmer period of the year, when primary production plays a role, the diurnal range and short-term variation can be 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. The role of algae in this short reach is not well understood. Field data suggest that conditions may be sufficient for phytoplankton to continue to photosynthesize and respire in portions of this reach, as is suggested by the larger daily diurnal range at the bottom of the reach than at the top.

Alkalinity and pH

Generally, the alkalinity of Upper Klamath Lake at Link River dam is between 40 and 60 mg/L. This level of alkalinity represents a weakly buffered system (EPA 1987). A weakly buffered system is predisposed to fluctuations in pH if sufficient primary production occurs (Horne and Goldman 1994). Elevated pH can lead to increased toxicity of certain constituents (e.g., ammonia) (Colt et al. 1979). Changes in pH can lead to increased toxicity of certain constituents (e.g., ammonia). 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. Values above 8.5 to 9.0 can lead to ammonia toxicity. Alkalinity and pH are generally unchanged from the upstream end to the downstream end of this reach.

Summary and Relationship of Link River to Downstream Water Quality

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.

Keno Reservoir

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.

Currently, Keno reservoir experiences severe water quality impairment, including persistent summer anoxia for several miles of the river. This impairment, although variable, can extend from the bed to just a few inches below the water surface and from just downstream of Link River to Keno dam. Although the impacts of anthropogenic inputs are notable, and legacy impacts (from agricultural development and other land use changes in the basin) are present, the primary source of loadings of nutrients and organic matter to this system is Upper Klamath Lake.

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[11] 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).

Water Temperature

Keno reservoir does not experience seasonal thermal stratification, but exhibits weak, intermittent temperature gradients during summer periods. Annual water temperatures range from near zero degrees Celsius (C) to more than 25°C and are at or near equilibrium temperatures,[12] reflecting local meteorological conditions and the fact that Upper Klamath Lake is generally at or near equilibrium. The inputs of tributaries to the reservoir are usually small compared to the overall volume of the Klamath River inflow (although agricultural return flows can, at times, form a large percentage of the in-river flows). The inputs of tributaries also have similar temperatures to ambient river temperatures, so these inputs do not affect reservoir thermal conditions appreciably. The reservoir freezes in some winters. Water temperatures of reservoir inflows are similar to water temperatures of reservoir outflows.

Nutrients and Algal Production

One of the most notable aspects of the reach is the large amount of inorganic nutrients present during periods of anoxia (e.g., total inorganic nitrogen [nitrate and ammonia] is in excess of 1 mg/L, and orthophosphate values are in excess of 0.5 mg/L) (PacifiCorp 2008a). Under anoxic conditions, nutrients that are normally bound in sediments become soluble and can be released from the sediments back into the water (referred to as “internal nutrient cycling”) (Eilers and Raymond 2003, Raymond and Eilers 2004). However, at times of severe anoxia the reservoir has limited primary production, apparently as a result of the lack of available oxygen to meet algal respiratory demands.

To estimate nutrient retention (reduction) in Keno reservoir, PacifiCorp completed mass balance estimates on reach inflows and outflows for total nutrients (PacifiCorp 2006, 2008a). These analyses are not comprehensive mass balances accounting for all inflow and outflow within the reach. Rather, these results indicate loads at the top of the reach and at the bottom of the reach, and internal processes are implicitly included. Figure 2 shows the differences in total mass of nutrients (nitrogen and phosphorus) at the upstream and downstream end of Keno reservoir, and indicates that Keno reservoir is a net sink of total nitrogen and total phosphorous.

Dissolved Oxygen

Dissolved oxygen conditions vary seasonally in Keno reservoir. Winter conditions result in near saturation values for DO, while summer and fall values can remain well under saturation and may be near zero in some reaches for weeks. These conditions consistently occur, to one degree or another, each year. The source of the depressed DO is largely organic matter influx from Upper Klamath Lake. The influent algal population from Upper Klamath Lake does not fare as well in Keno reservoir due to reduced photic zone (compared to Upper Klamath Lake) and the weak stratification that occurs in Keno reservoir. 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

[12] 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.

produce persistent sub-saturation conditions for much of the reservoir during summer and into fall.

At times of severe anoxia, Keno reservoir is limited in primary production, apparently as a result of the lack of available oxygen to meet algal respiratory demands. Low DO concentrations persist well into October and may extend into November (depending on the timing of the typical seasonal increase in flows during fall). Figure 3 shows DO isopleths in Keno reservoir for example dates in May, July, and October 2005, which depict the timing and magnitude of the reservoir's low DO conditions.

It is common to see some recovery in DO conditions by the time waters reach Keno dam. This recovery may be due to residence time (e.g., processing time and settling), physical reaeration aided by windy conditions in the Keno area, which can aerate the reservoir, primary production, or other factors. Conditions below Keno dam are generally improved due to reaeration during releases from the dam, where the configuration of radial gates can act to reaerate releases to some degree, and from natural mechanical aeration in the riverine environment downstream of the dam. Overall, DO concentrations in Keno reservoir are highly variable due to the variability of local conditions (e.g., phytoplankton blooms, meteorological conditions) in and around Upper Klamath Lake.

Alkalinity and pH

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 DO persist.

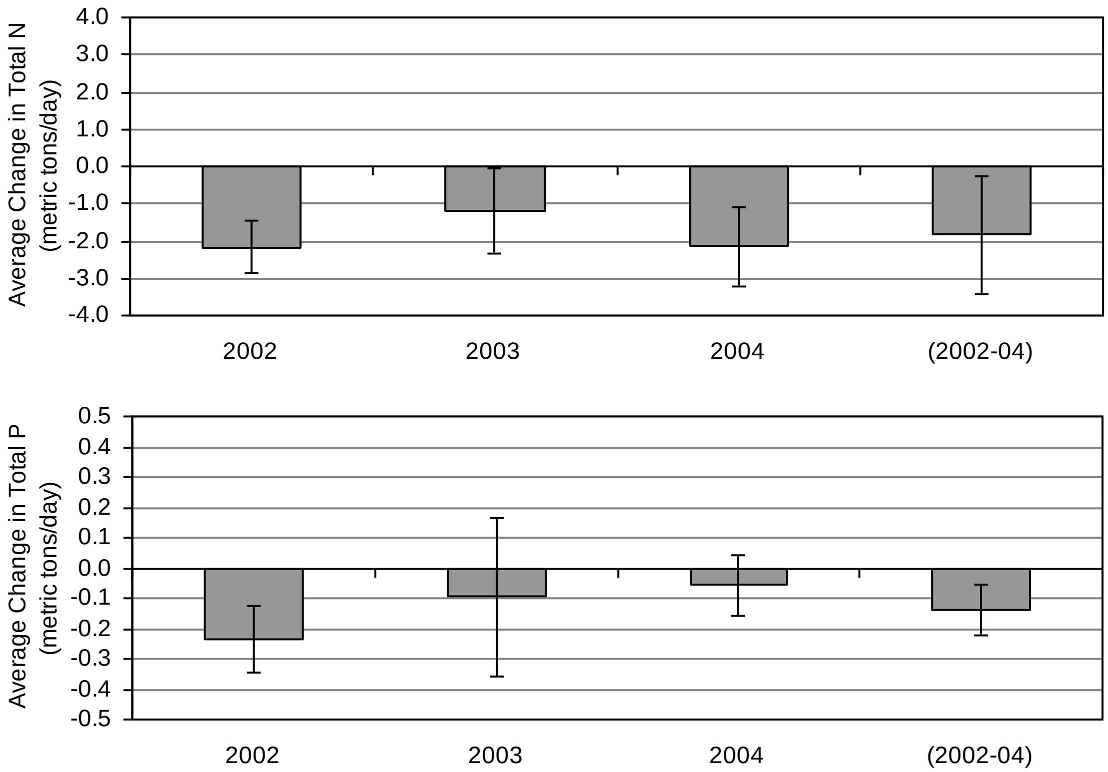

FIGURE 2
Annual change in total nitrogen (top plot) and total phosphorous (bottom plot), in metric tons/day, between Link River above Lake Ewauna and Klamath River below Keno Dam, 2002, 2003, 2004, and 2004-2004 (positive represents increase, negative represents decrease). The 90 percent confidence intervals are represented by error bars.

Summary and Relationship to System Water Quality

The net effect of Keno reservoir on water temperature is minimal, with inflow temperatures similar to outflow temperatures. Although DO conditions may be notably depressed within the impoundment, particularly during summer, conditions at the downstream end of the reservoir are generally similar to the upstream end. However, in the fall there are periods when DO conditions immediately below Keno dam are notably lower than in Link River. The overall effect on biological oxygen demand (BOD) and total suspended solids is reduced concentrations below Keno dam as compared to Link River. Specific conductance and alkalinity both show notable increases in this reach, presumably from the Reclamation irrigation project's return flows. At Link River dam, pH is generally similar or higher than at Keno dam.

This reservoir reach experiences highly variable, complex water quality conditions in response to hydrology (including water resources development), meteorology, and impaired water quality from Upper Klamath Lake. The result of extensive temporal and spatial impairment, particularly with regard to low DO conditions, is a reduced ability to process organic matter and retain nutrients. Further, this impairment can cause fish die-offs in the reservoir, as occurred in 2005 (PacifiCorp 2008a). Overall, these findings suggest that this reach is doing little to reduce total elevated incoming nutrient levels in the river under typical conditions.

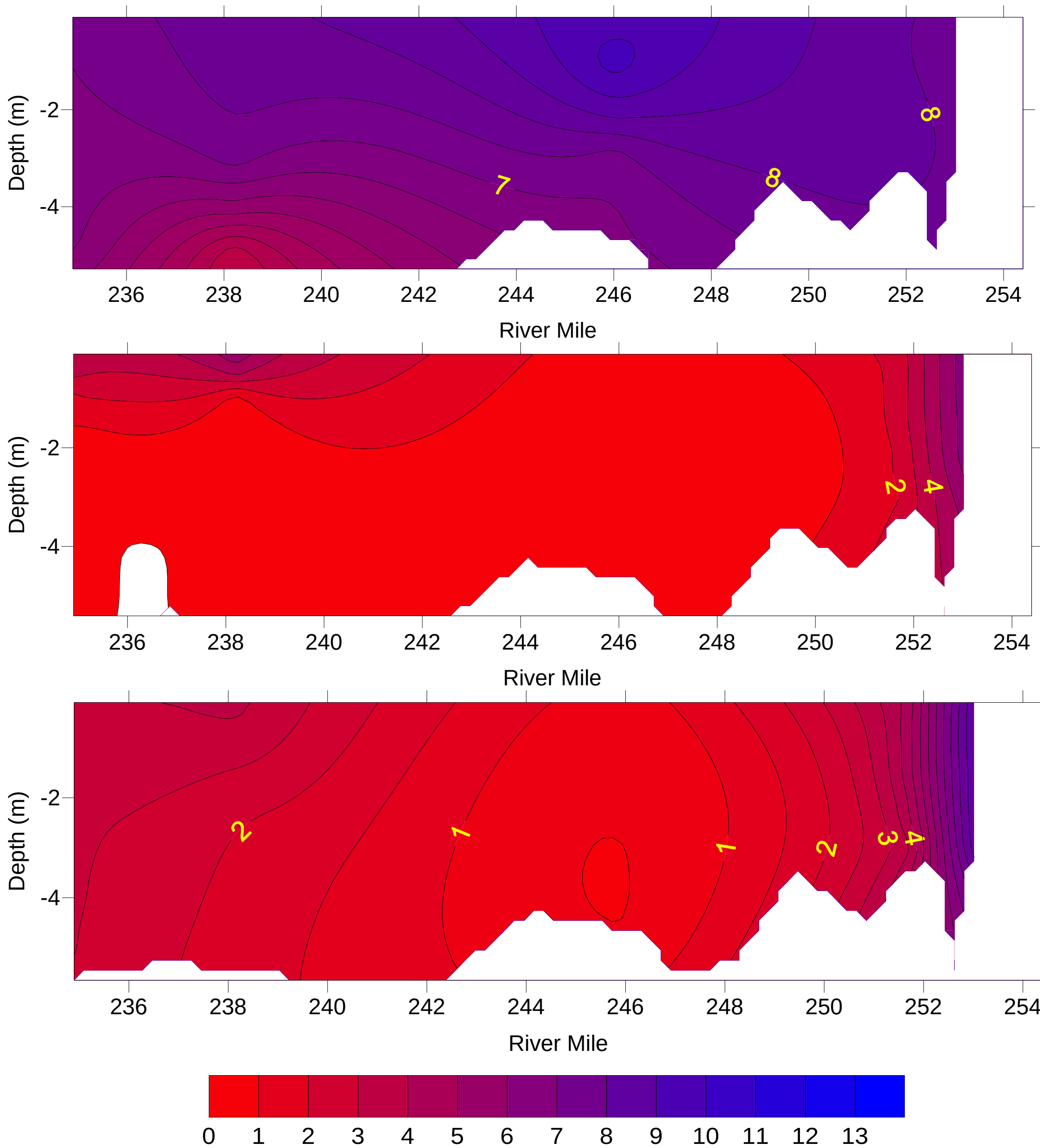

FIGURE 3
Dissolved oxygen isopleths (in mg/L) in Keno reservoir on May 3, 2005 (top plot), July 26, 2005 (middle plot), and October 18, 2005 (bottom plot). Data obtained from U.S. Bureau of Reclamation.

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).

Water Temperature

Water temperatures in this reach vary along its length only modestly. The exception is that releases from Keno dam may experience only a modest diurnal range during warmer periods of the year due to the depth and volume of water upstream of the dam. However, by the time flows reach 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.

Nutrients and Algal Production

Data collected at Keno dam and just above J.C. Boyle reservoir suggests overall total nitrogen and phosphorous is almost unchanged in this reach from upstream levels (PacifiCorp 2008a). Figure 4 shows the differences in total mass of nutrients (nitrogen and phosphorus) at the upstream and downstream end of Keno reach, and indicates that this reach is doing little to reduce total nutrient levels in the river under typical conditions.

Diurnal variations in DO concentrations above J.C. Boyle reservoir, as well as periphyton sampling, suggest that there is some level of primary production occurring in this reach (i.e., producing diurnal variations in excess of those associated with diurnal temperature fluctuations). However, the high velocities and variable flows, coupled with relatively high light extinction characteristic[13], 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.

Dissolved Oxygen

The river channel in the Keno reach is much steeper than the Keno reservoir upstream. Due to the steepness of this reach and the associated natural physical aeration, DO concentrations generally improve as waters from Keno reservoir subsequently flow through the Keno reach, approaching equilibrium conditions with the atmosphere. However, DO 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 DO 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.

Alkalinity and pH

Alkalinity does not appreciably change in this relatively short reach. Values for pH generally show 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

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[13] "High light extinction" occurs when particulate matter in the water (from floating algae and other particulates) is so dense that sunlight does not penetrate nearly as deeply as it otherwise would in clearer water. This high light extinction can limit or prevent growth of algae that may be present in deeper waters because light needed for photosynthesis is too low.

of primary production in Keno reservoir inflows to the reach and the potential for entraining carbon dioxide via natural physical aeration in the reach.

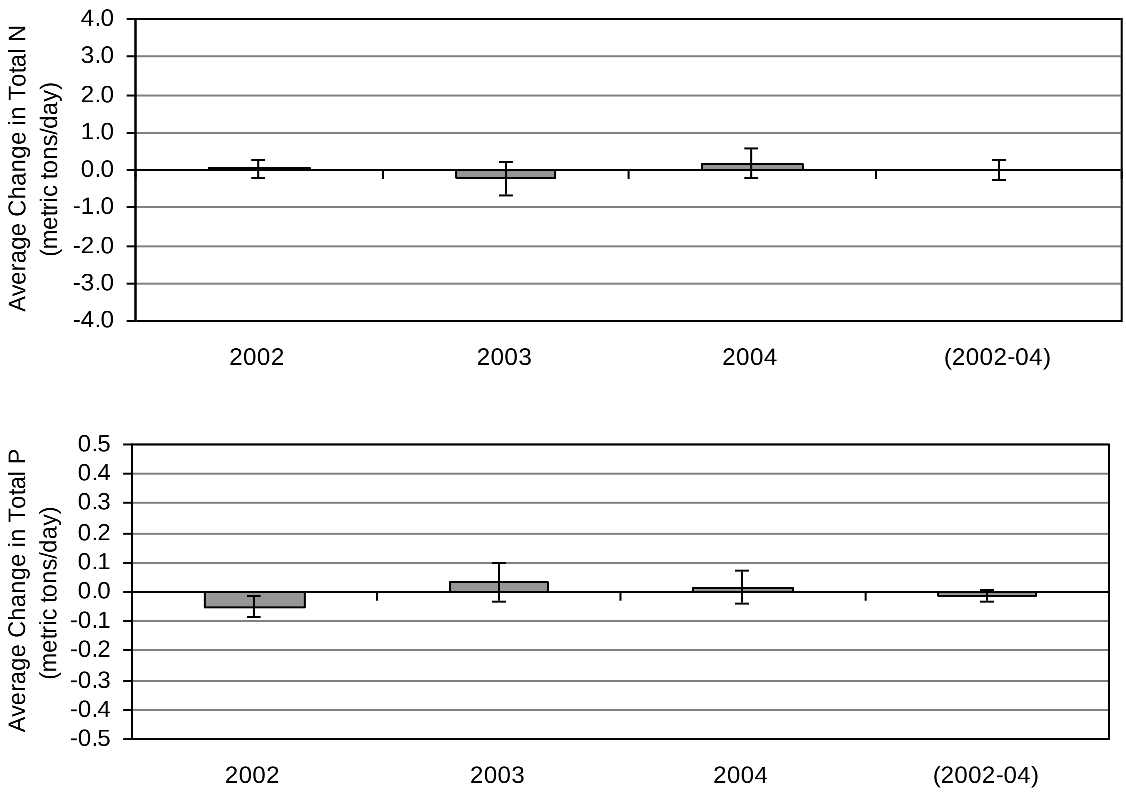

FIGURE 4
Annual change in total nitrogen (top plot) and total phosphorous (bottom plot), in metric tons/day, in the Keno reach of the Klamath River between Keno dam and J.C. Boyle reservoir, 2002, 2003, 2004, and 2004-2004 (positive represents increase, negative represents decrease). The 90 percent confidence intervals are represented by error bars.

Summary and Relationship to System Water Quality

The available data for the Keno dam to J.C. Boyle reach suggests that many water quality characteristics do not change appreciably: temperature, total nitrogen, total phosphorus, total organic carbon, alkalinity, pH, and specific conductance. The ability of 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 unchanged or increase within the reach.

J.C. Boyle Reservoir

J.C. Boyle reservoir primarily serves to provide peaking flows for the J.C. Boyle powerhouse (RM 220.4). This reach extends from the headwaters of the reservoir (the end of the Keno reach at 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.

Water Temperature

The short residence time, hydropower peaking operations, and modest depth of J.C. Boyle reservoir prevent the development of thermal stratification driven by solar heating of the reservoir. 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. The short residence time also contributes to this condition. As with Keno reservoir, the outflow temperatures exhibit a reduced diurnal variation due to the deep profile of the reservoir compared to shallow depths in typical river reaches. This reduced diurnal variation results in a maximum daily temperature that is lower in the reservoir's outflow than inflow.

Nutrients and Algal Production

The total nutrient concentrations in the reservoir's outflowing waters are often similar to those in inflowing waters. Figure 5 shows the differences in total mass of nutrients (nitrogen and phosphorus) at the upstream and downstream end of J.C. Boyle reservoir, and indicates that J.C. Boyle is not appreciably retaining (reducing) nutrient levels under typical conditions. This is in contrast to the larger downstream Copco and Iron Gate reservoirs, which retain (reduce) significant amounts of the annual load of nutrients that flow into those reservoirs. The lesser retention of nutrients in J.C. Boyle reservoir in comparison to Copco and Iron Gate reservoirs is attributed to the much shorter hydraulic retention or residence time in J.C. Boyle reservoir, which is on the order of 2 days in J.C. Boyle reservoir during average summer flow conditions, compared to 32 and 42 days, respectively, in Copco and Iron Gate 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 September but might show a modest rebound in October and then decrease 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 the standing crop of phytoplankton (i.e., the total amount of phytoplankton present in the reservoir at a given time).

The short residence time produces a noticeable current in the reservoir, which is not generally conducive to phytoplankton populations. However, the reservoir morphology and setting allows primary production to generally persist from spring through fall. 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 of the same magnitude as in upstream areas such as Upper Klamath Lake and Keno reservoir.

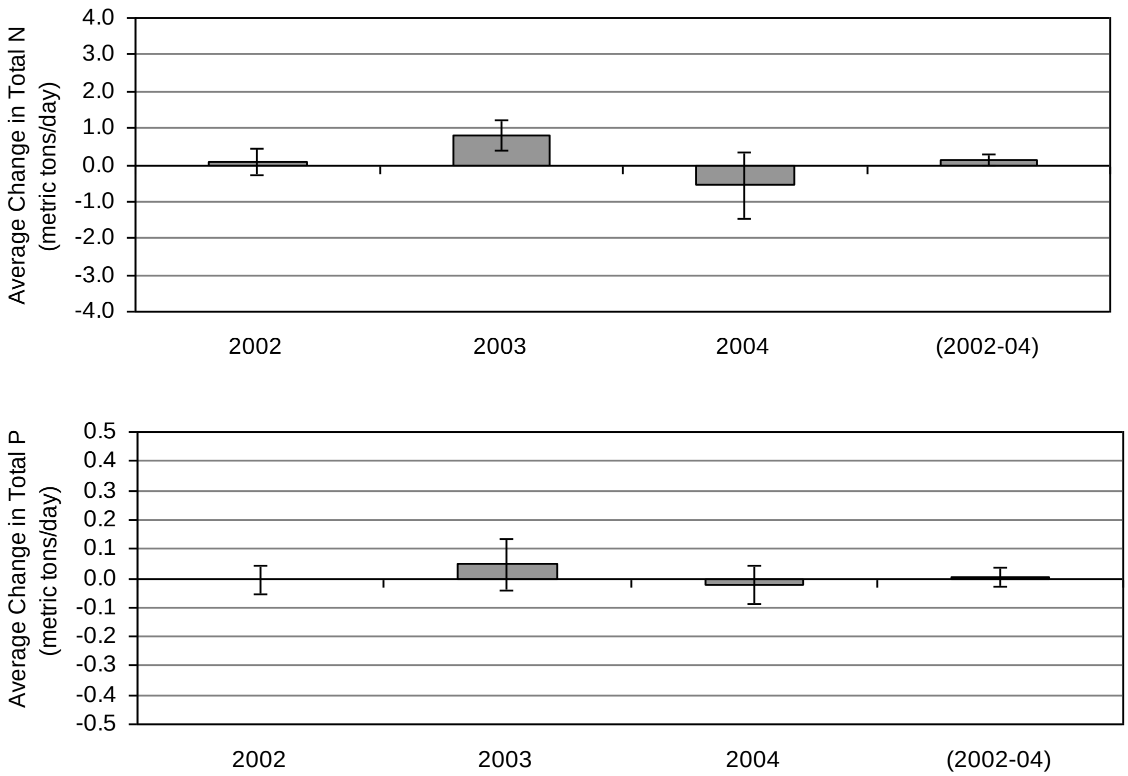

FIGURE 5
Annual change in total nitrogen (top plot) and total phosphorous (bottom plot), in metric tons/day, in the inflow versus outflow of J.C. Boyle reservoir, 2002, 2003, 2004, and 2002-2004 (positive represents increase, negative represents decrease). The 90 percent confidence intervals are represented by error bars.

Dissolved Oxygen

J.C. Boyle reservoir experiences DO concentrations that deviate from saturation—falling to about 3 mg/L at certain times of the year. The lowest DO levels are restricted to a relatively small volume of water in the deeper portions of the reservoir during summer when seasonally low flows produce less efficient mixing near the bottom 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 DO. Dissolved oxygen concentrations in water released from the reservoir are often similar to inflow concentrations.

Alkalinity and pH

These parameters do not appreciably change in this relatively short reservoir reach. The values for pH 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.

Summary and Relationship to System Water Quality

J.C. Boyle reservoir is eutrophic because of the large nutrient load from upstream sources and seasonally warm water temperatures. Inflowing waters are distributed throughout the depth of the reservoir as a result of the diurnal temperature change in the inflow. This 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, but it is likely limited by the reservoir's short hydraulic residence time. This organic material is primarily from upstream sources (Upper Klamath Lake, Keno reservoir). In general, the reservoir is not producing marked reductions or increases in nutrients or organic matter.

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. There is a minimum 100 cfs required release from J.C. Boyle dam to meet instream flow requirements. Large spring-fed inflows enter the bypass reach approximately 0.75 miles below the dam.

Water Temperature

The river 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 within much of the bypass reach. As a result of the spring inflows, the river temperature deviates substantially from equilibrium in summer and winter. During the winter, the springs provide warmer water to a river that otherwise may be less than 2°C, and in summer they provide cool water to a river that may exceed 25°C. Flows out of the bypass reach range in temperature from less than 10°C in winter to greater than 15°C in summer. 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 (which is also the proposed flow release in PacifiCorp's Final License Application to FERC) provides the best balance of preferred water temperature conditions and available physical habitat for redband/rainbow trout (*Oncorhynchus mykiss*) in the reach (PacifiCorp 2004b, 2004e, 2005a, 2005e). Modeling by PacifiCorp indicates that higher instream flows would substantially impair water quality in the J.C. Boyle bypass reach by degrading the beneficial cooling effects of the 250 cfs contributed by 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.

Independent water temperature predictions by Bartholow and Heasley (2005) for the J.C. Boyle bypass reach are similar to those of PacifiCorp as described above—that is, as bypass release flows are incrementally increased above 100 cfs, water temperatures in the bypass reach are incrementally warmed as the cooling benefits of the significant groundwater accretions in this reach are progressively diminished. Bartholow and Heasley's (2005) estimates suggest that a release from J.C. Boyle dam of 100 cfs retains a much more expansive region of high quality water temperature conditions throughout the J.C. Boyle bypass reach.

Nutrients and Algal Production

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 total nitrogen, total phosphorous, and total organic carbon 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 (e.g., approximately 0.15 mg/L of PO_4^{-3} and NO_3^-), 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.

Dissolved Oxygen

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. There is a modest diurnal variation in observed DO concentrations above the powerhouse in the summer. A portion of this may be due to diurnal temperature differences, with the balance the result of modest levels of primary production.

Alkalinity and pH

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, i.e., weakly buffered. The values for pH 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.

Summary and Relationship to System Water Quality

This short residence time reach is largely dominated by the spring inflow, 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 reservoir is spilling. If the spills are sufficiently large (on the order of 600 to 800 cfs), the river dominates the spring inputs. The total nitrogen, phosphorous, and organic carbon data suggests that the principal "process" in this reach is dilution. The physical constraints of high velocity, substrate, and possibly light (topographic shading and/or color in the upper reaches) limit the ability to support a large standing crop of attached algae. Other processes in this reach include natural physical reaeration, which creates sufficient conditions to support oxidation of organic and inorganic nutrient forms (Chapra 1997). Thermal conditions within the reach during the summer are well below equilibrium conditions in response to the large, cold spring inflows.

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.

Water Temperature

Inflow temperatures 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 large flow rates associated with peaking power production. 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. The peaking operations, combined with constant temperature spring inputs in the bypass reach, may also impose unique temperature signals on the river above Copco reservoir.

Nutrients and Algal Production

Nutrient conditions also respond to variations due to peaking operations. Nitrate concentrations in the Klamath River above Copco reservoir can increase 30 percent between non-peak and peaking periods. Ammonia and phosphate also respond to the flow regime, but not as dramatically. Total nitrogen, phosphorous, and organic carbon are generally lower at the bottom of the J.C. Boyle peaking reach than at the top. It appears that only modest changes in nutrients occur within the relatively short residence time, with the exception of reduction via dilution. 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). 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).

Dissolved Oxygen

Dissolved oxygen conditions in the peaking reach are variable due to the flow regime (low and high flow conditions). In the upper portion of this reach, the river is steep and punctuated by several large rapids. In the vicinity of the California border, the slope of the river lessens but is still steep. Natural physical reaeration in the larger, more extensive rapids results in DO conditions at or near saturation (Chapra 1997, Thomann and Mueller 1987). However, primary production also plays a role in DO during the growing season (Wetzel 2001). Primary production occurs in this reach, but is modest for the reasons described above. The diurnal range in DO at the California border is close to 2 mg/L, while above Copco reservoir it can exceed 2 mg/L. These levels, over a daily average, suggest the system is running under 100 percent saturation during the summer months. This condition may be associated with the appreciable organic load imparted on the reach from upstream sources.

Alkalinity and pH

Alkalinity concentration does not change dramatically within this 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.

Summary and Relationship to System Water Quality

The J.C. Boyle peaking reach is a highly dynamic reach. Inflows from the bypass reach provide dilution and reduce overall nutrient concentrations accordingly. Physical reaeration may create an oxidative environment that allows decay of organic matter and nitrification to proceed. Field data suggest that the river DO concentrations generally are under saturation during summer periods, a condition that is presumed to be associated with the organic load from upstream sources. Upstream of Copco reservoir, water temperature and DO are close to equilibrium and 100 percent saturation, respectively.

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).

Water Temperature

The onset of seasonal stratification typically occurs in mid to late March, and the breakdown of stratification in October. 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 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. This cool pool of water is relatively small (approximate annual minimum is less than 2,000 AF).

During the spring months, the reservoir tends to minimize deviations from seasonal mean temperatures, i.e., the relatively deep water release moderates short term response in water temperature to deviations in meteorological conditions (“hot” or “cold” spells). During late spring and mid-summer, the reservoir releases are generally below equilibrium. In the fall, reservoir release temperatures tend to be above equilibrium temperatures of the Klamath River upstream and downstream due to the seasonal loading (summer) and large thermal mass of the reservoir. This thermal lag is perceptible in late August and persists through the fall period. Throughout the year, diurnal range of release temperatures is moderated by the volume of the reservoir. Due to these dynamics of the reservoir and upstream river, release waters are sometimes warmer and sometimes cooler than the inflowing river.

Nutrients and Algal Production

Copco reservoir acts as an annual net sink for both total nitrogen and total phosphorous (Kann and Asarian 2005). Reservoirs can act as traps, reducing organic matter, nutrient, and particulate matter (Thornton 1990, Ward and Stanford 1983). There are periods usually outside of the growth season when the reservoir may act as a source of nutrients. Asarian et al. (2009) developed a multi-year nutrient budget for Copco and Iron Gate reservoirs and found that concentrations of total nitrogen were consistently lower in the Klamath River below Iron Gate dam than the Klamath River above Copco reservoir for July through October, and total phosphorus concentrations were lower below Iron Gate dam than above Copco reservoir from mid-July through August.

Average phytoplankton biovolume and chlorophyll concentrations in Copco reservoir show a general succession typical of the Klamath River system. Values are typically high in March, decrease in April and 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 standing crop.

Nuisance bloom-forming blue-green algae, such as *Aphanizomenon* and *Microcystis,* have been observed to form large blooms in the reservoir during summer. This succession is consistent with other systems where these species are prevalent, with controlling factors potentially linked to macronutrient (e.g., nitrogen) limitation. *Aphanizomenon* is usually the dominant bloom-forming species, although large blooms of *Microcystis* have been observed recently, particularly in late summer. 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.

Overall, the nutrient processes at work in Copco Reservoir are complex. 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.

Dissolved Oxygen

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, seasonal anoxia of bottom waters occurs. The onset of anoxic conditions occurs initially in bottom waters (typically commencing in May through June), reaching a maximum in July when roughly the bottom 60 feet of the reservoir can have DO concentrations less than 1.0 mg/L.

The reservoir is productive, leading to DO concentrations in surface waters during the growth season at, or even above, saturation. Copco 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 from where water is withdrawn.

Alkalinity and pH

Alkalinity and pH conditions in Copco reservoir vary seasonally and with depth. Generally, during winter isothermal conditions the pH ranges from below 7 to about 8. With the onset of thermal stratification, pH in surface waters can reach levels above 9 units due in large part to primary production in these weakly buffered waters that are typical of Upper Klamath Lake and the Klamath River. When anoxia is present in the lower portions of the reservoir, it is not uncommon for pH values to fall below 6, even during summer periods.

Summary and Relationship to System Water Quality

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 water quality that is ultimately borne out of Upper Klamath Lake and any agricultural and municipal/industrial return flows. 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, upstream (Upper Klamath Lake and Keno reservoir) algal blooms and die-offs, fish die-offs, severe anoxia and the associated water quality conditions may reach Copco reservoir in a matter of days. The result of these substantial upstream loads is a eutrophic reservoir.

Copco reservoir is generally productive during summer months, but can produce large nuisance algal blooms if the influx of nutrients via the inflow increases in response to upstream conditions (e.g., large algal blooms). In general, field data suggest that Copco reservoir acts as a net sink for both total nitrogen and phosphorous. The transit time from the upper basin, the reservoir residence (or transit) time, and stratification in Copco reservoir each play important roles in this regard. Such basin-scale processes are important to understanding the character of water quality in Copco reservoir and downstream reaches.

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, DO 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.

Water Temperature

The onset of seasonal stratification in Iron Gate reservoir typically occurs in mid to late March, and the breakdown of stratification in November. Iron Gate reservoir thermal profiles indicate a strong seasonal thermal stratification. Copco reservoir provides fairly constant temperature inflows to Iron Gate reservoir, which delays the break-up of thermal stratification (i.e., "fall turnover") in Iron Gate reservoir by approximately 3 to 4 weeks after Copco reservoir. The associated contribution of variable temperature inflows to destratification is thus reduced, and convective cooling plays a more prominent role in fall destratification of Iron Gate reservoir (Fischer, 1979).

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. The bottom waters of Iron Gate reservoir are appreciably cooler than Copco reservoir owing to the larger size of Iron Gate and the generally stable (short-term) inflow temperatures from Copco No. 2 powerhouse releases to Iron Gate reservoir. These conditions create a fairly isolated hypolimnion (approximate annual minimum 5,000 AF) and minimize mixing into the deeper portions of Iron Gate reservoir. The Iron Gate fish hatchery also draws on this cold water volume.

During the spring months, Iron Gate reservoir tends to minimize deviations from seasonal mean temperatures, i.e., the relatively deep water release moderates short term response in water temperature to deviations in meteorological conditions ("hot" or "cold" spells). During late spring and mid-summer, the reservoir releases are generally below equilibrium. In the fall, reservoir release temperatures tend to be above equilibrium temperatures of the downstream Klamath River because of the large mass of the reservoir (compared to the river). This thermal lag is perceptible in late August and persists through the fall period.

Fall turnover does not immediately ameliorate this condition. Rather, continued cooling in response to meteorological conditions and river inflows results in an isothermal condition that is near equilibrium. 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.

Nutrients and Algal Production

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). There are periods usually outside of the growth season when the reservoir may act as a source of nutrients. Asarian et al. (2009) developed a multi-year nutrient budget for Copco and Iron Gate reservoirs and found that concentrations of total nitrogen were consistently lower in the Klamath River below Iron Gate dam than the Klamath River above Copco reservoir for July through October, and total phosphorus concentrations were lower below Iron Gate dam than above Copco reservoir from mid-July through August.

At times, the upstream conditions from Upper Klamath Lake and Keno reservoir may produce large quantities of organic matter and can increase the nutrient fluxes into both Copco and Iron Gate reservoirs substantially. However, the subsequent impact on 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 reservoirs. Because of this time lag, it is expected that the reservoirs will occasionally experience nutrient fluxes in release waters greater than that in inflowing waters.

Overall, the nutrient processes at work in Iron Gate reservoir are complex. Field observations suggest that Iron Gate reservoir water quality responds strongly to inflow quantity and quality. The annual contribution to the reservoir's nutrient loading from internal reservoir nutrient cycling is probably not significant, due to the comparatively large hydraulic and nutrient loads from the river, the complete replacement of reservoir volume during winter periods, and the reservoir's persistent stratification during the algae growth season.

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.

Dissolved Oxygen

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, seasonal anoxia of bottom waters occurs. The onset of anoxic conditions occurs initially in bottom waters (typically commencing in May through June), and reaching a maximum in September wherein roughly the bottom 100 feet of the reservoir can experience DO concentrations less than 1.0 mg/L.

The reservoir is productive, leading to DO concentrations in surface waters during the growth season at, or even above, saturation. 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.

Alkalinity and pH

Alkalinity and pH conditions in Iron Gate reservoir vary seasonally and with depth. Generally during winter isothermal conditions, the pH ranges from below 7 to approximately 8. With the onset of thermal stratification, pH in surface waters can reach levels above 9 units due in large part to primary production in these weakly buffered waters that are typical of Upper Klamath Lake and the Klamath River. When anoxia is present in the lower portions of Iron Gate reservoir, it is not uncommon for pH values to fall to 6, even during summer periods. Values for pH below Iron Gate dam may be elevated during periods of high primary production in the reservoir.

Summary and Relationship to System Water Quality

Iron Gate reservoir is the second relatively large mainstem reservoir on the Klamath River below Upper Klamath Lake. Iron Gate reservoir receives large hydraulic and nutrient loads from the inflowing Klamath River. The result of these substantial upstream loads is a eutrophic reservoir.

Iron Gate reservoir is generally productive during summer months, and can produce nuisance algal blooms if the influx of nutrients increases in response to upstream conditions (e.g., large Upper Klamath Lake algal blooms, severely impaired water quality conditions in Keno reservoir). The transit time from the upper basin (including Copco reservoir), the reservoir residence (or transit) time, and stratification in Iron Gate reservoir each play important roles in this regard. Such basin-scale processes are important to understanding the character of water quality in Iron Gate reservoir and downstream reaches.

Klamath River from Iron Gate Dam to Turwar

The Iron Gate dam to Turwar reach extends from Iron Gate dam (RM 190.5) to the USGS gauge at Turwar (RM 5.3) near the mouth of the Klamath River. There are several main tributaries flowing into the reach—Shasta River (RM 177.3), Scott River (RM 143.6), Salmon River (RM 66.4), and Trinity River (RM 43.3)—as well as many minor tributaries. The flow in the river increases significantly in the downstream direction due to major and minor tributary contributions. There are no major diversions in this reach and the river largely flows through forested, mountainous terrain.

Water Temperature

Water temperatures in this reach are generally at or near equilibrium with ambient air temperature, with the exception of immediately below Iron Gate dam and in the vicinity of certain tributaries. As previously described, Iron Gate reservoir releases are generally moderated owing to the relatively large reservoir volume and a penstock release elevation that is about 30 feet deep. These attributes lead to water temperatures that may be at or slightly below equilibrium temperature of the river downstream of the dam in the spring (the river is considerably smaller in terms of volume per unit length, and thus cools and heats more quickly than the reservoir in response the ambient meteorological conditions).

During the fall period, release water temperatures from Iron Gate dam are higher than equilibrium temperature of the river due to the thermal lag caused by the reservoir's mass. This lag is largest at the dam and diminishes relatively quickly in the downstream direction as the river comes into equilibrium with the local meteorological conditions. By the time flows reach the Shasta River, the impact of the lag is diminished by approximately 50 percent, and continues to diminish in the downstream direction. Regulation of the river at Iron Gate dam also produces a thermal signal downstream of the reservoir spaced at intervals of 24 hour travel time (PacifiCorp 2008b).

Water temperatures are generally at or near equilibrium once below the Shasta River. Exceptions may include periods during spring snowmelt runoff or rain on snow events when tributary contributions yield cold runoff to the main stem Klamath River. In addition, during warmer periods of the year there are isolated regions at the confluence of many tributaries where water temperatures are markedly colder than the main stem. These areas, termed thermal refugia, may range from a few square yards to several hundred square yards in size depending on the flow and temperature in the tributary, flow conditions in the main stem Klamath River, and local geomorphology. These thermal refugia have been the subject of an ongoing study sponsored by the USBR (Sutton et al. 2002).

Field observations indicate that the warmest reach of the Klamath River under existing conditions is the reach between approximately Seiad Valley (RM 129) and Clear Creek (RM 98.8). Maximum daily temperatures can approach 30°C and daily minimum temperatures in the 20° to 24°C range are common in this reach during summer. Downstream of this reach, the river experiences considerable accretion and the aspect ratio of the channel changes from a broad shallow stream to a deeper river. The diurnal range in temperature is moderated in the lower river as well. Temperatures in the lower river experience lower river temperatures overall during summer periods, with highs generally in the vicinity of 25°C; however, daytime lows remain in the 20° to 24°C range. As the river approaches the coast, marine influences can moderate river temperatures, but when clear warm conditions prevail, water temperatures respond accordingly. During winter, the lower river locations may be warmer than the locations closer to Iron Gate dam due to more mild meteorological conditions at lower elevations.

Nutrients and Algal Production

Waters flowing downstream carry a variety of particles and nutrients from the headwaters to the terminus of the river system. However, nutrients (herein including particulate and dissolved organic matter) are not simply traveling downstream without interaction with the surrounding aquatic environment. Instead, nutrients in river systems cycle through the ecosystem in a manner similar to the cycling processes in lakes and reservoirs: organic matter breaks down into its components as it moves downstream; aquatic plant life extracts nitrogen and phosphorus from the water; aquatic flora and fauna excrete nutrient rich waste or through mortality produce organic matter and the cycle begins anew—albeit at a location downstream (Elwood et al. 1983).

During summer and fall periods there is a considerable amount of particulate matter readily observable in the Klamath River in this reach. The proportion of this particulate matter that is derived from Iron Gate reservoir and upstream sources compared to that generated within the river downstream of Iron Gate dam is unknown at this time but decreases with distance downstream. Regardless, the eutrophic nature of the Klamath River downstream of Iron Gate dam is largely due to upstream sources of nutrients. This particulate matter (and presumably dissolved matter as well) is readily advected downstream and a portion ultimately settles in the Klamath River Estuary.

Dissolved Oxygen

Daily mean DO conditions are at or near saturation throughout the entire reach due to the many cascades, rapids, and riffles in this steep reach of river that provide mechanical reaeration. An exception is the reach immediately below Iron Gate dam during late summer and fall periods, where relatively deep releases from Iron Gate reservoir entrain water with low DO concentration, resulting in discharges from the dam of water that is below 100 percent saturation.

Further, it is not uncommon to find the Klamath River at several locations farther downstream experiencing "chronic" mild subsaturation during the warmer periods of the year (PacifiCorp 2008b). These are conditions when the average DO concentration over a period of time (days or weeks) is below saturation, and DO never rises above saturation. It is postulated that this mild, persistent subsaturation is related to the appreciable organic load being carried by the river. During winter, conditions are typically at or near saturation throughout the reach.

Alkalinity and pH

Alkalinity is generally under 100 mg/L throughout the reach. Unlike the water from Upper Klamath Lake, water from the Shasta River is well buffered with 200 to 300 mg/L of alkalinity. The Scott River inputs are on the order of 100 mg/L, while the Salmon and Trinity Rivers are well under 100 mg/L. While the Shasta River contributes appreciable alkalinity, its overall contribution is small and the Klamath River retains a weakly buffered status. Thus the river is prone to pH changes in response to primary production, where sufficient algal growth is present.

A byproduct of this level of primary production in a weakly buffered system is a notable diurnal variation in pH (Wetzel 2001). It is not uncommon to observe pH values in excess of 9.0 in the early afternoon during late spring and summer periods in the reach between Iron Gate dam and the mouth of the Klamath River.

Summary and Relationship to System Water Quality

The Klamath River downstream of Iron Gate dam can be described as a eutrophic stream. Winter conditions are generally benign from a water quality perspective with cool to moderate water temperatures and DO conditions at or near saturation. Although there may be nutrients sufficient for primary production, low water temperatures and short day length preclude a large algal standing crop. Conditions change markedly with the onset of warmer weather. Water temperatures rise and primary production (benthic algae) can lead to deviations in DO (above and below saturation), but these effects are spatially variable. Primary production is driven in large part by nutrients from upstream sources, with tributaries generally providing waters that are lower in nutrients and organic matter. The impact of upstream reaches diminishes with distance downstream of Iron Gate dam, but even with 190 miles of free flowing river and multiple tributaries, the large loads of nutrients and organic matter out of Upper Klamath Lake and the upper basin play a role in the water quality of the Klamath River downstream to the Pacific Ocean.

Klamath River Estuary

The Klamath River estuary forms approximately the lower 5 or 6 miles of the river that are tidally influenced between the free flowing river and the Pacific Ocean. This area has not been intensively studied in the past, but more recent efforts are beginning to shed light on this feature of the Klamath River.

Water quality of the estuary is potentially an important component of the overall water quality picture, because anadromous fishes utilize the region as a migratory pathway, and the estuary plays a role in juvenile salmonid rearing (Moyle 2002, Biggs and Cronin 1981). As an area of ongoing study, water quality aspects are only briefly presented herein.

Water Temperature

River inflows to the estuary may cool slightly as they approach the Pacific Ocean during summer in response to marine influences (e.g., fog); however, such influences may or may not be persistent through time and may vary spatially up river. There are few upstream operations that affect temperature at this location, with the possible exception of Trinity reservoir operations. However, the lowermost estuary can stratify during summer months, with cooler, brackish or saline water near the bottom and warmer freshwater on top (Biggs and Cronin 1981). Stratification appears to be intermittent based on river flows, influences of the Pacific Ocean, and perhaps other factors. During winter, when flows are high, the estuary is dominated by river conditions and stratification is absent.

Nutrients and Algal Production

The nutrient inputs and outputs, as well as storage in the estuary are not completely characterized at this time. Nutrient levels generally are at their lowest concentrations at the downstream most portion of the Iron Gate dam to Turwar reach. Although ammonia levels are typically low, nitrate and orthophosphate levels are at sufficient levels for primary production to occur. Seasonal variation in nutrient levels occurs, although not as marked as in upstream reaches. The estuary provides an opportunity for phytoplankton growth, probably supporting a diverse assemblage of species adapted to fresh, brackish and/or marine conditions. Levels of production are not well understood spatially or temporally. Inflowing river waters are weakly buffered but brackish waters may not be.

Dissolved Oxygen

Dissolved oxygen conditions in the estuary are generally at or near saturation. Because velocities are greatly reduced in the broad, relatively shallow estuary, particulate matter borne out of the Klamath River tends to settle. There are instances where near bottom waters or deeper waters under stratified conditions indicate DO conditions well under saturation. The impact of organic matter loading on the estuary has not been thoroughly studied to date.

Primary production in the estuary also occurs, but the dynamics are not completely understood at this time.

Summary and Relationship to System Water Quality

The Klamath River estuary is an important reach in the Klamath River system, providing a vital transition between the freshwater environment of the Klamath River and the marine environment of the Pacific Ocean. It is a dynamic system that is highly dependent on hydrologic (freshwater and marine), water quality (freshwater and marine), and meteorological conditions. Stratification may play a critical role in water quality conditions in the estuary, with cool brackish waters underlying warm freshwaters. During summer and fall months when river flows are at their annual minimums, water quality of inflowing river waters can impact the estuary as evidenced by occasional subsaturated DO conditions in bottom waters. This sub-saturation condition suggests that eutrophic conditions from far upriver can affect estuarine water quality.

Coho Salmon Habitat

The legal status and a general description of coho salmon distribution, life history, and habitat requirement were presented in Chapter III. This section builds upon that information by further describing the 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 coho salmon.

Status of Coho Salmon in the SONCC ESU

Reliable data on naturally-produced adult spawners are sparse for SONCC coho salmon (Good et al. 2005). For a summary of historical and current distributions of SONCC coho salmon in northern California, refer to CDFG's (2002) coho salmon status review, historical population structure by Williams et al. (2006), as well as the presence and absence update for the northern California portion of the SONCC coho salmon ESU (Good et al. 2005).

All SONCC coho salmon stocks between Punta Gorda and Cape Blanco are depressed relative to past abundance (Weitkamp et al. 1995, Good et al. 2005). In the latest status review by NMFS, Good et al. (2005) concluded that SONCC coho salmon were likely to become endangered in the foreseeable future, this conclusion being consistent with an earlier assessment by Weitkamp et al. (1995).

The main stocks in the SONCC coho salmon ESU (Rogue River, Klamath River, and Trinity River) remain heavily influenced by hatcheries and have little natural production in mainstem rivers (Weitkamp et al. 1995, Good et al. 2005). The listing of SONCC coho salmon includes all within-ESU hatchery programs (June 28, 2005, 70 FR 37160). Trinity River Hatchery maintains high production, with a significant number of hatchery SONCC coho salmon straying[14] into the wild population (NMFS 2001). Straying of Iron Gate Hatchery coho salmon into important tributary streams is also a frequent occurrence, with hatchery fish occurring regularly on spawning grounds in the Shasta River, Scott River, and in mainstem tributaries below Iron Gate Dam (Ackerman and Cramer 2006).

Weitkamp et al. (1995) estimated that the rivers and tributaries in the California portion of the SONCC coho salmon ESU had "recently" produced 7,080 naturally spawning coho salmon and 17,156 hatchery returns, including 4,480 "native" fish occurring in tributaries having little history of supplementation with nonnative fish. Combining the California run-size estimates with Rogue River estimates, Weitkamp et al. (1995) arrived at a rough minimum run-size estimate for the SONCC coho salmon ESU of about 10,000 natural fish and 20,000 hatchery fish.

Overall Viability of the SONCC Coho Salmon ESU

The viability of an ESU depends on several factors, including the number and status of populations, spatial distribution of populations, the characteristics of large-scale catastrophic risk, and the collective diversity of the populations and their habitat (Lindley et al. 2007). In order to determine the current likelihood of viability of the SONCC coho salmon ESU, NMFS (2010) used the historical population structure of SONCC coho salmon presented in Williams et al. (2006) and the concept of viable salmonid populations (VSP) for evaluating populations described by McElhany et al. (2000). The parameters are population size, population productivity, spatial structure, and population diversity. These specific parameters are important to consider because they are predictors of extinction risk, and the

[14] For a wild fish, home is the natal stream where it incubated, hatched, and emerged. "Straying" of wild fish occurs when adult salmon move into non-natal streams, rather than returning to their natal stream. Straying of wild fish may occur for a variety of reasons. Upriver migration is characterized by a certain amount of exploratory movement into non-natal streams. For hatchery fish, the definition of "straying" considers the hatchery as home, so "straying" occurs when returning hatchery-produced adults return and spawn in the river away from the hatchery. Straying by even a small percentage of hatchery-produced adults has the potential to disrupt the genetic composition of nearby wild populations.

parameters reflect general biological and ecological processes that are critical to the growth and survival of salmon (McElhany et al. 2000). The following description of baseline SONCC ESU viability is taken from the NMFS 2010 Biological Opinion on Reclamation's Operation of the Klamath Project 2010-2018.

Population Size

In general, smaller populations face a host of risks intrinsic to their low abundance levels. The most recent status review concluded SONCC coho salmon populations ". . . continue to be depressed relative to historical numbers, and [there are] strong indications that breeding groups have been lost from a significant percentage of streams within their historical range (Good et al. 2005)." Experts consulted during the status review gave the ESU a mean risk score of 3.5 (out of 5, with 5 being the highest risk) for the abundance category (Good et al. 2005), indicating its reduced abundance contributes significantly to long-term risk of extinction, and is likely to contribute to short-term risk of extinction in the foreseeable future. NMFS (2010) concluded that this ESU falls far short of McElhany's 'default' goal of historical population numbers and distribution, and is therefore not currently viable in regards to the population size VSP parameter.

Population Productivity

The productivity of a population (i.e., production over the entire life cycle) can reflect conditions (e.g., environmental conditions) that influence the dynamics of a population and determine abundance. In general, declining productivity equates to declining population abundance. The most recent status review for the SONCC coho salmon ESU concluded data were insufficient to set specific numeric population productivity targets for viability (Spence et al. 2008, Williams et al. 2008). However, SONCC coho salmon have declined substantially from historical levels. Experts consulted for that status review gave the ESU a risk score of 3.8 for the growth rate/productivity VSP category (Good et al. 2005), indicating its current impaired productivity level contributes significantly to long-term risk of extinction and may contribute to short-term risk of extinction in the foreseeable future. NMFS (2010) concluded that the ESU is not currently viable in regards to the population productivity VSP parameter.

Spatial Structure

In general, there is less information available on how spatial processes relate to salmonid viability than there is for the other VSP parameters (McElhany et al. 2000). Understanding the spatial structure of a population is important because the population structure can affect evolutionary processes and, therefore, alter the ability of a population to adapt to spatial or temporal changes in the species' environment (McElhany et al. 2000). The most recent status review for the SONCC coho salmon ESU concluded data were insufficient to set specific population spatial structure targets (Spence et al. 2008, Williams et al. 2008). Recent information for SONCC coho salmon indicates that their distribution within the ESU has been reduced and fragmented, as evidenced by an increasing number of previously occupied streams from which they are now absent (NMFS 2001). However, populations can still be found in all major river basins within the ESU.

Experts consulted for the status review gave the ESU a mean risk score of 3.1 for the spatial structure and connectivity VSP category (Good et al. 2005), indicating its current spatial structure contributes significantly to long-term risk of extinction, but does not in itself constitute a danger of extinction in the near future. NMFS (2010) concluded that this ESU is not currently viable in regards to the spatial structure VSP parameter.

Population Diversity

Diversity, both genetic and behavioral, is critical to success in a changing environment. Salmonids express variation in a suite of traits, such as anadromy, morphology, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, and physiology and molecular genetic characteristics. The more diverse these traits (or the more these traits are not restricted), the more diverse a population is, and the more likely that individuals, and therefore the species, would survive and reproduce in the face of environmental variation (McElhany et al. 2000).

The primary factors affecting the diversity of SONCC coho salmon are the influence of hatcheries and out-of-basin introductions (NMFS 2007a). In addition, some brood years have abnormally low abundance levels or may even be absent in some areas (e.g., Shasta River and Scott River), further restricting the diversity present in the ESU. Experts consulted during the most recent status review gave the ESU a mean risk score of 2.8 for the diversity VSP category (Good et al. 2005). This score indicates that the ESU’s current genetic variability and variation in life history factors contribute significantly to long-term risk of extinction but do not, in themselves, constitute a danger of extinction in the near future. NMFS (2010) concluded that the current phenotypic diversity in this ESU is much reduced compared to historical levels, such that the ESU is not currently viable in regards to the diversity VSP parameter.

ESU Viability

Based on the population viability parameters and qualitative viability criteria presented in Williams et al. (2008), NMFS concluded that the SONCC coho salmon ESU is currently not viable and is at moderate risk of extinction (NMFS 2010). The precipitous decline in abundance from historical levels and the poor status of population viability metrics in general are the main factors behind this conclusion. The cause of this decline is likely from the widespread degradation of habitat, particularly those habitat attributes that support the freshwater rearing life-stages of the species.

Populations of Coho Salmon in the Project Area

Williams et al. (2006) identified 45 historical populations within the SONCC coho salmon ESU, and further categorized the historical populations based on their distribution and demographic role (i.e., independent, dependent, or ephemeral). Within the Klamath River diversity stratum, five populations of coho salmon were identified: Upper Klamath River, Middle Klamath River, Shasta River, Scott River, and Salmon River populations. Williams et al. (2006) characterized the Upper Klamath River, Shasta River and Scott River populations as “Functionally Independent,” defined as those populations sufficiently large to be historically viable-in-isolation and whose demographics and extinction risk were minimally influenced by immigrants from adjacent populations. The Middle Klamath River and Salmon River populations were classified as “Potentially Independent,” defined as those populations that were potentially viable-in-isolation, but that were demographically influenced by immigrants from adjacent populations (Williams et al. 2006). Due to the relatively long distance between Iron Gate dam and the Salmon River and the effects of tributary accretions, the Salmon River population and other downstream populations in the Klamath Basin are expected to experience little or no effects from PacifiCorp's actions (NMFS 2007a). Although flow volumes may impact these downstream populations, the covered activities under this HCP will not change the minimum flow requirement imposed on Reclamation. Therefore, the Salmon River population would not be affected by interim operations and is excluded from the population descriptions below.

Upper Klamath River Population Unit

The Upper Klamath River (from Portuguese Creek upstream of Iron Gate dam to Spencer Creek) is the river reach most likely to be influenced by interim operations.

Population Size and Productivity. Based on juvenile surveys in the Upper Klamath between 2002 and 2005 there is low production in Upper Klamath tributaries with fewer than 200 juveniles found in most tributaries and most years (Karuk Tribe and HCRD, unpublished data). The greatest number of juveniles was just over 1,000, which were found in Horse Creek in 2005. Spawning surveys also give an indication of the population size and productivity.

Spawning has been documented in low numbers within the mainstem Klamath River. From 2001 to 2005, Magneson and Gough (2006) documented a total of 38 coho salmon redds between Iron Gate dam (RM 190) and the Indian Creek confluence (RM 109), although over two-thirds of the redds were found within 12 river miles of the dam. Many of these fish likely originated from Iron Gate Hatchery. In 2003, the total spawner abundance for surveyed streams in the Upper Klamath population was 10 adults. In 2004 it was 108 adults with the majority of fish found spawning in Seiad and Grider creeks (Karuk Tribe and HCRD, unpublished data).

Using a variety of methods, including data from a video weir on Bogus Creek and maps and an Intrinsic Potential (IP) database, Ackerman et al. (2006) developed run size approximations for tributaries in this stretch of river. They assumed that spawning in the mainstem was limited to fewer than 100 fish. From 2001 to 2004, the estimated number of adult spawners returning to the Upper Klamath River Population Unit (100 to 4,000) was below the Low Risk Abundance Level[15] proposed by Williams et al. (2008) of 5,900 spawners. The lower range of this estimate is below the depensation threshold[16] for the population (425 spawners). Based on the above information, NMFS (2010) concluded that the Upper Klamath River Population Unit is at high risk of extinction given its low population size and negative population growth rate.

Spatial Structure and Diversity. Coho salmon are currently spatially restricted to habitat below Iron Gate dam. Coho salmon within the Upper Klamath River population spawn and

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[15] Low risk annual abundance level represents the minimum number of spawners required for a population to be considered at low risk for spatial structure and diversity threshold.

[16] "Depensation threshold" definition: "Depensation" is a phenomenon that can occur when salmon population growth rates decrease at low levels of abundance. For example, it can be more difficult for individuals to find mates at low levels of abundance. The gene pool tends to be smaller at low levels of abundance, which can result in a loss of average fitness. Depensatory effects heighten extinction risk.

rear primarily within several of the larger tributaries between Portuguese Creek and Iron Gate dam, namely Bogus, Horse, Beaver, and Seiad creeks. A small proportion of the population spawns within the mainstem channel, primarily within the section of the river several miles below Iron Gate dam. A population of coho salmon parr and smolts rear within the mainstem Klamath River by using thermal refugia near tributary confluences to survive the high water temperatures and poor water quality common to the Klamath River during summer months. Surveys by CDFG between 1979 and 1999 and 2000 to 2004 showed coho salmon were moderately well distributed downstream of Iron Gate dam in the upper Klamath population area. Juveniles were found in 21 of the surveyed 48 tributary streams (Jong et al. 2008). Based on the above information, NMFS (2010) concluded that the Upper Klamath River coho salmon population is at a high risk of extinction because its spatial structure and diversity are substantially limited compared to historical conditions.

Middle Klamath River Population Unit

The Middle Klamath River Population Unit covers the area from the Trinity River confluence upstream to Portuguese Creek (inclusive).

Population Size and Productivity. Few data on adult coho salmon are available for this stretch of river. Adult spawning surveys and snorkel surveys have been conducted by the U. S. Forest Service and Karuk Tribe. A few tributaries in the mid-Klamath (e.g., Boise, Red Cap, Clear, and Indian creeks) are thought to support significant populations of coho salmon, however total spawner abundance and population productivity is unknown. Spawning surveys by the Karuk tribe in 2003, 2004, 2007, and 2008 in some spawning tributaries found only a handful of redds and adult coho salmon each year. One estimate of the total population size is from 2001 to 2004; Ackerman et al. *(*2006) estimated a run size between 0 and 1,500. Juvenile counts indicate that productivity is relatively low with fewer than 12,000 juvenile coho salmon found between 2002 and 2009 during surveys of mid-Klamath tributaries (Six Rivers and Klamath National Forest and Karuk Tribe, unpublished data). Many of these juveniles are likely from other populations and the actual number of juveniles produced by the mid-Klamath population could be much lower.

Based on current estimates of the population, it is likely that the population is above depensation, but it is well below the low risk spawner threshold of 4,000 fish proposed by Williams et al. (2008). Therefore, NMFS (2010) concluded that the Middle Klamath River population is at moderate risk of extinction given the low population size and negative population growth rate.

Spatial Structure and Diversity. Adults and juveniles appear to be well distributed throughout the mid-Klamath area; however, use of some spawning and rearing areas is restricted by water quality, flow, and sediment issues in the mainstem and tributaries. Juvenile surveys have been conducted over the past several decades by various parties including the Karuk Tribe, the Mid Klamath Watershed Council, and the Forest Service. These surveys have found coho salmon juveniles in Hopkins, Aikens, Bluff, Slate, Red Cap, Boise, Camp, Pearch, Whitmore, Irving, Stanshaw, Sandy Bar, Rock, Dillon, Swillup, Coon, Kings, Independence, Titus, Clear, Elk, Little Grider, Cade, Tom Martin, China, Thompson, Fort Goff, and Portuguese creeks (U.S. Forest Service unpublished data; Soto et al. 2008; MKWC, unpublished data). Most of the juvenile observations are of juveniles using the lower parts of the tributaries and it is likely that many of these fish are non-natal rearing[17] in these refugial areas. Coho salmon spawning surveys have been limited in the mid-Klamath and therefore information on adult distribution is scarce. Known adult spawning coho salmon have been documented in Bluff, Red Cap, Camp, Boise, South Fork Clear, Indian, and Grider creeks (Soto et al. 2008). Spawning surveys by the Karuk Tribe found adults spawning in Aikens, China, Elk, and the South Fork of Clear Creek. Based on the above information, NMFS (2010) concluded that the Upper Klamath River coho salmon population is at a high risk of extinction because its spatial structure and diversity are substantially limited compared to historical conditions. Its spatial distribution appears to be good but too little is known to infer its extinction risk based on spatial structure.

Shasta River Population Unit

Population Size and Productivity. Adult spawning surveys and fish counting weir information started in 1934, though not including entire coho salmon runs. Currently, coho salmon entering the Shasta River are counted at the Shasta River Fish Counting Facility (SRFCF) operated by CDFG. Adult coho salmon returns were 30 and 9 in 2008 and 2009, respectively. Ackerman et al. (2006) used the coho salmon counts from this video weir combined with return timing information and the number of hatchery coho salmon carcasses recovered at the weir to develop approximations of run sizes for the Shasta River. The estimated number of adult coho salmon returning to the Shasta River ranges from 100 to 400 annually. At these low levels, depensation (e.g., failure to find mates), inbreeding, and genetic drift, which accelerate the extinction process, become a concern. These brood year population estimates are low, and have not trended upward over time. The estimates fall well below the low risk spawner threshold and below the high risk threshold[18] proposed by Williams et al. (2008). Therefore, NMFS (2010) concluded that the Shasta River Population Unit is at high risk of extinction given the unstable and low population size and presumed negative population growth rate.

Spatial Structure and Diversity. The current distribution of spawners is limited to the mainstem Shasta River from river mile 17 to river mile 23, lower Parks Creek, lower Yreka Creek, the upper Little Shasta River, and the Shasta River Canyon. Juvenile rearing is also currently confined to these same areas. Because of this limited distribution, NMFS (2010) concluded that the Shasta River coho salmon population is at high risk of extinction because its spatial structure and diversity are very limited compared to historical conditions.

Scott River Population Unit

Population Size and Productivity. The Scott River coho salmon population size is not precisely known, although Ackerman et al. (2006) estimated total run size for the Scott River basin. Estimated run sizes were 1,000 to 4,000 in 2001, 10 to 50 in 2002 and 2003, and 2,000 to 3,000 in 2004. Variable rates of effort and differences in survey conditions between years may have influenced these estimates of run size. Uncertainty regarding mainstem spawning

[17] For wild rearing juveniles, home is the natal stream habitat where it incubated, hatched, and emerged. Non-natal rearing occurs when wild juvenile fish move into and occupy non-natal stream habitats for rearing and feeding.

[18] High risk threshold corresponds to a population threshold below which there exists a high risk of depensation (i.e., decreasing productivity with decreasing density). Depensatory processes at low population abundance result in high extinction risks for very small populations because any decline in abundance further reduces the population’s average productivity, resulting in a steep slide toward extinction (McElhany et al. 2000).

of coho salmon in the Scott River was also a source of concern (Ackerman et al. 2006). In 2009, 81 adult coho salmon returned to the river. The adult return estimates for the Scott River were less than the low risk spawner threshold in each of the years examined, and below high risk threshold in two of the four years. Therefore, NMFS (2010) concluded that the Scott River Population Unit is at high risk of extinction, given the extremely low population size and presumed negative population growth rate.

Spatial Structure and Diversity. Routine fish surveys of the Scott River and its tributaries have been occurring since 2001. These surveys have documented coho salmon presence in 11 tributaries, with the six most productive of these tributaries consistently sustaining rearing salmon juveniles in limited areas. The five other tributaries do not consistently sustain juvenile coho salmon, indicating that the diversity of this population is restricted by available rearing habitat. Because the current spatial structure and distribution of spawners is limited, and suitable rearing habitat is scattered and covers only a small portion of historical range, NMFS (2010) concluded that the Scott River coho salmon population is at high risk of extinction.

Habitat Conditions in the Upper Klamath River

The Upper Klamath River reach begins at mouth of Portuguese Creek (RM 128) and extends upstream to Iron Gate dam as described in Hamilton et al. (2008) and FERC (2007). Historically, coho salmon are thought to have inhabited all accessible stream reaches within the Upper Klamath Population Unit up to, and including, Spencer Creek (Hamilton et al. 2005, Williams et al. 2008). Based on the historical IP model it appears that coho salmon likely occupied much of the area upstream of the dam and occupied numerous large tributaries (e.g., Spencer Creek, Jenny Creek, Fall Creek, Shovel Creek). These tributaries historically provided cold-water spawning and rearing habitat for coho salmon. The current upstream limit for Klamath River salmon is Iron Gate dam at river mile 190.

Water quality and hydrologic conditions within the current range of coho salmon in the Upper Klamath have reduced the functionality of essential habitat types in this area and have diminished the ability of habitat to establish essential features. Releases from Iron Gate dam typically have a proportionally larger effect on the flow regime in this reach than in downstream reaches because tributary accretions boost discharge further downstream.

Juvenile Summer and Winter Rearing Areas. For the Upper Klamath River Population Unit, juvenile summer rearing areas have been compromised by low flow conditions, high water temperatures, insufficient DO levels, excessive nutrient loads, habitat loss, disease effects, pH fluctuations, non-recruitment of LWD, and loss of geomorphological processes that create habitat complexity (NMFS 2010). Water released from Iron Gate dam during summer months is already at a temperature stressful to juvenile coho salmon, and solar warming can increase temperatures even higher as flows travel downstream (NRC 2004). Nighttime DO levels directly below Iron Gate dam are likely below 7.0 mg/L and highly stressful to coho salmon adults and juveniles during much of the late summer and early fall. Between Iron Gate dam and Seiad Valley, daily maximum pH values in excess of 9.0 have been documented, as high primary production within the weakly buffered Klamath River basin causes wide diurnal pH fluctuations (NMFS 2010). Riparian recruitment within the first several miles below Iron Gate dam is likely impaired by the typically fast recession of the spring hydrograph, since the roots of newly established vegetation are unlikely to keep up with the rapidly lowering water table (FERC 2006). NMFS (2010) indicates that dams also impair gravel and fine sediment recruitment downstream of PacifiCorp's Project reservoirs, which result in poorly functioning floodplains that fail to support healthy riparian recruitment. NMFS (2010) concludes that this may limit the amount of cover available to rearing coho salmon, and that winter rearing areas suffer from non-recruitment of LWD and stream habitat simplification.

Juvenile Migration Corridor. NMFS (2010) concludes that, in the Upper Klamath River reach, the juvenile migration corridor suffers from low flow conditions, disease effects, high water temperatures and low water velocities that slow and hinder emigration or upstream and downstream redistribution. The unnatural and steep decline of the hydrograph in the spring may slow the immigration of coho salmon smolts, speed the proliferation of fish diseases, and increase water temperatures more quickly than would occur otherwise. NMFS (2010) indicates that disease effects, particularly in areas such as the Trees of Heaven site, likely have a substantial impact on the survival of juvenile coho salmon in this stretch of river.

Adult Migration Corridor. The current physical and hydrologic condition of the adult migration corridor in the Upper Klamath River reach likely functions in a manner that supports its intended conservation role. Water quality is likely suitable for upstream adult migration, and flow volume is above the threshold at which physical barriers may form (NMFS 2010).

Spawning Areas. Coho salmon are typically tributary spawners. However, low numbers of adult coho salmon do spawn in the Upper Klamath River reach annually. Upstream dams reduce the transport of sediment into this reach of river. NMFS (2010) indicates that the lack of clean and loose gravel diminishes the amount and quality of salmonid spawning habitat downstream of dams, especially below Iron Gate dam. Water temperatures and water velocities are generally sufficient in this reach for successful adult coho salmon spawning.

Habitat Conditions in the Middle Klamath River

The Middle Klamath River section begins above the Trinity River confluence and extends upstream 85 miles to the mouth of Portuguese Creek. It is substantially different from the Klamath River upstream and downstream and adjacent sub-basins (Salmon and Scott rivers), particularly in precipitation and flow patterns (Williams et al. 2006). NMFS (2010) concludes that the effects of Iron Gate dam on channel processes (e.g., recruitment of sediment and LWD) and water quality in the Klamath River diminish in the downstream direction as flow combines with tributary inputs. NMFS (2010) indicates that, while the effects of Iron Gate dam are minimal in this reach, they may combine with other factors to influence the coho salmon population. The following description of current habitat conditions is taken from the description of critical habitat in the Biological Opinion on Reclamation's Operation of the Klamath Project 2010-2018 (NMFS 2010).

Juvenile Summer and Winter Rearing Areas. Juvenile summer rearing areas in the Middle Klamath River are likely degraded relative to historical conditions (NMFS 2010). A few key tributaries within the Middle Klamath River Population Unit (e.g., Boise, Red Cap and Indian creeks) support populations of coho salmon and offer critical cool water refugia within their lower reaches when mainstem temperatures and water quality approach uninhabitable levels. High tributary sediment loads have caused chronically high sediment concentrations within most tributaries (NFMS 2010). Daytime water temperatures are at levels stressful to juvenile coho salmon, above 22ºC for much of July and August, 2004 at Weitchpec (NMFS 2010). Values for pH at Weitchpec tend to rise throughout the monitoring season toward peak values in late August. Daily maximum values were greater than 8.5 for most of the summer, but attenuated in early October. High pH, in combination with high water temperatures, can precipitate high ammonia levels during summer months. Highly fluctuating DO concentrations, such as those measured during summer 2004 at the Weitchpec site, are common throughout the mainstem, resulting from high primary productivity fueled by naturally elevated water temperatures and the large loads of nutrients from upstream sources, notably Upper Klamath Lake. DO levels at Weitchpec during 2004 peaked above 10 mg/L for several days in mid-October, but were generally above 7 mg/L for most of the summer (NMFS 2010). The exception was several days in both late August and early September, when DO levels as low as 5.5 mg/L were measured. NMFS (2010) concludes that disease effects, likely have a substantial impact on the survival of juvenile coho salmon in this stretch of river. NMFS (2010) further concludes that, because the Klamath River is highly productive, food resources may not be limiting.

Juvenile Migration Corridor. Disease effects in this stretch of river can limit the survival of juvenile coho salmon as they emigrate downstream (NMFS 2010). Low flows can slow the emigration of juvenile coho salmon, which can in turn lead to longer exposure times for disease, and greater risks due to predation.

Adult Migration Corridor. Most migrating adult coho salmon are likely unaffected by elevated summer water temperatures characteristic of the Middle Klamath River section (NMFS 2010). By late September when adult coho salmon migration begins, water temperatures are usually close to 19ºC throughout the Middle Klamath River section. Based upon comparative analysis with historical Klamath flow records, CDFG (2004b) could not conclusively demonstrate that water depth impeded upstream migration during the 2002 fish die-off[19], although anecdotal evidence (i.e., field observations, gage height data, etc.) suggest some fish migration may have been impeded.

Spawning Areas. There is some evidence that limited spawning of coho salmon occurs in the Middle Klamath River reach (Magneson and Gough 2006). However, NMFS (2010) indicates that the quality and amount of spawning habitat in the Middle Klamath River reach is limited due the geomorphology and the prevalence of bedrock in this stretch of river. Coho salmon are typically tributary and headwater stream spawners, so it is unclear if there was historically very much mainstem spawning in this reach.

[19] In September 2002, at least 33,000 adult salmonids, consisting primarily of fall-run Chinook salmon (but also including some coho salmon and steelhead) were estimated to have died-off in the lower 36 miles of the Klamath River (CDFG 2004b). The primary cause of this fish kill was a rapid disease outbreak in the fish, which was amplified by several factors, including crowding of fish in the river due to the combination of above-average fish return numbers and atypically low flows.

V. Project Effects on Coho Salmon

Covered Activities include continued maintenance and operation of Project facilities over the term of the ITP, as well specific conservation actions to be implemented under the conservation strategy of the HCP. NMFS in its 2007 BiOp (NMFS 2007a) identified the following effects related to PacifiCorp's Klamath Hydroelectric Project:

- Project facilities (dams and reservoirs) prevent access to historical coho salmon habitat upstream of Iron Gate dam
- Project facilities contribute to seasonal water quality impairment of coho salmon habitat in the river downstream of Iron Gate dam
- Project facilities contribute to water quality and flow-related effects on the incidence of disease in coho salmon in the river downstream of Iron Gate dam
- Project facilities contribute to reduced transport of sediment and LWD to coho salmon habitat in the river downstream of Iron Gate dam

The following section describes each of the Project-related factors that could result in potential incidental take of listed coho salmon. Table 3 summarizes the Covered Activities that may result in impacts to listed coho salmon, the extent and type of impact, and how the impact can be avoided, minimized, or addressed through conservation actions.

TABLE 3
Summary of Covered Activities That Could Potentially Result in Incidental Take[a] of Listed Coho Salmon, the Type of Take, Impacts of the Taking, and Whether Take Can Be Avoided, Minimized, or Addressed through Conservation Actions

Mechanism for Potential Take	Type of Take	Effect on Coho Salmon	Life Stage(s) Affected	Populations Impacted	Extent and Impact of Potential Take	Potential Take Avoidance	Impact Minimization	Conservation Actions	Methods for Monitoring Effectiveness
Blockage of Fish Passage	Indirect Harm	Project dams will block coho salmon access to approximately 58 miles of upstream river and tributary habitat. While blockage of habitat upstream of the dam does not result in direct take of individual coho salmon, it does influence the distribution of the Upper Klamath population and the spatial structure of the ESU.	All	Upper Klamath	Historically, coho salmon accessed approximately 58 miles of mainstem and tributary habitat above Iron Gate dam, the current limit of upstream passage at RM 190 (NMFS 2010). Under interim operations, this condition would persist at its current extent for another 10 years. The continued blockage of upstream habitat may influence the distribution of the Upper Klamath population and the distribution of the upper Klamath population.	For context, in the longer term, outside the term of this HCP, volitional fish passage will be achieved through dam removal as specified in the KHSA or operation under a new FERC license with fish passage requirements. Since access to historic habitat will occur through either the KHSA or a new FERC license avoidance measures as part of interim operations are not practicable.	For context, in the longer term, outside the term of this HCP, volitional fish passage will be achieved through dam removal as specified in the KHSA or operation under a new FERC license with fish passage requirements. Therefore, minimization measures under interim operations are not practicable.	For context, in the longer term, outside the term of this HCP, volitional passage will be achieved through dam removal as specified in the KHSA or operation under a new FERC license with fish passage requirements. Iron Gate Hatchery was originally constructed as mitigation for blocked habitat between Iron Gate and Copco 1 dams. The hatchery will continue operations through the term of this HCP. The implementation of an HGMP pursuant to an approved Section 10(a)(1)(A) permit will provide additional improvements in hatchery operations to aid the viability of the Upper Klamath population. In addition, habitat restoration and improvements in the Klamath River downstream of Iron Gate dam and its tributaries (under the Coho Enhancement Fund), would enhance spatial structure of the ESU by increasing habitat availability downstream of Iron Gate dam.	The effectiveness of habitat and passage improvements downstream of Iron Gate dam can be monitored by measuring the implementation of these improvements and their effectiveness in enhancing habitat on a project-by-project basis and improving the distribution of the upper Klamath population. The HGMP has an independent monitoring strategy.

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Water Quality Effects Related to Nutrients and Algae Production	Indirect Harm	Water quality throughout the Klamath River is affected by large loads of nutrients and organic matter from upstream sources, notably from Upper Klamath Lake. Although the Project facilities are not a source (but rather a net sink) of the large nutrient loads, the reservoirs do create impoundments of water that can contribute to the occurrence of algal blooms (fed by the large nutrient loads from upstream) and related water quality effects. Nutrient inputs alone generally do not directly affect fish populations. However, the primary productivity driven by nutrient levels can affect other water quality stressors on coho salmon. These stressors can include high pH (that can increase susceptibility to ammonia toxicity), and fluctuating DO concentrations (from algal production and respiration).	All	Primarily Upper and Middle Klamath, but potentially Scott and Shasta	Project-related effects from the large nutrient loads from upstream sources are due to the presence (or existence) of the reservoirs. Under interim operations, this condition would persist at its current extent for another 10 years. Coho salmon upstream migration and spawning downstream of Iron Gate dam typically occurs during periods when water quality conditions are suitable. Juvenile coho salmon can be present when conditions are less suitable and can result in detrimental effects on the growth and survival of individuals. However, some individuals may avoid adverse water quality conditions by rearing within lower tributary reaches and refugia within the mainstem Klamath River where water quality conditions are suitable.	Avoidance of this impact may not be practicable under interim operations. Existing project-related water quality effects are the result of the presence of the facilities and upstream loads of nutrients and organic matter are from sources outside of PacifiCorp's control. In the longer term, outside the term of this HCP, water quality impacts will be addressed through dam removal as specified in the KHSA or otherwise addressed under a new FERC license and issuance of a 401 certification.	For context, under the KHSA, PacifiCorp's contribution to minimization of impaired water quality related to nutrients and organic matter will be achieved through the implementation of water quality-related Interim Measure No. 11 under the KHSA that will address nutrient loading to the Klamath River and associated water quality effects in Project reservoirs. Alternatively, water quality issues related to project operations will be addressed in state 401 water quality certifications incorporated into a new FERC license. No additional measures have been identified because these ongoing processes are addressing water quality impacts.	Improvements to refugia immediately downstream of Iron Gate dam in affected reaches would enhance opportunities for avoidance and reduced effects on coho, and would further address the effects of nutrients and algal production.	The effectiveness of water quality downstream of Iron Gate dam related to nutrients and algal production can be monitored through ongoing monitoring under Interim Measure 15 under the KHSA or other ongoing basin monitoring programs. Effectiveness of refugia enhancements could be achieved through effectiveness monitoring of enhancement projects.

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Summary of Covered Activities That Could Potentially Result in Incidental Take[a] of Listed Coho Salmon, the Type of Take, Impacts of the Taking, and Whether Take Can Be Avoided, Minimized, or Addressed through Conservation Actions

Mechanism for Potential Take	Type of Take	Effect on Coho Salmon	Life Stage(s) Affected	Populations Impacted	Extent and Impact of Potential Take	Potential Take Avoidance	Impact Minimization	Conservation Actions	Methods for Monitoring Effectiveness
Dissolved Oxygen (DO)	Indirect Harm	Due to seasonal stratification of Iron Gate reservoir, the hypolimnion can exhibit low DO concentrations. When the Iron Gate intake structure withdraws water from mid-depth in the reservoir, this low DO water can be entrained into the releases to the Klamath River from Iron Gate powerhouse, resulting in low DO immediately downstream of Iron Gate dam until mechanical reaeration raises DO levels. Low DO concentrations may be stressful to coho salmon adults and juveniles.	Juveniles	Upper Klamath	Coho salmon upstream migration and spawning downstream of Iron Gate dam typically occurs during periods when DO conditions are suitable. Juvenile coho salmon can be present when conditions are less suitable, resulting in fewer opportunities to forage and potential reductions in growth and survival. However, the potential for take of rearing juvenile coho is likely low given: (1) the limited downstream extent of Iron Gate dam's influence on DO; and (2) the likely avoidance by fish of adverse DO conditions by moving to lower tributary reaches and refugia where DO conditions are suitable.	The conditions that produce low DO concentrations result from the combination of nutrient inputs from upstream sources, algal growth and reservoir stratification. Improving conditions in tributary streams may help avoid potential impacts because fish may avoid the mainstem As described above, avoidance of this impact may not be practicable under interim operations. Existing project-related water quality effects are the result of the presence of the facilities and upstream loads of nutrients and organic matter are from sources outside of PacifiCorp's control. In the longer term, outside the term of this HCP, water quality impacts will be addressed through dam removal as specified in the KHSA or otherwise addressed under a new FERC license and issuance of a 401 certification.	The potential effects of low DO can be minimized under interim operations through turbine venting. PacifiCorp has the ability to improve the DO content in the water that is routed through the turbine and released into the Klamath River downstream of Iron Gate dam through turbine venting. Introducing air into the penstock increases DO concentrations in the release water, thus minimizing the effects on fish.	Improvements to refugia immediately downstream of Iron Gate dam in affected reaches would enhance opportunities for avoidance and reduced effects on coho, and would further address the effects of reduced DO.	The effectiveness of turbine venting can be demonstrated through monitoring DO concentrations downstream of the release. The effectiveness of water quality improvements downstream of Iron Gate dam related to nutrients and algal production can be monitored through ongoing monitoring under Interim Measure 15 or other ongoing basin monitoring programs. Effectiveness of refugia enhancements could be achieved through effectiveness monitoring of enhancement projects.

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Water Temperature	Indirect Harm	The mass of water in the Project reservoirs will continue to cause a “thermal lag” compared to the same location in the Klamath River under a hypothetical “without-dam” or river-only scenario. The natural seasonal trends of warming river temperatures in the spring and cooling temperatures in the fall are expected to be “lagged” about 2 to 4 weeks with the existence of the reservoirs compared to a hypothetical “without-dam” or river-only scenario. This lag could affect the timing (or periodicity) of coho salmon life stages below Iron Gate dam, or affect coho salmon egg pre-spawn viability and juvenile growth (bioenergetics), foraging, and fitness.	All	Primarily Upper Klamath, and potentially Scott and Shasta	As summer ends and transitions into the fall period, the thermal lag resulting from the presence of Iron Gate reservoir causes a more gradual cooling of the river below Iron Gate dam (as compared to a hypothetical “without-dam” or river-only scenario). The “lagged” cooling of temperatures (by about 2 to 4 weeks) during upstream coho migration in the fall may delay the onset of spawning accordingly (as compared to a hypothetical “without-dam” scenario). However, spawning, incubation, and emergence later in the fall should not be affected as “lagged” temperatures converge with hypothetical “without-dam” temperatures, and are within suitable ranges for these coho life stages. NMFS believes that warmer temperatures extending into the fall may reduce the ability of coho juveniles to use habitat in the mainstem during those periods. This may reduce growth or survival of juvenile coho redistributing into habitats in the mainstem. During the spring period, the thermal lag resulting from the presence of Iron Gate reservoir causes a more gradual warming of the river below Iron Gate dam (as compared to a hypothetical “without-dam” or river-only scenario). The cooler “lagged” temperatures are likely not adversely affecting juvenile coho present in the river at this time, and may improve conditions and extend the period of suitable temperatures for juvenile coho salmon migrating and rearing during that period in the mainstem.	The thermal lag is a product of presence of the reservoirs in place. Improving conditions in tributary streams may help avoid potential impacts because fish may avoid the mainstem. As described above, avoidance of this impact may not be practicable under interim operations. Existing project-related temperature effects are the result of the presence of the facilities. In the longer term, outside the term of this HCP, temperature impacts will be addressed through dam removal as specified in the KHSA or otherwise addressed under a new FERC license and issuance of a 401 certification.	PacifiCorp has investigated options to minimize temperature impacts (e.g., selective withdrawal, curtain barriers). However, the construction of these measures is infeasible because (1) limited volume of cold water in Iron Gate reservoir; (2) detrimental impacts to the Iron Gate Hatchery; and (3) the short duration of the interim period.	Improvements to refugia in affected reaches would enhance opportunities for avoidance and reduced effects on coho, and would further address temperature impacts. Such actions could include enhancements to improve the extent, duration and access to refugial habitats.	Effectiveness of refugia enhancements could be achieved through effectiveness monitoring of enhancement projects.

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Disease	Indirect Harm	Modifications to the river's historical hydrologic regime, along with large loads of nutrients and organic matter in the river, may create instream conditions that favor disease proliferation and fish infection. These disease pathogens will impact coho salmon populations inhabiting the Klamath River below Iron Gate dam. NMFS (2007a) indicates that Project reservoirs may continue to contribute to the conditions favoring the population of *Manayunkia speciosa*, the intermediate host for the pathogens *Ceratomyxa shasta* and *Parvicapsula minibicornis* that occurs below Iron Gate Dam. Potential linkages to project reservoirs include reductions in coarse sediment, flow variability, blockage to upstream habitat, and reductions in water quality resulting in increased incidence and susceptibility of disease.	Juveniles	Primarily Upper Klamath but potentially Scott and Shasta	Incidences and severity of disease vary by location and environmental conditions within the mainstem Klamath River. Once infected with C. shasta, fish survival rates are generally low. Incidence of disease is highest within the reach between the Shasta and Scott Rivers with decreasing incidences downstream. Disease effects are most pronounced for juveniles that are rearing or migrating in the mainstem Klamath River when water quality conditions make them more susceptible to disease and when actinospore concentrations are high.	The key conditions that favor disease proliferation are reductions in coarse sediment, flow variability, simplified habitat, and reductions water quality. Avoidance of these factors would entail removal of project dams. Improving conditions in tributary streams may help avoid potential impacts because fish may avoid the mainstem. As described above, avoidance of this impact may not be practicable under interim operations. Existing project-related effects are the result of the presence of the facilities. In the longer term, outside the term of this HCP, impacts will be addressed through dam removal as specified in the KHSA or otherwise addressed under a new FERC license and issuance of a 401 certification.	Any disruption of the disease pathogen's life cycle would contribute to impact minimization. Potential minimization measures include increased flow variability, increased coarse sediment, water quality improvements, increases in habitat complexity, and reductions in nutrient load. It is unclear at this time what if any other minimization measures are available to address these impacts; however, additional research may clarify measures.	Any improvements to habitat in tributary reaches would enhance opportunities for avoidance and reduced effects on coho, and would further address disease impacts. Such actions could include enhancements to improve the extent, duration and access to habitats.	Ongoing fish disease research and monitoring assist in the identification and effectiveness of management measures or Project operational changes. In addition, effectiveness of measures to increase flow variability, increase coarse sediment, improve water quality, increase habitat complexity, reduce nutrient load, and improve habitat in tributary reaches are listed in other rows of the table and can be linked to disease monitoring. .

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Blockage of Downstream Transport of Sediment and Wood	Indirect Harm	Iron Gate and other upstream dams will continue to impede the downstream transport of sediment (i.e., gravel and fine sediment) and large woody debris (LWD). Coho salmon downstream of Iron Gate dam may be indirectly harmed by a reduction of spawning habitat resulting from long-term depletion of spawning gravel. Also, reduction of coho salmon rearing habitat may result from disruption of the habitat-forming channel, riparian, and floodplain processes that rely on supplies of sediment and LWD. The absence of coarse sediment reduces the scouring ability of flow events, resulting in more favorable habitat conditions for *M. speciosa* and potentially higher disease rates.	Juveniles, Adults	Primarily Upper Klamath and potentially Scott and Shasta	The effect of loss of sediment and LWD affect prevalence of disease, the complexity of juvenile rearing and adult holding habitats. The loss of coarse sediment also impacts the amount and extent of spawning habitat for mainstem spawners.	The blockage of sediment and LWD is a product of the system of dams and reservoirs in place. As described above, avoidance of this impact may not be practicable under interim operations. Existing project-related effects are the result of the presence of the facilities. In the longer term, outside the term of this HCP, impacts will be addressed through dam removal as specified in the KHSA or otherwise addressed under a new FERC license and issuance of a 401 certification.	Minimizing the impact of the take potentially resulting from blockage of sediment and LWD is not practicable given the systemic nature of this effect. The blockage of sediment and LWD is a product of the system of dams and reservoirs in place. As described above, avoidance of this impact may not be practicable under interim operations. Existing project-related effects are the result of the presence of the facilities. In the longer term, outside the term of this HCP, impacts will be addressed through dam removal as specified in the KHSA or otherwise addressed under a new FERC license and issuance of a 401 certification.	Conservation actions would entail gravel augmentation and placement of LWD below Iron Gate dam. Improvements to floodplain habitats could also contribute to conservation.	The effectiveness of actions to address effects of sediment and LWD blockage can be monitored through implementation of monitoring plans focused on the specific actions.
Flows and Rearing Habitat Conditions Downstream of Iron Gate Dam	Indirect Harm	Iron Gate dam provides relatively stable downstream flows over long time periods. Stable flows can remove or reduce hydrological cues that stimulate downstream migration by juvenile coho salmon, reduce flooding/flushing flows necessary to create and maintain floodplain habitat, and contribute to conditions favorable for disease. In addition, these factors may affect coho salmon by reducing access to habitat, impeding their ability to redistribute within the system, reducing overwinter survival, altering the timing of outmigration, , and reducing the quality of refugia areas at creek mouths.	All	Upper Klamath, Shasta, Scott	NMFS (2010) describes the extent and impact of potential take associated with flows and rearing habitat conditions below Iron Gate Dam. The accretion between Keno and Iron Gate provide flows that PacifiCorp possesses some incremental control, subject to the direction of Reclamation. Flow releases from Iron Gate dam are made in compliance with the NMFS BiOp (NMFS 2010) covering Reclamation's Klamath River operations. These flow releases are intended to minimize and mitigate Reclamation's impacts on coho salmon.	PacifiCorp operates its facilities at Iron Gate dam in compliance with the minimum flow requirements placed on Reclamation by NMFS (NMFS 2010). As described above, avoidance of this impact may not be practicable under interim operations. Existing project-related effects are the result of the presence of the facilities. In the longer term, outside the term of this HCP, impacts will be addressed through dam removal as specified in the KHSA or otherwise addressed under a new FERC license and issuance of a 401 certification.	Although PacifiCorp has little operational flexibility to influence flows downstream of Iron Gate dam, it may be able to minimize the potential for flow-related take by increasing (in cooperation with Reclamation) the seasonal variability of flows downstream of Iron Gate dam.	Given that PacifiCorp operations are in compliance with the flow requirements contained in the NMFS BiOp, any residual effects of reduced survival could be addressed by conservation actions that improve habitat conditions, reduce juvenile mortality, and increase access and connectivity to tributary habitat. Habitat actions that mimic flow variability effects include restoring mainstem habitats, improving floodplain and tributary connectivity, and reducing water diversions.	The effectiveness of actions to address effects of reduced juvenile survival can be monitored through implementation of monitoring plans focused on the specific actions as they are developed.

[a] The contents of this table respond to NMFS' suggestion that indirect effects of individual coho salmon could occur as a result of PacifiCorp's operation of its hydroelectric facilities during the interim period. PacifiCorp prepared this HCP to obtain incidental take authorization for its operations in the event that it is determined that the indirect effects result in incidental take. PacifiCorp believes there is no evidence documenting take of individual coho salmon as a result of PacifiCorp's operation of the Klamath Hydroelectric Project and PacifiCorp does not believe that such take actually occurs. Nonetheless, PacifiCorp has developed this Habitat Conservation Plan to address concerns raised by NMFS.

[b] For the purpose of this HCP, the term "avoid" refers to actions that prevent the potential take from occurring (e.g., removal of the Project dams in accordance with the KHSA).

[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 effects of low DO concentrations through turbine venting).

[d] For the purpose of this HCP, the term conservation 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., enhancing habitat conditions in refugial areas to offset water quality impacts).

Degradation and Loss of Habitat

Blockage of Fish Passage

Iron Gate dam blocks coho salmon access to upstream river and tributary reaches (up to, and including, Spencer Creek) that are believed to have been historically inhabited by coho salmon from the Upper Klamath coho population (NMFS 2007a). Approximately 58 miles of this habitat are believed to have been historically suitable for coho salmon including 21.6 miles of tributary habitat (NMFS 2007a, Hamilton et al. 2005) and blockage of fish passage to these habitats will continue during the Permit Term. This blocked habitat constitutes 40 percent of the historic habitat of the Upper Klamath coho population (Williams et al. 2006). This habitat consists of high quality, cold-water spawning and rearing habitat with high intrinsic potential for coho salmon spawning and rearing. At least 10 miles of perennial stream reaches that are blocked by Project facilities have gradients below 4 percent including Jenny Creek, Fall Creek, Shovel Creek, and Spencer Creek. NMFS (2007a) describes the characteristics of these habitats for coho salmon.

Blockage of upstream habitat will continue to reduce the availability of suitable habitat and could reduce the overall abundance, productivity, and diversity of the Upper Klamath River population of coho salmon over the next 10 years. In addition, it will reduce the spatial structure of the population, which could also reduce population viability.

Blockage of Downstream Transport of Sediment and Organic Matter

Over the Permit Term, Project dams may reduce wood, gravel and fine sediment transport downstream of Project reservoirs, resulting in impacts on spawning habitat, floodplain and channel structure, and streamside and floodplain function, including recruitment of riparian vegetation. The loss of potential floodplain and riparian habitat could result in the loss of important rearing habitat for coho salmon juveniles (NMFS 2007a). Project dams may also physically block the transport downstream of gravel and wood from upstream sources, which could limit salmonid spawning habitat and simplify instream habitat below Iron Gate dam (NMFS 2007a, 2010). The loss of habitat-forming woody debris may contribute to reduced potential for coho salmon rearing in affected reaches. These effects are largely confined to the area between Iron Gate dam and the Shasta River, since large influxes of gravel and wood from tributary sources minimize the effect from the Shasta River downstream (NMFS 2007a, 2010).

Flows and Habitat Conditions Downstream of Iron Gate Dam

Reclamation is responsible for management of flows in the upper Klamath River to ensure that flow requirements at Iron Gate dam are met. As such, PacifiCorp's Project operations do not determine or control the availability of flows released from Iron Gate dam. PacifiCorp's operations may to some extent influence flow variability, and therefore conditions below Iron Gate dam during the project term. Tributary accretions below Keno dam and upstream of Iron Gate dam will generally not contribute to flow variability above and beyond flow requirements in the 2010 NMFS Biological Opinion (NMFS 2010) except under certain conditions, such as those described above under "Flow Releases" when Iron Gate dam is in spill. The loss of flow variability may affect habitat quality and availability as well as migration and rearing of coho salmon.

NMFS (2010) indicated that stable flows may interfere with environmental cues that initiate the redistribution of juvenile coho salmon in the river and potentially other important ecological functions. NMFS (2010) further indicated that the failure of juvenile coho salmon to redistribute in the upper reach of the Klamath River may prevent them from leaving poor over-wintering habitat in the upper Klamath River and seeking out more favorable over-wintering habitat downstream, thus resulting in lower overwinter survival. Stable flows might also reduce the amount of short-term (i.e., transitory and refugial) rearing habitat that would become available during higher flow events. NMFS concluded that these factors likely influence the fitness and overwintering survival of juvenile coho salmon in the mainstem Klamath River, particularly in the reach from Iron Gate dam to the Scott River (NMFS 2010). Smolt outmigration timing and smolt size also appear to respond to small-scale habitat variability (Weitkamp et. al 1995) and could be affected by release flows. NMFS (2010) indicated that fall/early winter flows also may have a latent effect on disease risks from *P. minibicornis* and *C. shasta* on juvenile coho salmon in the upper reach of the Klamath River. NMFS (2010) also indicated the loss of flow variability in the spring may result in habitat reductions for juvenile coho salmon in portions of the Upper Klamath River reaches (R-Ranch to Trees of Heaven).

Water Quality

Water Quality Effects Related to Nutrients and Algal Production

Naturally productive (nutrient-enriched) conditions of the waters of the upper Klamath basin and the widespread land use changes and developments in the upper Klamath basin over the last 120 years have had a pronounced effect on water quality in the Klamath River (see the Chapter IV "Current Conditions"). The highly eutrophic outflow from Upper Klamath Lake upstream of Klamath Straits Drain confounds the ability to separate water quality effects of the Project from other factors. Water quality in Keno reservoir is strongly influenced by the amount of nutrients and organic matter (primarily in the form of blue-green algae) originating from Upper Klamath Lake and exceeding the assimilative capacity of the reservoir, resulting in a considerable oxygen-demanding load on the system during the summer (Deas et al. 2006, FERC 2007). High pH and unionized ammonia are also associated with the heavy transfer of blue-green algae from Upper Klamath Lake (Deas et al. 2006).

A recently completed Total Maximum Daily Load (TMDL) analysis by Oregon Department of Environmental Quality (ODEQ 2010) indicates that inflows from Upper Klamath Lake account for all of the loading of nutrient and organic matter to Link River. The TMDL indicates that inflows from Upper Klamath Lake via Link River account for most of the loading of nutrient and organic matter to Keno reservoir, with nearly all the remainder from municipal, industrial, and other non-Project sources. In Keno reservoir, less than one percent of the loading of nutrients occurs internally (from reservoir sediments) within the reservoir. These non-Project sources likewise account for nearly all of the nutrient and organic matter loading to the downstream Project reservoirs (J.C. Boyle, Copco, and Iron Gate) (ODEQ 2010, NCRWQCB 2010a). As in Keno reservoir, less than one percent of the loading of nutrients occurs internally within J.C. Boyle, Copco, and Iron Gate reservoirs. In fact, Copco and Iron Gate reservoirs actually act to reduce annual nutrient loading (on the order of 10 to 20 percent) through settling and retention of inflowing particulate-bound nutrients (PacifiCorp 2006, NCRWQCB 2010a).

Under current conditions, PacifiCorp (2006) has shown that the large loads of algae biomass that are discharged to the upper Klamath River from Upper Klamath Lake, particularly during summer, diminish in consistent fashion with distance from Keno reservoir through the Project area reservoirs. The decomposition of these large algae loads during downriver transit is not only a large potential source of nitrogen (via mineralization), but also of biochemical oxygen demand (BOD) imposed on the water's DO content. By contrast, PacifiCorp (2006) concludes that, if Project reservoirs were absent, substantially more of the current load of upstream nutrients and organic matter would remain available throughout the lower Klamath River downstream of Iron Gate dam, thereby increasing the levels of inorganic nitrogen, phosphorus, and BOD from decay.

On the basis of these analyses, PacifiCorp concludes that Covered Activities related to on-going Project operations do not contribute to nutrient and organic matter loading effects on water quality conditions for coho salmon downstream at Iron Gate dam, and would not affect conditions during the term of the ITP. Rather, these analyses indicate that the presence of Project facilities helps to reduce net nutrient and organic matter loading that could otherwise exacerbate water quality impairment in the river from increased BOD, reduced DO, and increased growth of benthic algae (periphyton).

Although the Project facilities are not a net source (but rather a net sink) of the large nutrient loads causing enrichment effects in the Klamath River system, the reservoirs do create impoundments of water that contribute to the occurrence of algal and cyanobacterial blooms fed by the large inflowing nutrient loads (PacifiCorp 2008b). As such, the presence of the reservoirs is a factor that contributes to seasonal algal and cyanobacterial blooms and related water quality effects. Under interim operations, these effects are expected to persist at the current extent for another 10 years.

The long-term resolution of water quality issues will be studied and assessed through PacifiCorp's Reservoir Management Plans, TMDL Implementation Plans, and ultimately achieved through 401 Certification requirements for the Project under a new FERC license or by removal of the dams under the terms of the KHSA. Under the KHSA, PacifiCorp's actions to address water quality related to nutrients and organic matter will be achieved through the implementation of water quality-related interim measures that will address nutrient loading to the Klamath River and associated water quality effects in Project reservoirs.

Dissolved Oxygen

As discussed in Chapter IV, "Current Conditions," DO conditions in Copco and Iron Gate reservoirs vary seasonally due to thermal stratification, seasonal water temperature variations in inflowing waters, and seasonal nutrient loading and organic matter from upstream sources (PacifiCorp 2004c, 2006, 2008b). Under purely isothermal conditions, DO concentrations are generally at or near equilibrium (Wetzel, 2001); however, even small temperature differences can impede mixing that can lead to subsaturated conditions within deeper portions of the reservoir. DO concentrations in 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 in deeper portions of the reservoir.

In the Klamath River downstream of Iron Gate dam, daily mean DO concentrations are typically at or near saturation throughout the river because of the turbulence in the river that provides mechanical aeration (PacifiCorp 2008b). However, the reach from Iron Gate dam to approximately Seiad Valley can experience a diurnal range in DO of 3 to 4 mg/L in response to the changes in consumption of oxygen by the benthic algal community (epiphytes and attached algae/macrophytes).

Low DO concentrations are primarily observed in the Upper Klamath River reach in summer and early fall coinciding with relatively warm water temperatures, low flows, and high organic matter concentrations. Instream DO variations attributed to Project operations are generally restricted to the area within about six miles below Iron Gate dam (PacifiCorp 2006, 2008b, 2008c, 2011). During late summer and fall periods, relatively deep releases from Iron Gate reservoir can entrain water with low DO concentrations and result in discharges of water from the dam that fall below 100 percent saturation.

NMFS (2007a) concluded that low DO concentrations below Iron Gate dam during summer likely decrease the availability and suitability of over-summer rearing habitat for juvenile coho salmon. NMFS (2007a) assumed that, when subjected to low DO conditions, rearing coho salmon below Iron Gate dam experience fewer opportunities to forage in the mainstem Klamath River outside of cold-water refugial habitat, which likely results in lower fitness and survival. The potential level of take resulting from reduced DO directly related to operations at Iron Gate dam is uncertain because translating water quality effects (i.e., DO) into definitive numbers of fish taken or the taking of any individual fish is difficult given the current uncertainty regarding coho salmon population numbers and distribution patterns within the Klamath River below Iron Gate dam (NMFS 2007a, page 109). While the number of fish potentially impacted, if any, is uncertain, the number likely would be low because most coho salmon rear in tributaries or within the mainstem in cool water refugia near the tributary mouths.

Water Temperature

NMFS has indicated that water temperature is a stressor within the river reach downstream of Iron Gate dam (Iron Gate dam to Portuguese Creek (RM 128), especially during summer months when agricultural diversions limit cold water accretions from the Shasta and Scott rivers (NMFS 2007a). As discussed in Chapter IV, "Current Conditions," owing to the mass of Iron Gate and Copco reservoirs (and the resulting thermal lag), water released from Iron Gate dam is sometimes warmer and sometimes cooler than the inflows from the Copco No. 2 powerhouse into Iron Gate reservoir. During the spring months, Iron Gate reservoir is expected to minimize deviations from seasonal mean temperatures, i.e., the relatively deep water release moderates short term responses in water temperature to deviations in meteorological conditions ("hot" or "cold" spells). During late spring and mid-summer, the reservoir releases are expected to be generally below equilibrium temperatures in the Klamath River downstream. In the fall, reservoir release temperatures are expected to be above equilibrium temperatures because of the large mass of the reservoir (compared to the river). This thermal lag is expected to be perceptible in late August and persist through the fall period as it is currently. Throughout the year, the diurnal range of release temperatures from Iron Gate reservoir is moderated by the volume of the reservoir.

Water released from Iron Gate dam during summer months may already be at a temperature stressful to juvenile coho salmon (NMFS 2007a), and intense solar warming can increase temperatures even higher (up to 26˚C) as flows travel downstream (National Research Council 2004). These stressful water temperatures have the potential to impact juvenile coho salmon rearing and migrating through the mainstem River during these times. Populations most affected include the Middle and Upper Klamath and Scott and Shasta coho populations. During summer months of stressful temperatures, juvenile coho salmon have been documented rearing within mainstem Klamath River habitat, mainly in areas adjacent to tributary mouths (e.g., Horse Creek, Beaver Creek) where cold water seeps cool mainstem river temperatures several degrees within a small spatial area (Soto 2007, Sutton et al. 2004). These fish may spend short periods of time in the mainstem migrating downstream and redistributing among habitats.

NMFS (2007a) indicated that large numbers of juvenile coho salmon are displaced into the mainstem Klamath River from the Scott and Shasta rivers as irrigation diversions begin in early April (Chesney and Yokel 2003), and likely make up a proportion of the coho salmon observed at mainstem thermal refugial areas. NMFS concluded that even though coho salmon prefer tributary habitat for rearing, juvenile coho salmon annually rear within the river reach between Iron Gate dam and Seiad Valley, relying on thermal refugia and cooler nighttime water temperatures to survive (NMFS 2007a). However, the number of coho salmon using these refugial areas is relatively small. In multiple surveys of refugial areas created by Beaver Creek and Tom Martin Creek in July and August of 2006, Sutton et al. (2007) found that the number juvenile coho salmon observed in these areas ranged from 0 to 25 individuals. Because of the relatively few individuals that would be exposed to those conditions for extended periods of time, the potential for mortality of juvenile coho salmon due to lethal temperatures is expected to be low. Because the period of upstream migration of adult coho occurs during the late fall and winter, water temperature is not expected to have an adverse effect on adult migration or spawning (PacifiCorp 2008b).

Disease

Water quality, nutrient, sediment, and flow conditions in the mainstem Klamath River have favored an increase in disease proliferation and fish infection rates (Stocking and Bartholomew 2007). A reduction in riverbed scour caused by a blockage of coarse sediment may also contribute to conditions favoring disease organisms. Large loads of organic matter can contribute to the feeding habits for the polychaete intermediate host (*M. speciosa)* and may lead to an increase in periphyton (*Cladophora*) which provides habitat for *M. speciosa.*

As described above, the Project reservoirs receive high loadings of nutrients and organic matter from upstream sources, particularly Upper Klamath Lake. Copco and Iron Gate reservoirs act to reduce annual nutrient loading (on the order of 10 to 20 percent) through settling and retention of inflowing particulate-bound nutrients (PacifiCorp 2006, NCRWQCB 2010a). As a result, the observed concentrations of nutrients that control growth of periphyton (*Cladophora*), particularly total inorganic nitrogen and total nitrogen, are consistently lower in water released from Iron Gate reservoir than in the water entering Copco reservoir.

As discussed above in *Water Quality Effects Related to Nutrients and Algal Production*, PacifiCorp (2006) concludes that the Project reservoirs act to substantially reduce (on a net basis) the large loads of algae biomass that are discharged to the upper Klamath River from Upper Klamath Lake, and that could otherwise exacerbate water quality conditions in the river downstream of Iron Gate dam from increased BOD, reduced DO, and increased growth of benthic algae (periphyton). Asarian et al. (2010) concluded that nutrient concentrations are predicted to increase in the mainstem Klamath River if PacifiCorp's dams are removed; total phosphorous and nitrogen are predicted to increase 2 to 12 percent and 37 to 42 percent, respectively, during the June-October growing season following a dam removal scenario. These observations support PacifiCorp's conclusion that Iron Gate and Copco reservoirs likely have a beneficial effect on reducing downstream periphyton in the river. In other words, periphyton in the Klamath River downstream of Iron Gate dam could increase in the absence of the Project reservoirs based on nutrient data.

The influence of Project reservoirs on seasonal water temperature downstream of Iron Gate dam might also affect the incidence of disease infection (NMFS 2007a). Project effects on water temperature (i.e., the thermal lag[20]) relative to *C. shasta* and *P. minibicornis* infection rates are unknown at this time (NMFS 2007a). PacifiCorp (2008b) concluded that exposure of juvenile salmonids to seasonally reduced water temperatures during spring and early summer under existing Project operations, primarily within the Iron Gate dam reach, would be expected to benefit the overall health and condition of rearing juvenile salmon and thus would contribute to reduced vulnerability of juveniles to disease and infection. Bartholomew (2008) found that mortality rates of coho salmon (and also Chinook salmon) were lower at cooler temperatures. Therefore, because the Project effects on seasonal water temperature (i.e., the thermal lag) result in cooler water releases below Iron Gate dam during spring, mortality rates from infection likely are lessened during this time period.

Sentinel studies conducted by Oregon State University researchers revealed that coho salmon (note: the coho used for this study were from Iron Gate Hatchery) morality was high after a 72-hour exposure in ambient Klamath River water in September 2008 (Bartholomew 2009). The studies also reported that warmer temperatures after exposure result in higher mortalities. Average water temperatures in the mainstem Klamath River below Iron Gate dam at the sentinel sites from Klamathon (RM 184) to Orleans (RM 59) in September ranged from 18.7 to 19.7°C. Temperatures in the mainstem Klamath River tend to decrease starting in September due to ambient conditions (e.g., shorter day length). Decreasing water temperatures and the likelihood that fish are moving and not stationary in one location for 72 hours, decreases the possibility of similar morality risks to coho that were observed during the study.

Researchers believe modifications to the river's historical hydrologic and sediment transport regime have likely created instream conditions that favor disease proliferation and fish

[20] The thermal lag is the delay in seasonal changes in water temperature caused by the reservoir impoundments. Thermal lag caused by reservoir impoundments can effectively delay both the spring warming trend and the fall cooling trend by several weeks.

infection (Stocking and Bartholomew 2007). Less frequent fall pulse-flows may affect disease transmission from adult salmon carcasses to the intermediate polychaete host. It is believed that the current flow regime does not effectively redistribute carcasses within the Iron Gate dam to Shasta River reach, resulting in high densities of decomposing fish downstream of popular spawning areas, specifically the areas directly below Iron Gate Hatchery and the confluence of Bogus Creek and the Klamath River mainstem (NMFS 2010). In addition, Project dams block the downstream transport of coarse sediment and reduce scour of the riverbed during high flow events. NMFS (2010) concludes that these effects may promote substrate conditions that support the intermediate host.

Fish disease likely will continue through the interim period. The effects of fish disease on coho are unknown at this time since the presence of the parasite is variable from year to year. Disease effects are likely to negatively impact all of the VSP parameters of the Interior-Klamath population units (NMFS 2010).

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VI. Conservation Program

To meet the statutory requirements for approval, NMFS must find, among other things, in the ITP and this HCP: (i) how PacifiCorp will minimize and mitigate the impacts of authorized incidental take of coho salmon that may result from Covered Activities to the maximum extent practicable and (ii) how PacifiCorp will ensure that any such taking will not appreciably reduce the likelihood of the survival and recovery of coho salmon in the wild. In addition, NMFS and the USFWS have issued and 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 relate to the amount or quality of the habitat or to the individuals or populations of the species. This section describes the HCP's conservation program, which includes a mix of habitat and species-based goals and objectives that comprehensively address potential Project-related effects on coho salmon as described in Chapter V (and summarized in Table 3). These goals and objectives provide the guidance in developing the operating conservation measures for the conservation program. This conservation program uses a combination of prescriptive-based strategies where a specific set of actions are identified to achieve a certain result, and results-based strategies where NMFS, CDFG, and PacifiCorp will select the best suited measure from a suite of alternatives to achieve the desired results. The results-based strategy is best applied where there is implementation uncertainty within the Permit Term (e.g., measure dependent on landowner cooperation). The results-based strategy allows implementation flexibility insuring greater success in achieving intended results (i.e. the goals and objectives).

Coho Salmon Conservation Strategy

The HCP describes actions to benefit the conservation of the listed SONCC coho salmon populations in the Klamath River downstream of Iron Gate dam during the interim period prior to providing fish passage at this facility. Volitional fish passage is proposed in the next decade by removal of the dams as described under the KHSA, or through other means in a new FERC license. Therefore, installation of volitional fish passage is not contemplated under the interim period covered by this HCP. Instead, PacifiCorp proposes measures as described below to address the lack of access to habitat upstream of Iron Gate dam during the interim period. The measures in this HCP focus on enhancement of coho salmon habitat availability and use in the Klamath River basin downstream of Iron Gate dam during the interim period. As such, these interim enhancement actions will expedite efforts to recover the listed SONCC coho salmon prior to implementing fish passage at Iron Gate dam, and further augment the anticipated future benefits of providing fish passage.

Goals and Objectives

Detailed biological goals and objectives are essential to ensure the HCP will minimize and mitigate take to the maximum extent practicable, and to ensure that permitted activities will not appreciably reduce the likelihood of survival and recovery of SONCC coho salmon. In the context of HCPs, biological goals are the broad, guiding principles for the operating conservation program. They are the rationale behind these strategies. For more complex HCPs such as this, biological objectives are used to step down the biological goals into manageable, and, therefore, more understandable units. Biological goals and objectives are necessary to guide implementation of the HCP but are not considered hard commitments as they need to have flexibility in order for the conservation program to adapt and adjust to conditions and provide greatest conservation benefits.

A clearly articulated set of biological goals and objectives for this HCP's conservation program were developed in consultation with NMFS technical staff based on the conservation needs of the SONCC coho salmon, threats to the species, the potential effects of Covered Activities, and the scope of this HCP. The goals are as follows:

Goal I: Offset biological effects of blocked habitat upstream of Iron Gate dam by enhancing the viability of the Upper Klamath coho salmon population

Goal II: Enhance coho salmon spawning habitat downstream of Iron Gate dam

Goal III: Improve instream flow conditions for coho salmon downstream of Iron Gate dam

Goal IV: Improve water quality for coho salmon downstream of Iron Gate dam

Goal V: Reduce disease incidence and mortality in juvenile coho salmon downstream of Iron Gate dam

Goal VI: Enhance migratory and rearing habitat for coho salmon in the Klamath River mainstem corridor

Goal VII: Enhance and expand rearing habitat for coho salmon in key tributaries

The biological goals are accompanied by specific biological objectives. The biological objectives identify the components (e.g., enhancement actions or projects) needed to achieve the biological goal. The objectives also provide benchmarks to determine effectiveness of the measures that comprise the coho salmon conservation strategy for the HCP. Each objective includes metrics to track progress toward achieving goals. These metrics are referred to as targets.

The conservation strategy comprised of measures described below will provide substantial benefits to the protection and enhancement of coho salmon habitat availability and use in the Klamath River basin. Furthermore, as discussed further in the following section titled "Effects of the Coho Salmon Conservation Strategy," implementing these conservation measures will, to the maximum extent practicable, minimize or mitigate the impact of any take of SONCC coho salmon resulting from interim Project operations.

Goal I: Offset the biological effects of blocked habitat upstream of Iron Gate dam by enhancing the viability of the Upper Klamath coho salmon population

Rationale

Project dams have blocked coho salmon access to upstream river and tributary reaches since completion of Copco 1 dam in 1918 and Iron Gate dam in 1962. While blockage of habitat upstream of the dam does not result in direct take of individual coho salmon, it does influence the distribution of the Upper Klamath population and the spatial structure of the ESU. Under interim operations, this condition would persist at its current extent for another 10 years until volitional fish passage is accomplished by removal of the dams as anticipated under the KHSA or through a new FERC license.

Iron Gate Hatchery was originally constructed as mitigation for blocked habitat between Iron Gate and Copco 1 dams. The hatchery will continue operations through the term of this HCP. The measures described below under this goal include implementation of a Hatchery and Genetic Management Plan (HGMP) and related ESA Section 10(a)(1)(A) enhancement permit covering hatchery operations. The HGMP is addressed in a separate permit process.. The HGMP contains measures to ensure hatchery operations are consistent with the most current plans for species conservation and reintroduction efforts. Although Iron Gate Hatchery is operated as a mitigation hatchery to compensate for habitat blocked between Iron Gate dam and the Copco developments, a conservation focus for the coho program has been deemed necessary to protect the remaining genetic resources of the Upper Klamath coho population unit. Recent adult coho returns to this population (and to the entire Klamath River) have been decreasing over time to the point where currently fewer than 60 fish returned to the hatchery and the largest tributary in this population unit (Bogus Creek) in 2009.

In addition, the measures described below under this goal include habitat restoration and improvement projects and activities in the Klamath River and its tributaries downstream of Iron Gate dam. These projects, conducted under the Coho Enhancement Fund, will enhance the spatial structure of the ESU by creating, maintaining, or improving access to habitats downstream of Iron Gate dam. Such actions, along with those under other goals, will contribute to improving the viability of the affected coho populations by increasing their abundance, productivity, diversity, and spatial structure. Improving viability is important because the natural population is currently experiencing low returns, little or no productivity, limited spatial structure, and limited life history and genetic diversity. Improving viability will help conserve coho salmon during the interim period prior to reestablishment of volitional fish passage, which NMFS (2007a) has determined will aid in the viability of SONCC coho salmon.

Objective A: Fish Passage

Over the term of the ITP, maintain and improve access to spawning and rearing habitat in Klamath River tributaries downstream of Iron Gate dam that are within the range of the Upper Klamath coho salmon population.

Objective A: Fish Passage is based on two targets:

A1. Maintain and improve access to existing spawning and rearing habitat in approximately 60 miles of Upper Klamath tributaries between April and November of each year.

A2. Remove existing fish passage barriers to create permanent access to at least 1 mile of potential spawning and rearing habitat in Upper Klamath tributaries.

Measures Undertaken to Achieve Objective

The measures undertaken to achieve this objective will include projects and actions aimed at creating, maintaining, and improving access by coho salmon to important tributary habitats downstream of Iron Gate dam that are within the potential range of the Upper Klamath coho salmon population. In developing this objective and targets, PacifiCorp coordinated with NMFS, tribes, watershed groups, and other stakeholders to identify activities and actions that would best enhance coho access to important habitat in Upper Klamath tributaries, and that could be implemented within the interim time period. Based on this coordination, PacifiCorp proposes to implement projects and actions that include those identified by the Mid-Klamath Watershed Council in the Klamath River Tributary Fish Passage Improvement Project. The Mid-Klamath Watershed Council, along with its partners in the basin, is developing a plan that identifies and prioritizes restoration actions in the subbasin to complement the Mid Klamath Subbasin Fisheries Resource Recovery Plan and other existing planning documents.

For target A1, projects and actions undertaken would include monitoring of tributaries to ensure adequate access by coho salmon from the river, and modifications to tributary mouths to ensure access, including removal of swimmer dams, gradient barriers, log jams, and other types of impediments. The sites chosen to address target A1 include sites prioritized by the Klamath River Tributary Fish Passage Improvement Project and other important tributaries in the Upper Klamath coho salmon population area that contain coho salmon habitat. These include (in upstream to downstream order): Bogus Creek, Willow Creek, Cottonwood Creek, Humbug Creek, Beaver Creek, Horse Creek, Tom Martin Creek, Negro Creek, O'Neil Creek, Walker Creek, Grider Creek, Seiad Creek, and Portuguese Creek. The actual sites where the first target of this objective is implemented may be different than those listed above if: (1) on-site conditions (such as access to, or physical conditions at the site) preclude planned work; or (2) new technical information (such as related to habitat conditions or coho salmon use) is obtained that suggests priority of sites should be adjusted. However, possible adjustments in sites under this measure are expected to have similar value for coho salmon. Any such adjustments will be made as described below for the planning and implementation of these measures, and as further described in Chapter VIII under *Adaptive Management*.

For target A2, projects and actions undertaken would include removal of certain known barriers to allow permanent access by coho salmon to additional spawning and rearing areas. Projects and actions to address target A2 would include barrier removals caused by road crossings (e.g., culverts) at Canyon Creek (tributary to Seiad Creek), Tom Martin Creek, McKinney Creek, and Portuguese Creek. If these barrier removal projects are not available for funding within the term of the ITP, then other fish passage projects with comparable benefits for coho salmon will be implemented. These could include roadcrossing barriers, diversion barriers, or other permanent or seasonal barriers that impede fish passage.

Planning and Selection of Measures

As described above, PacifiCorp proposes to implement projects and actions from the Klamath River Tributary Fish Passage Improvement Project plan by the Mid-Klamath Watershed Council and its partners in the basin, which identifies and prioritizes restoration actions in the subbasin to complement the Mid Klamath Subbasin Fisheries Resource Recovery Plan and other existing planning documents. The development of this plan was funded in 2010 by PacifiCorp under the Coho Enhancement Fund. This plan will specifically determine resource benefits and prioritize proposed measures related to this objective.

From the specific project plans of the Mid-Klamath Watershed Council and others in the basin, NMFS and CDFG will jointly recommend final projects and actions that meet this objective. PacifiCorp will then evaluate and approve the selected projects to ensure consistency with this goal and objectives, and with applicable license conditions and other regulatory requirements. Projects selected will comply with applicable agency policies, regulations and planning documents relating to salmonid conservation in the Klamath River Basin (i.e., Magnuson-Stevens Reauthorization Act, Klamath River Coho Salmon Recovery Plan, NMFS' SONCC Coho Salmon Recovery Plan, and CDFG's Recovery strategy for California coho salmon).

Implementation of Measures

The implementation of these measures will be through the already-established Coho Enhancement Fund, which as previously mentioned was established as part of the Interim Conservation Plan that served as the starting point for this HCP. PacifiCorp has established this fund to be administered in consultation with a Technical Review Team consisting of PacifiCorp, CDFG, NMFS, and affected Tribes. CDFG coordinates with the State Water Resources Control Board and North Coast Regional Water Quality Control Board (NCRWQCB) in its capacity as a part of this Technical Review Team.

PacifiCorp contributed $510,000 to this fund in 2009 and 2010 and will continue to provide this amount of funding annually by January 31 of each year of the Permit Term. In April, 2009, PacifiCorp, NMFS, and CDFG entered into a letter agreement (Appendix A of this HCP) that establishes the Klamath River Coho Enhancement Fund and outlines the roles and responsibilities of the individual parties. The agreement also describes the process for reviewing, recommending, and selecting projects that will be implemented under the agreement, and also identifies a qualified third party administrator and reporting requirements for the Coho Enhancement Fund.

The Coho Enhancement Fund will be administered by the National Fish and Wildlife Foundation (NFWF)[21]. NFWF will administer the Coho Enhancement Fund upon receiving a list of coho salmon enhancement projects that have been agreed upon by NMFS, CDFG,

[21] 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.

and PacifiCorp in consultation with the Technical Review Team. Thereafter, NFWF will be responsible for overseeing contracts to implement projects with funds provided from the Coho Enhancement Fund.

Objective B: Hatchery Production

Improve Iron Gate Hatchery operations to maximize conservation benefits and minimize risks from the hatchery program to coho salmon.

Objective B: Hatchery Production is based on one target:

> *B1. Release at least 75,000 coho smolts each year from Iron Gate Hatchery under an approved Hatchery and Genetic Management Plan.*

Measures Undertaken to Address Objective

PacifiCorp will implement an HGMP developed by CDFG and PacifiCorp for Iron Gate Hatchery and authorized by NMFS in an ESA Section 10(a)(1)(A) enhancement permit. The primary goal of an HGMP is to devise biologically based hatchery management strategies that contribute to the conservation and recovery of salmon and steelhead. Implementation of the HGMP is important to ensure that ongoing Iron Gate Hatchery operations contribute to the conservation and recovery of listed coho salmon in the Klamath River Basin.

The HGMP has been incorporated into an application by CDFG for a permit under ESA Section 10(a)(1)(A), which was submitted to NMFS in September, 2010. Section 10(a)(1)(A) permits allow for authorization under the ESA for scientific research activities or actions to enhance the propagation and survival of the species of an ESA-listed species that will likely result in the take of the species. Hatchery operations, genetic research, and monitoring of coho salmon are among the activities at Iron Gate Hatchery for which a section 10(a)(1)(A) permit is being sought. Upon issuance of a permit under ESA section 10(a)(1)(A) for the Iron Gate Hatchery, CDFG and PacifiCorp will implement all measures contained in the HGMP as provided in the permit.

During the term of the ESA Section 10 permit (i.e., the interim period 2010-2020), the coho program at the Iron Gate Hatchery will be operated in support of the basin’s coho salmon recovery efforts by conserving a full range of the existing genetic, phenotypic, behavioral, and ecological diversity of the run. The program will include conservation measures, genetic analyses, broodstock management, and rearing and release techniques that maximize fitness and reduce straying of hatchery fish to natural spawning areas. Monitoring and evaluation activities will also be conducted to ensure that the performance standards and indicators identified for the program are achieved, and that critical uncertainties are addressed.

Planning and Selection of Measures

Measures contained in the HGMP and related Section 10(a)(1)(A) permit application are consistent with specific, measurable objectives and criteria contained in relevant NMFS regulations and policies for the conservation of listed species. CDFG and PacifiCorp will adhere to those measures identified in the NMFS-approved ESA Section 10(a)(1)(A) permit.

An active broodstock management plan, based on real-time genetic analysis, will be implemented each year to reduce the rate of inbreeding that has occurred in the hatchery population over time. Additionally, the proportion of the total hatchery spawning population will consist of up to 50 percent natural origin (maximum of 70 fish) to increase population diversity and fitness.

Hatchery culture practices will be improved to increase egg-to-smolt survival rates. The increase in survival will be achieved by increasing survival during egg incubation and covering raceways with netting to reduce bird predation. Egg incubation survival will be investigated to identify measures that will improve survival such as changes to incubation methods, improvements in egg rearing water quality, filtering organic matter from the water source and/or decreasing egg density in incubation trays.

Implementation of Measures

PacifiCorp will fund 100 percent of the costs associated with implementation of the HGMP for Iron Gate Hatchery. Implementation will proceed through cooperation and coordination among PacifiCorp, CDFG, and NMFS. As operators of the Iron Gate Hatchery, CDFG will be the entity implementing the HGMP.

Goal II: Enhance coho salmon spawning habitat downstream from Iron Gate dam

Rationale

Iron Gate and other upstream dams will continue to restrict the downstream transport of coarse sediment (e.g., gravel), which could reduce the amount and quality of spawning habitat in the mainstem Klamath River downstream of Iron Gate dam. As described in Chapter V, NMFS (2007a, 2010) concludes that degraded coho salmon spawning and rearing habitat are limiting factors for Klamath River coho salmon production. Coho salmon downstream of Iron Gate dam may be indirectly harmed by a reduction of spawning habitat resulting from long-term depletion of suitable spawning gravel.

This goal seeks to use gravel augmentation to increase the availability of suitable spawning habitat below Iron Gate dam and improve coho salmon production during the interim period prior to reestablishment of fish passage in the Klamath River. Gravel augmentation, along with actions under other goals, will contribute to improving the viability of the affected coho populations by increasing their abundance, productivity, diversity, and spatial structure. Improving viability is important because the natural population is currently experiencing low returns, little or no productivity, limited spatial structure, and limited life history and genetic diversity. Improving viability will help conserve coho salmon during the interim period prior to reestablishment of volitional fish passage and gravel recruitment from upstream by removal of the dams as anticipated under the KHSA or through a new FERC license.

As discussed further in the following section titled “Effects of the Coho Conservation Strategy,” the gravel augmentation actions implemented under this goal will, to the maximum extent practicable, compensate for continued restriction of downstream transport of coarse sediment (e.g., gravel) to the river below Iron Gate dam during the interim period.

Objective C: Gravel Augmentation

Improve the river substrate for spawning through the augmentation of gravel in the mainstem Klamath River downstream of Iron Gate dam.

Objective C: Gravel Augmentation is based on one target:

> *C1. Provide 500 cubic yards of gravel augmentation either annually or 3,500 cubic yards over the term of the ITP downstream from Iron Gate dam.*

Measures Undertaken to Achieve Objective

PacifiCorp will develop a gravel augmentation plan, place spawning gravel in the Klamath River downstream of Iron Gate dam, and monitor the sediment augmentation efforts. The target for gravel augmentation will be to place 500 cubic yards of gravel approximately annually to a total amount of 3,500 cubic yards during the term of the ITP. This target is consistent with gravel augmentation measures recommended as a result of previous FERC relicensing analyses and agency recommendations (FERC 2007). However, the gravel augmentation program will commence with development of the gravel augmentation plan to verify augmentation species benefits, amounts, along with specific placement techniques and locations. This Plan will be reviewed by CDFG and NMFS prior to finalization.

Planning and Selection of Measures

The gravel augmentation measure will use an adaptive approach that begins with development of a gravel augmentation plan. The gravel augmentation plan will include: (1) an evaluation of its intended purpose; (2) an evaluation of the current conditions of suitable spawning gravel from Iron Gate dam to the confluence of the Shasta River; (3) a determination of appropriate make-up (i.e., composition of sediment sizes and proportions in the mix) and amounts of gravels to be augmented; and (4) recommended techniques and locations for gravel placement.

The plan will provide recommendations on the appropriate timing of gravel augmentation for given years based on flow conditions and avoidance of disturbance to water quality, coho salmon, and other biota. The plan will provide other recommendations as appropriate to maximize the benefits of gravel augmentation for spawning habitat enhancement (this objective) as well as the Goal V objective for disease reduction related to gravel scour (discussed below under Goal V).

It is estimated that augmentation will occur in about 7 of the 10 years during the term of the ITP, since planning will occur during the initial year, and augmentation likely will not be required in every subsequent year of the ITP term. For example, during some years, it may not be necessary to provide any augmentation if previous gravel has remained at locations that would provide appropriate spawning habitat (e.g., during relatively dry years).

Monitoring of gravel augmentation efforts would establish if the project objectives are being met and enable subsequent augmentation efforts to reflect findings from previous replenishment. Volume, location, and frequencies of recurring (approximately annually) gravel augmentation would be based on monitoring of initial gravel placements and assessment of bed mobilizing flow recurrence intervals. As noted above, during some years (e.g., relatively dry years), it may not be necessary to provide any augmentation if previous gravel has remained at locations that would provide appropriate spawning habitat. Alternatively, in some year, larger quantities of gravel may be needed to augment gravel washed downstream from suitable spawning areas (e.g., during wet years).

Implementation of Measures

The implementation of gravel augmentation will take place over the Permit Term through the already-established Coho Enhancement Fund (as described above under Objective A). The selected project(s) will comply with the recommendations of the gravel augmentation plan.

Goal III: Improve instream flow conditions for coho salmon downstream of Iron Gate dam

Rationale

Flow releases from Iron Gate dam are made in compliance with the NMFS BiOp (NMFS 2010) covering Reclamation's Klamath Project operations. NMFS (2010) describes the extent and impact of potential take of coho salmon associated with flows below Iron Gate dam. These flow releases are intended to avoid, minimize, and mitigate the impact of potential take of coho salmon as described in the NMFS BiOp (NMFS 2010) covering Reclamation's operations.

Flow releases from Iron Gate dam consist of three types of flow management as described in the NMFS BiOp (2010): (1) instream flow releases; (2) flow variability; and (3) flow ramp rates. The instream flow releases ensure adequate base levels of flow in the river for protecting and maintaining coho habitat. Flow variability, particularly during fall and winter, provide hydrological cues that stimulate downstream migration by juvenile coho salmon, provide flows necessary to create and maintain floodplain habitat, and contribute to conditions that reduce fish disease. Flow ramp rates are followed to ensure the reduction in flows are done slowly enough to prevent potential stranding of fish.

The measures described below under this goal address each of the three types of flow management as addressed by the NMFS BiOp (2010). Although PacifiCorp has limited discretion over management of flows below Iron Gate dam, PacifiCorp's operations can help ensure that flows are provided in a manner consistent with requirements of the NMFS BiOp (2010).

These flow management measures, along with actions under other goals, will contribute to improving the viability of the affected coho salmon populations by increasing their abundance, productivity, diversity, and spatial structure. Improving viability is important because the natural population is currently experiencing low returns, little or no productivity, limited spatial structure, and limited life history and genetic diversity. As discussed further in the following section titled "Effects of the Coho Conservation Strategy," the flow management measures implemented under this goal will, to the maximum extent practicable, minimize and mitigate the effects on coho salmon of flows from Iron Gate dam during the interim period.

Objective D: Flow

Over the term of the ITP, provide instream flows, flow variability, and flow ramp rates in the Klamath River downstream of Iron Gate dam to support coho salmon conservation and recovery.

Objective D: Flow is based on three targets:

D1. Provide instream flow releases from Iron Gate dam consistent with requirements contained in the NMFS (2010) BiOp on Reclamation's Klamath Project Operations.

D2. Implement obligations under the Fall and Winter Flow Variability Program contained in the NMFS (2010) BiOp, which provides for up to 18,600 acre feet of water to be available to simulate natural flow variability at Iron Gate dam.

D3. Conduct maintenance actions at Iron Gate powerhouse that result in streamflow changes in a manner that adheres to the ramp rates prescribed in the NMFS (2010) BiOp to reduce potential fish stranding.

Measures Undertaken to Achieve Objective

For target D1, PacifiCorp will coordinate with Reclamation to ensure adherence to instream flow releases from Iron Gate dam that are consistent with flow requirements stipulated in the NMFS (2010) BiOp on Reclamation's Klamath Project Operations. These consist of instream flow releases described for Reclamation's Proposed Action, and modified by the Reasonable and Prudent Alternative (RPA) for flows stipulated in the NMFS (2010) BiOp. The modified RPA flows include recommended adjustments to flows under Reclamation's Proposed Action for some monthly exceedance categories (per Table 18 in the NMFS [2010] BiOp). PacifiCorp also will coordinate with Reclamation to ensure implementation of any further adjustments to instream flow releases from Iron Gate dam that may arise from related flow research and monitoring activities as stipulated in the Terms and Conditions of the NMFS (2010) BiOp.

For target D2, PacifiCorp will coordinate with Reclamation to ensure implementation of the Fall and Winter Flow Variability Program (Flow Variability Program) as described in the NMFS (2010) BiOp. As described in section RPA A(1) of the NMFS (2010) BiOp, the Flow Variability Program will provide up to 18,600 acre-feet of water in the fall and winter period to simulate short-term flow increases from significant precipitation runoff events that would naturally occur at the point of Iron Gate dam release. Specific procedures for the implementation of the Flow Variability Program are still under development. NMFS has developed a recommended Flow Variability Protocol to assist in the implementation of this Flow Variability Program. A Variable Flow Technical Team, including NMFS, Reclamation, PacifiCorp, USFWS, states, and tribes, has been convened to further refine and settle on protocols and procedures for the implementation of the Flow Variability Program as discussed in a letter from Reclamation to NMFS dated January 3, 2011[22].

Pursuant to understandings and agreements reached between NMFS, Reclamation, and PacifiCorp regarding implementation of the Flow Variability Program prior to issuance of an Incidental Take Permit to PacifiCorp, PacifiCorp has cooperated with Reclamation and NMFS to implement variable flow releases from Iron Gate dam in February 2011 to achieve the goals and objectives outlined in the NMFS (2010) BiOp[23]. PacifiCorp expects that the

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[22] The January 3, 2011 letter from Jason Phillips (Manager, Klamath Basin Area Office, Reclamation) to Irma Lagomarsino (Supervisor, Northern California Office, NMFS) discusses status of implementation and suggested modification to the Flow Variability Program in compliance with the NMFS (2010) BiOp.

[23] The understandings and agreements on implementation of variable flow releases in February 2011 are contained in: (1) the February 4, 2011 letter from Dean Brockbank (Vice President, PacifiCorp) to John Bezdek (Department of Interior) and Rodney McInnis (Regional Administrator, Southwest Region, NMFS); (2) the February 7, 2011 letter from Rodney McInnis (Regional

planning, coordination, and implementation of variable flow releases at Iron Gate dam during the permit term will be consistent with the procedures used to develop and implement February 2011 variable flow releases.

For target D3, PacifiCorp will undertake maintenance actions at Iron Gate powerhouse to maintain flow ramp rates as specified in the NMFS (2010) BiOp. These ramp rates are designed to avoid or reduce potential stranding of fish that might otherwise occur due to flow changes from Project operations (as specified in NMFS 2010). The ramp rates specify that, if flows are greater than 1750 cfs, but less than 3,000 cfs, the rate at which flows can be decreased will be no more than 300 cfs in 24 hours and no more than 125 cfs in any 4-hour period. If flows are less than or equal to 1750 cfs, the rate at which flows can be decreased will be no more than 150 cfs in 24 hours and no more than 50 cfs in any 2-hour period.

The 2010 BiOp (NMFS 2010) does not contain specific daily or hourly ramp rates when the flow release at Iron Gate dam is greater than 3,000 cfs. The 2010 BiOp (NMFS 2010) assumes Reclamation's proposed approach that the ramp-down of flows greater than 3,000 cfs should mimic natural hydrologic conditions of the basin upstream of Iron Gate dam. PacifiCorp will coordinate with Reclamation to ensure that the ramp-down of flows greater than 3,000 cfs is done to be consistent with natural hydrologic conditions, and that is practicable based upon the physical limitations of the Iron Gate facilities as well as other safety considerations.

Planning and Selection of Measures

PacifiCorp will coordinate with Reclamation to provide instream flow releases from Iron Gate dam that are consistent with flow requirements stipulated in the NMFS (2010) BiOp on Reclamation's Klamath Project Operations. These will consist of instream flow releases as determined by Reclamation and NMFS per the NMFS (2010) BiOp. If future adjustments to instream flow needs from Iron Gate dam arise from related flow research and monitoring activities (per the Terms and Conditions of the NMFS [2010] BiOp), PacifiCorp will confer with NMFS and Reclamation to ensure such adjusted flows can be provided in light of the practical limitations on, and existing FERC license requirements for operation of PacifiCorp's facilities, such as limits on the capacities and authorized operational ranges of powerhouses, spillways, and reservoir facilities.

PacifiCorp will coordinate with Reclamation to implement the Flow Variability Program described in the NMFS (2010) BiOp. PacifiCorp will participate on the Variable Flow Technical Team during each year of the HCP term to develop a flow variability plan with measures pursuant to the Flow Variability Program. The Team is charged with making recommendations to Reclamation to enhance flow variability between September 1 and March 1. Team recommendations may include all components of the hydrological response, including the ascending and descending limb of the hydrograph and the duration of peak flows resulting from precipitation runoff events. The maximum volume of water available for the Team's combined annual (September 1 through March 1) recommendations will be

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Administrator, Southwest Region, NMFS) to Dean Brockbank (Vice President, PacifiCorp); and (3) the February 7, 2011 letter from Michael Connor (Commissioner, Reclamation) to Dean Brockbank (Vice President, PacifiCorp).

18,600 acre-feet, which is equal to the volume of water conserved as a result of flow modifications described in RPA element B of the NMFS (2010) BiOp.

Flow Variability Program recommendations must be consistent with flow ramp rates as specified in the NMFS (2010) BiOp and that are crucial for achieving target D3 of this HCP flow objective. PacifiCorp will coordinate with Reclamation to implement the Variable Flow Technical Team's recommendations for the September 1 through March 1 time period unless: (1) operational constraints interfere with implementation[24]; or (2) the implementation of the recommendation will result in a risk to human safety or property. In the event that (1) or (2) prohibit the implementation of the Variable Flow Technical Team's recommendation, the Team will have the opportunity to modify its recommendation to Reclamation. PacifiCorp may also provide an alternative recommendation that can be implemented in a manner to avoid operational or safety impacts.

PacifiCorp will implement ramp rates prescribed in the NMFS (2010) BiOp. PacifiCorp will plan and coordinate with NMFS and Reclamation if adjustments to prescribed ramp rates are required for any reason.

Implementation of Measures

Instream flows as described above will be provided by PacifiCorp in consultation with Reclamation and NMFS. This HCP measure will act to ensure that instream flows required by the NMFS (2010) BiOp are implemented during the Permit Term. These measures will apply to NMFS (2010) BiOp instream flow requirements as well as future instream flow-related consultations between Reclamation and NMFS.

PacifiCorp will coordinate with Reclamation and NMFS, and participate in the Variable Flow Technical Team, to implement the Flow Variability Program as described above.

The ramping criteria specified above will be implemented during all maintenance activities at Iron Gate powerhouse.

Goal IV: Improve water quality for coho salmon downstream of Iron Gate dam

Rationale

Degraded coho salmon rearing and migrating conditions in the mainstem Klamath are limiting factors for Klamath River coho salmon production as described in NMFS (2007a, 2010). This goal derives from the effects of the Project on the water quality in the Klamath River downstream of Iron Gate dam (as discussed in Chapter V). NMFS has concluded that impaired water quality contributes to degraded conditions for coho salmon migrating and rearing in the mainstem during certain times of the year (NMFS 2007a, 2010).

This goal addresses improvement in water quality, specifically DO conditions, for coho salmon downstream of Iron Gate dam. NMFS (2007a) concluded that, when subjected to low DO conditions, rearing coho salmon below Iron Gate dam experience fewer opportunities during summer to forage in areas of the mainstem Klamath River that are outside of cold-water refugial habitat, which likely results in lower fitness and survival. Due to seasonal

[24] These constraints may include practical limitations on, and existing FERC license requirements for operation of PacifiCorp's facilities, such as limits on the capacities and authorized operational ranges of powerhouse, spillway, and reservoir facilities.

stratification of Iron Gate reservoir, the hypolimnion can exhibit low DO concentrations. When the Iron Gate intake structure withdraws water from mid-depth in the reservoir, this low DO water can be entrained into the releases to the Klamath River from Iron Gate powerhouse, resulting in low DO downstream from Iron Gate dam until reaeration through water movement in-river raises DO levels within about six miles (PacifiCorp 2008b, 2008c, 2011). Coho salmon upstream migration and spawning downstream of Iron Gate dam typically occurs during periods when DO conditions are suitable.

Avoidance and minimization of other water quality impacts are not practicable during the interim period of this HCP. PacifiCorp has limited ability to influence water quality in the mainstem Klamath River downstream of Iron Gate dam. Certain significant factors that cause water quality impairment are outside of PacifiCorp's control (e.g., large loads of nutrients and organic matter from upstream sources). Some effects that are Project-related (e.g., temperature lag) cannot be avoided or minimized during the interim period while the dams are in place. However, improvements to refugia downstream of Iron Gate dam (as described below under Objective G – Refugia) will enhance opportunities for avoidance and reduce effects on coho salmon, and will help address the effects of temperature and nutrients and algal production. These actions are in addition to those that PacifiCorp will implement to address nutrient and organic matter issues outside of this HCP under Interim Measure 10 (*Water Quality Conference*) and Interim Measure 11 (*Interim Water Quality Improvements*) of the KHSA.

The measures described below under this goal include enhancement of DO conditions for juvenile coho salmon below Iron Gate dam during the interim period (via turbine venting). As previously described, NMFS (2007a, 2010) concludes that degraded coho salmon rearing habitat is a limiting factor for Klamath River coho salmon production. These DO enhancement measures, along with those under other goals, will contribute to improving the viability of the affected coho populations by increasing their abundance, productivity, diversity, and spatial structure. Improving viability will help conserve coho salmon during the interim period. As discussed further in the following section titled "Effects of the Coho Conservation Strategy," the enhancement of DO conditions for juvenile coho salmon below Iron Gate dam will, to the maximum extent practicable, minimize DO effects below Iron Gate dam during the interim period.

Objective E: Water Quality

Over the term of the ITP, improve water quality conditions for coho salmon in the Klamath River downstream from Iron Gate dam.

Objective E: Water Quality is based on one target:

> *E1. Maintain DO concentrations at or above 85 percent saturation in the Klamath River from the dam to the Iron Gate Hatchery bridge during the period from June 15 to September 30.*

Measures Undertaken to Achieve Objective

PacifiCorp will implement turbine venting to enhance the DO concentration in flows released from the Iron Gate powerhouse. Turbine venting uses an air admission valve to allow the induction of air into the water passageways within a turbine to aerate the releases from a dam. As the admitted air travels through the draft tube and into the powerhouse tailwaters, a fraction of the oxygen (and nitrogen) goes into solution, increasing DO (and dissolved nitrogen).

Turbine venting provides an efficient method for improving DO by configuring the air admission valve to remain open at a wider range of wicket gate openings. PacifiCorp will implement turbine venting at Iron Gate dam on an ongoing basis (throughout the term of interim operations) to improve DO concentrations downstream of the dam. Pending the results of routine monitoring and evaluation, the air admission valve will be kept in a fully open setting during periods when DO levels fall below 87 percent saturation in the Klamath River immediately below Iron Gate powerhouse. The saturation level of 87 percent is intended to provide a margin of safety that helps ensure that DO levels do not fall below the 85 percent surrogate indicator for DO (as described in chapter VII), which is consistent with the North Coast Regional Water Quality Control Board (NCRWQCB) site-specific DO objective for the Klamath River for the April 1-September 30 timeframe (NCRWCB 2010c).

Planning and Selection of Measures

PacifiCorp submitted an initial report to NMFS outlining the feasibility of initial turbine venting studies (PacifiCorp 2008c). Upon completion of additional evaluations in 2011, PacifiCorp will submit a final turbine venting plan to NMFS for review and approval, and will develop standard operating procedures in consultation with NMFS for on-going turbine venting and concurrent monitoring of DO conditions.

Implementation of Measures

PacifiCorp has the discretion to implement turbine venting at the Iron Gate powerhouse and has already modified its facilities at the powerhouse to implement this measure. Implementation of the measure will be based on a final turbine venting plan which could use a blower to increase air entrainment into the turbine draft tube.

Goal V: Reduce disease incidence and mortality in juvenile coho salmon downstream of Iron Gate dam

Rationale

Modifications to the river's historical hydrologic regime, along with large loads of nutrients and organic matter in the river, may create instream conditions that favor disease proliferation and fish infection. Disease contributes to poor conditions for coho salmon migrating and rearing in the mainstem during certain times of the year (NMFS 2007a, 2010). NMFS (2007a) indicates that Project reservoirs may continue to contribute to the conditions favoring the intermediate polychaete host (*M. speciosa*) for disease pathogens *C. shasta* and *P. minibicornis* that occur below Iron Gate dam. NMFS (2007a) indicates that potential linkages of this host to potential Project-related effects include blockage to upstream habitat, and reductions in coarse sediment and flow variability.

This goal strives to reduce disease incidence and mortality in juvenile coho salmon downstream of Iron Gate dam. PacifiCorp may have some ability to reduce the incidence of disease in the mainstem, and has therefore developed measures NMFS concludes have the potential to help disrupt disease cycles and reduce mortality from disease. These include improved flow variability and enhanced gravel scour, which together can help disrupt disease host habitat and reduce the incidence of disease in the mainstem. Research is also included as a measure to help improve understanding and management of conditions to reduce disease.

These disease research and management measures, along with those under other goals, will contribute to improving the viability of the affected coho populations by increasing their abundance, productivity, diversity, and spatial structure. Improving viability will help conserve coho salmon during the interim period. As discussed further below in "Effects of the Coho Conservation Strategy," the disease research and management measures will, to the maximum extent practicable, minimize and mitigate for potential Project-related effects on the incidence of disease in the mainstem below Iron Gate dam during the interim period.

Objective F: Disease:

Reduce disease incidence and mortality in juvenile coho salmon in the mainstem Klamath River below Iron Gate dam.

Objective F: Disease is based on three targets:

> *F1. Improve understanding of disease mechanisms to be better able to reduce effects from disease within the term of the ITP.*
>
> *F2. Implement measures under Objective C: Gravel Augmentation to improve scour of disease host habitat through the strategic placement of coarse sediment annually in the mainstem Klamath River.*
>
> *F3. Implement measures under Objective D: Flow by facilitating the implementation of fall/winter flow variability.*

Measures Undertaken to Address Objective

For target F1, PacifiCorp will proactively solicit and fund fish disease research projects to enhance understanding and fill knowledge gaps related to factors and conditions causing disease in coho salmon in the Klamath River. In a letter agreement dated May 21, 2009 (Appendix B), PacifiCorp and NMFS set forth the terms concerning the use and administration of the Klamath River Fish Disease Research Fund. PacifiCorp will work with the Klamath River Fish Health Workgroup to identify research projects that address key scientific questions concerning fish disease and the survival and recovery of listed coho salmon in the Klamath River Basin. These projects will be funded and implemented within the 10-year Permit Term and the results used to inform management and further research decisions.

For target F2, gravel augmentation in the Klamath River downstream from Iron Gate dam will be implemented approximately annually during the Permit Term in accordance with a gravel augmentation plan (in conjunction with Objective C: Gravel Augmentation). The amounts and locations of gravel placements will be determined in consultation with the Klamath River Fish Health Workgroup, and will be consistent with the standards and guidelines contained in the Klamath River Fish Disease Research Plan (including pertinent results from research thereby conducted) and any applicable recovery plans.

For target F3, PacifiCorp will coordinate with Reclamation to ensure implementation of the Flow Variability Program as described above under Objective D: Flow. The Flow Variability Program will provide variable flow releases from Iron Gate dam to simulate short-term flow increases from significant precipitation runoff events that would naturally occur at the point of Iron Gate dam release. Specific procedures for the implementing the Flow Variability Program are still under development. The protocols and procedures for the implementing the Flow Variability Program will be developed as described above under Objective D: Flow.

Planning and Selection of Measures

NMFS and PacifiCorp will jointly select research projects to be conducted under the Klamath River Fish Disease Research Fund. Fish disease research projects selected for funding will be consistent with the standards and guidelines contained in the Klamath River Fish Disease Research Plan, applicable recovery plans, and other relevant agency policies. In addition, PacifiCorp will consult with the Klamath River Fish Health Workgroup regarding selection and prioritization of research projects.

In evaluating and selecting proposed research projects, PacifiCorp and NMFS will consider the following criteria:

1. Whether the proposed research project will produce information to inform resource management decisions to reduce levels of disease infection in Klamath River salmonids;
2. The objectives of the proposed research project and estimated costs to complete the proposed project;
3. Whether the entity proposing to conduct the proposed research project possesses all required permits and authorizations, including, but not limited to, an ESA Section 10 research permit; and,
4. The extent to which the proposed research project is consistent with coho salmon recovery plans or other pertinent scientific literature applicable to the Klamath River Basin.

The planning and selection of measures for gravel augmentation will be conducted as discussed above under Objective C: Gravel Augmentation. The Klamath River Fish Health Workgroup will be consulted during development of the gravel augmentation plan for recommendations on the appropriate locations of gravel augmentation to best address potential disease reduction related to gravel scour.

The planning and selection of measures for flow variability will be conducted as discussed above under Objective D: Flow. PacifiCorp will coordinate with Reclamation to implement the Flow Variability Program described in the NMFS (2010) BiOp. PacifiCorp will participate on the Variable Flow Technical Team during each year of the HCP term to develop a flow variability plan with measures pursuant to the Flow Variability Program.

Implementation of Measures

PacifiCorp has committed an amount of $500,000 in total funding during the term of the ITP for the Klamath River Fish Disease Research Fund. Research proposals will be solicited and agreed upon by PacifiCorp and NMFS for the purpose of determining that the projects are consistent with the criteria and requirements as described above. PacifiCorp will consult with the Klamath River Fish Health Workgroup regarding implementation of such studies. To the extent possible given the short duration of interim operations, the results of this research are expected to inform decisions made by NMFS and CDFG regarding the selection and implementation of other specific actions funded by the Coho Enhancement Fund. Gaining a better understanding of the factors that influence the severity of the disease and host species will also help inform resource management decisions and future recovery efforts in the Klamath River (as discussed in Chapter VIII).

PacifiCorp has already initiated the fund and solicitation of research proposals. Research projects that are now underway are investigating management actions to reduce the abundance of the intermediate polychaete host (*M. speciosa*) for disease pathogens *C. shasta* and *P. minibicornis* in the Klamath River through sediment scour and/or flow manipulations. Gaining a better understanding of factors that influence severity of the disease and the host species will inform resource management decisions, including future coho salmon recovery plan efforts in the Klamath River that will endure through and beyond the term of this HCP.

The implementation of measures for strategic placement of gravel in the mainstem Klamath River will be conducted as discussed above under Objective C: Gravel Augmentation. The implementation of measures for flow variability will be conducted as discussed above under Objective D: Flow.

Goal VI: Enhance migratory and rearing habitat for coho salmon in the Klamath River mainstem corridor

Rationale

As described in Chapter V, NMFS (2007a, 2010) concludes that the dams influence habitat availability and quality in the Klamath River downstream of Iron Gate dam. NMFS (2007a, 2010) concludes that Project-related effects on flows, water temperature, coarse sediment (i.e., gravel), and LWD transport may affect coho salmon by reducing access to habitat, impeding their ability to redistribute within the system, reducing overwinter survival, altering the timing of outmigration, and reducing the quality of refugia areas at tributary creek mouths.

This goal addresses the potential effects of the Project on the suitability of habitat for coho salmon migration and rearing in the Klamath River mainstem corridor downstream of Iron Gate dam. The term “mainstem corridor” in the context of this goal encompasses the main river channel and its side channels, off-channel habitats (alcoves, ponds, and groundwater channels associated with the floodplain), lower reaches of small tributaries—including their confluences with the mainstem, and the estuarine zone from the head of tidal influence to the river mouth. Project-related effects do not extend to or affect all components of the mainstem corridor encompassed in this definition. However, enhancement actions under this goal are potentially applicable to all components under this definition so as to optimize benefits of enhancement actions to coho salmon within the mainstem of the Klamath River downstream of Iron Gate dam.

Actions implemented under this goal to enhance cold water refugia habitat downstream from Iron Gate dam will help conserve coho salmon during the interim period prior to reestablishment of fish passage in the Klamath River. The availability of such habitats is currently limited and represents a critical component of conservation and recovery of the Klamath River coho salmon. Adding LWD to the mainstem at strategic locations will help offset the impacts of the Project on habitat-forming features.

These actions, along with those under other goals, will contribute to improving the viability of the affected coho populations by increasing their abundance, productivity, diversity, and spatial structure. Improving viability is important because the natural population is currently experiencing low returns, little or no productivity, limited spatial structure, and limited life history and genetic diversity. Improving viability will help conserve coho salmon during the interim period. As discussed further in the following section titled "Effects of the Coho Conservation Strategy," the habitat enhancement actions implemented under this goal will, to the maximum extent practicable, compensate for continued Project-related effects on flows, water temperature, coarse sediment (i.e., gravel), and LWD on the river below Iron Gate dam during the interim period.

Objective G: Refugia

Over the term of the ITP, improve the quality and carrying capacity of thermal refugia along the mainstem Klamath River downstream of Iron Gate dam.

Objective G: Refugia is based on two targets:

> *G1. Improve habitat cover and complexity (by about 30 to 50 percent of the total existing cover) or maintain habitat cover and complexity (if already suitable) at 28 coldwater refugia sites along the mainstem Klamath River.*
>
> *G2. Increase the extent and/or duration (by about 30 to 50 percent of the total existing extent and/or duration) of nine coldwater refugia sites along the mainstem Klamath River.*

Measures Undertaken to Achieve Objective

For target G1, PacifiCorp funds will add to or maintain cover and the complexity of cover features at refugia sites to enhance and protect habitat suitability and carrying capacity for rearing juvenile coho salmon from the Klamath River. Activities to add or enhance cover and the complexity of cover will include riparian planting, and placements of boulders, LWD, and brush bundles.

The sites chosen to address target G1 include refugia sites in the Upper Klamath and Middle Klamath coho salmon population areas prioritized by the Mid Klamath Coho Rearing Habitat Enhancement Project (2009 Coho Enhancement Fund Project). The 28 refugia sites considered most feasible and accessible for cover improvement and maintenance work during the interim period include (in upstream to downstream order): Humbug Creek, Beaver Creek, Tom Martin Creek, O'Neil Creek, Walker Creek, Seiad Creek, Portuguese Creek, Fort Goff Creek, Thompson Creek, Little Horse Creek, China Creek, Cade Creek, Indian Creek, Little Grider Creek, Elk Creek, Titus Creek, Independence Creek, King Creek, Swillup Creek, Ti Creek, Rock Creek, Sandy Bar Creek, Stanshaw Creek, Irving Creek, Whitmore Creek, Camp Creek, Boise Creek, and Slate Creek. The actual sites used to achieve this objective may be different than those listed above. However, possible adjustments in sites are expected to result in similar value for coho salmon.

For target G2, PacifiCorp funds will provide for restoration projects such as increasing the amount of refugia habitat on the mainstem Klamath floodplain (e.g., through channel re-alignment), increasing the available refugia area for juvenile coho salmon, increasing the flow from tributaries that create coldwater refugia on the mainstem Klamath, or adding structures at the refugia sites to increase the duration and extent of the coldwater plume.

The sites chosen to address target G2 were identified in consultation with lead investigators from the Mid Klamath Coho Rearing Habitat Enhancement Project (W. Harling and T. Soto, pers. comm.). The nine sites identified as most feasible and accessible for refugia extension work during the interim period include (in upstream to downstream order): Humbug Creek, Tom Martin Creek, O'Neil Creek, Grider Creek, Independence Creek, Sandy Bar Creek, Stanshaw Creek, Whitmore Creek, and Aikens Creek. The actual sites used to achieve this objective may be different than those listed above. However, possible adjustments in sites are expected to result in similar value for coho salmon.

Planning and Selection of Measures

From the specific project plans of the Mid-Klamath Watershed Council and others in the basin, NMFS and CDFG will jointly recommend final projects and actions that meet this objective. PacifiCorp will then evaluate and approve the selected projects to ensure consistency with this goal and objectives, and with applicable license conditions and other regulatory requirements. Projects selected will comply with applicable agency policies and regulations, and should be in alignment with planning documents relating to salmonid conservation in the Klamath River Basin (i.e., Magnuson-Stevens Reauthorization Act, Klamath River Coho Salmon Recovery Plan, NMFS' SONCC Coho Salmon Recovery Plan, and CDFG's Recovery strategy for California coho salmon).

Implementation of Measures

The implementation of these measures will be through the Coho Enhancement Fund (as described above under Objective A and in Appendix A of this HCP). The April 2009 letter agreement between PacifiCorp, NMFS, and CDFG that describes the Klamath River Coho Enhancement Fund is attached in Appendix A of this HCP. The agreement describes the process for reviewing, recommending, and selecting projects that will be implemented under the agreement.

The Coho Enhancement Fund will be administered by the National Fish and Wildlife Foundation (NFWF). NFWF will administer the Coho Enhancement Fund upon receiving a list of coho salmon enhancement projects that have been agreed upon by NMFS, CDFG, and PacifiCorp. Thereafter, NFWF will be responsible for overseeing contracts to implement projects with funds provided from the Coho Enhancement Fund.

H. Mainstem Rearing Habitat Enhancement

Over the term of the ITP, enhance coho juvenile rearing habitat in the mainstem Klamath River corridor downstream of Iron Gate dam.

Objective H: Mainstem Rearing Habitat Enhancement is based on one target:

H1. Enhance rearing habitat in two key rearing sites of the mainstem Klamath River corridor.

Measures Undertaken to Achieve Objective

For target H1, PacifiCorp funds will provide for restoration projects to increase the amount of, or quality of conditions in, Klamath River mainstem coho salmon rearing habitat, including side channels, or off-channel habitats (alcoves, ponds, and groundwater channels associated with the floodplain). Examples of such enhancement activities include channel re-alignment, alcove or pond deepening, riparian planting, and placements of boulders, LWD, and brush bundles.

The sites identified for target H1 were determined from the Mid Klamath Coho Rearing Habitat Enhancement Project (2009 Coho Enhancement Fund Project) and consultation with the Yurok Tribe. Mainstem sites near Humbug Creek and Ti Creek are presently considered most feasible and accessible for mainstem coho salmon rearing habitat work during the interim period. Alternatively, pending additional planning and assessment, other mainstem sites near Red Cap Creek, Blue Creek, Terwer Creek, McGarvey Creek, Waukell Creek, and Hunter Creek also are being considered for implementation during the interim period. The actual sites used to achieve this objective may be different than those listed above. However, possible adjustments in sites are expected to result in similar value for coho salmon.

Planning and Selection of Measures

NMFS and CDFG will jointly recommend projects that meet this objective. PacifiCorp will then evaluate and approve the selected projects to ensure consistency with this goal and objective and with applicable license conditions and other regulatory requirements. Projects selected will comply with applicable agency policies, regulations and planning documents relating to salmonid conservation in the Klamath River Basin. Similar to other objectives, the current planning efforts by the Mid-Klamath Watershed Council and Yurok Tribe are expected to help determine resource benefits and prioritize proposed measures related to this objective.

Implementation of Measures

The implementation of these measures will be through the already-established Coho Enhancement Fund (as described above under Objective A and in Appendix A of this HCP).

Objective I: Large Woody Debris (LWD)

Over the term of ITP, increase the abundance of LWD in the Klamath River downstream of Iron Gate dam to contribute to the river's habitat elements and habitat forming features.

Objective I: LWD is based on one target:

I1. Ensure that available LWD pieces (greater than 16 inches in diameter and 15 feet in length) trapped at Project dams are released downstream.

Measures Undertaken to Achieve Objective

PacifiCorp will retrieve LWD trapped at or near Iron Gate, Copco 1, and Copco 2 dams, and release retrieved LWD pieces to the river channel below Iron Gate dam. The definition of LWD in the context of this objective encompasses pieces of large wood greater than 16 inches in diameter and 15 feet in length. This measure will offset the impacts of the Project on LWD recruitment to the river and enhance the habitat forming functioning of LWD in the river.

Planning and Selection of Measures

PacifiCorp will conduct retrieval and release of LWD trapped at or near Project dams on a quarterly basis. PacifiCorp will conduct this activity as a part of PacifiCorp's Project maintenance activities. PacifiCorp will conduct initial planning to determine timing of retrieval and location of release below Iron Gate dam based on feasibility, access, and efficiency considerations. PacifiCorp will also evaluate retrieval and release of LWD to ensure consistency with and adherence to applicable regulatory requirements.

A potential alternative use of LWD retrieved at the dams may be as elements for habitat enhancement projects conducted under other HCP measures (e.g., enhancement of cover under Objective G: Refugia). Such alternative use of LWD retrieved at the dams will be determined in consultation with NMFS and CDFG as habitat enhancement projects are selected for implementation and funding under the Coho Enhancement Fund. Similar to other objectives, the current Mid-Klamath Watershed Council partnership-driven planning effort is expected to help determine resource benefits and prioritize proposed measures related to this objective for LWD.

Implementation of Measures

For LWD released directly downstream from Iron Gate dam, the implementation of this measure will be through PacifiCorp's Project maintenance activities. Alternatively, for use of LWD as elements for habitat enhancement projects elsewhere, the implementation of this measure will be through the Coho Enhancement Fund (as described above under Objective A and in Appendix A of this HCP).

Goal VII: Enhance and expand rearing habitat for coho salmon in key tributaries

Rationale

As described in Chapter V, NMFS (2007a, 2010) concludes that the dams influence habitat availability and quality in the Klamath River downstream of Iron Gate dam. NMFS (2007a, 2010) concludes that Project-related effects on flows, water temperature, coarse sediment (i.e., gravel), and LWD may affect coho salmon by reducing access to habitat, impeding their ability to redistribute within the system, reducing overwinter survival, altering the timing of outmigration, and reducing the quality of refugia areas at tributary creek mouths.

This goal addresses enhancement in the availability of suitable rearing habitat for coho in tributaries of the Klamath River. This goal responds indirectly to the potential effects of the Project on the suitability of habitat for coho salmon rearing in the Klamath River mainstem corridor downstream of Iron Gate dam. This goal is important because of the availability of suitable tributary rearing habitat is limited in tributaries of the Klamath River. Increasing the availability of suitable tributary rearing habitat represents a critical component of conservation and recovery of the Klamath River coho salmon.

Creating sufficient high quality tributary rearing habitat will help improve juvenile growth and survival and help bolster the viability of Klamath River coho salmon. Improvements such as protecting and enhancing existing rearing habitat, improving water quality and flow, and providing connectivity within and to rearing habitat would increase the opportunity and capacity of key tributaries for juvenile rearing.

The three primary tributaries chosen as priorities for this goal are the Scott River, Shasta River, and Seiad Creek. These priority areas were chosen based on the work currently underway to benefit coho salmon rearing in these areas and their importance to future recovery of Klamath River coho salmon. Other tributaries may also be targeted for rearing habitat improvements over the term of the ITP given that they provide similar benefits to coho salmon. These areas could include Walker Creek, Bogus Creek, Beaver Creek, Cottonwood Creek, and Horse Creek.

Objective J: Connectivity

Over the term of the ITP, protect and restore connectivity within coho salmon rearing habitat in tributaries of the Upper Klamath, Scott River, and Shasta River that are within the range of the Upper Klamath coho salmon population.

Objective J: Connectivity is based on two targets:

> *J1. Restore connectivity in 10 stream reaches of juvenile rearing habitat in tributaries of the Upper Klamath, Scott River, and Shasta River.*
>
> *J2. Fund a water transaction program to provide flow augmentation in key reaches used for coho spawning and juvenile rearing in tributaries of the Upper Klamath, Scott River, and Shasta River.*

Measures Undertaken to Achieve Objectives

NMFS has noted that connectivity within rearing habitats of Seiad Creek and the Scott and Shasta Rivers is an important limiting factor for the juvenile life stage. The definition of connectivity in the context of this objective includes establishment of suitable flows and habitat conditions (e.g., suitable water depths, velocities, and cover conditions) to allow connected movements and use within tributary habitats by spawning and rearing life stages of coho salmon.

The measures that will be undertaken to achieve this objective will include a variety of projects and actions that address seasonal and permanent reductions in instream flows (such as from diversions) that impede or prevent juvenile fish passage and habitat use (e.g., flow and thermal barriers). Implementation of these measures will be focused on important tributary habitats downstream of Iron Gate dam that are within the potential range of the Upper Klamath coho salmon population.

For target J1, PacifiCorp funded projects would include in-channel enhancements and improvements to eliminate flow and thermal barriers (e.g., removal or functional upgrades of diversion structures or screens, channel modifications or impediment removal to improve flow and access). The project and sites chosen to address the target J1 were identified in consultation with key stakeholders involved in the planning and implementation of these projects within the potential range of the Upper Klamath coho population, including the Mid Klamath Watershed Council, Karuk Tribe, Shasta Valley Resource Conservation District, and Siskiyou County Resource Conservation District.

PacifiCorp consulted with the stakeholders listed above to identify projects that would best enhance fish access and connectivity, and that could be implemented within the interim time period. These projects and sites include fish access and connectivity projects in key reaches in 10 tributaries including: Beaver Creek and Seiad Creek in the Upper Klamath subbasin; Shakleford Creek, Mill Creek, French Creek, East Fork, and the mainstem Scott River in the Scott River subbasin; and Little Shasta Creek, Parks Creek, and the mainstem Shasta River in the Shasta River subbasin. The actual sites used to achieve this objective may be different than those listed above. However, possible adjustments in sites are expected to result in similar value for coho salmon.

For target J2, PacifiCorp funds may be applied to an emergency water transaction program to increase instream flows for passage to and from key tributary rearing areas. Funding made available to an emergency water transaction program will meet this objective by providing the Scott and Shasta Water Trusts and other water transaction programs with funding at key times when rearing or spawning are impaired by flows. For example, funds would be available for temporary leases of water from those with active water rights to keep water instream. The water enhancement program will also provide prioritization and pricing for water transactions in the Scott, Shasta, and Upper Klamath. The program will help prevent seasonal and temporary fish passage barriers and improve water quality in key rearing and spawning areas.

Planning and Selection of Measures

From the planning efforts of the Mid Klamath Watershed Council, Karuk Tribe, Shasta Valley Resource Conservation District, Siskiyou County Resource Conservation District, and others in the basin, NMFS and CDFG will jointly recommend final projects and actions that meet the first target of this objective (J1). From the planning efforts of the Scott and Shasta Water Trusts and other water transaction programs in the basin, NMFS and CDFG will jointly recommend final projects and actions that meet the second target of this objective (J2). PacifiCorp will then evaluate and approve the selected projects to ensure consistency with this goal and objectives, and with applicable license conditions and other regulatory requirements. Projects selected will comply with applicable agency policies, regulations and planning documents relating to salmonid conservation in the Klamath River Basin (i.e., Magnuson-Stevens Reauthorization Act, Klamath River Coho Salmon Recovery Plan, NMFS' SONCC Coho Salmon Recovery Plan, and CDFG's Recovery strategy for California coho salmon).

Implementation of Measures

The implementation of measures will be through the Coho Enhancement Fund (as described above under Objective A and in Appendix A of this HCP). PacifiCorp will ensure that an amount of up to $100,000 per year of the total amount in the Coho Enhancement fund is available for the emergency water transaction program during the Permit Term. The water transaction program will be administered by NFWF and PacifiCorp under the Coho Enhancement Fund. Once the program and fund are established project proponents may apply to NFWF for funding at any point during the year. Projects will be reviewed by NMFS, CDFG, and NFWF and then approved by PacifiCorp. Implementation will be done by the project proponents.

Objective K: Tributary Rearing Habitat Enhancement

Over the term of the ITP, enhance coho rearing habitat in tributaries of the Upper Klamath, Scott River, and Shasta River that are within the range of the Upper Klamath coho salmon population.

Objective K: Tributary Rearing Habitat Enhancement is based on two targets:

> *K1. Enhance rearing habitat in five key rearing tributaries of the Upper Klamath, Scott River, and Shasta River.*
>
> *K2. Protect important summer rearing habitat in a total of 10 miles along tributaries of the Upper Klamath, Scott River, and Shasta River.*

Measures Undertaken to Achieve Objectives

For target K1, PacifiCorp funded projects will include enhancement of coho rearing habitats provided by tributary channels, side channels, alcoves, ponds, and groundwater channels associated with the floodplain. Projects are expected to include such actions as channel reconstruction, floodplain connection, off-channel habitat creation and connection, and beaver introduction or protection.

Sites used to determine the target for this objective include Humbug Creek and Seiad Creek (tributaries to the Upper Klamath), Shackleford Creek and French Creek (tributaries to the Scott River), and the mainstem Shasta River. The actual sites used to achieve this objective may be different than those listed above. However, possible adjustments in sites are expected to result in similar value for coho salmon.

For target K2, PacifiCorp funded projects will target fencing to protect riparian areas and streambanks along reaches that provide important summer rearing habitat in tributaries of the Upper Klamath, Scott River, and Shasta River. Protection of summer rearing habitat is important because the presence of sufficient rearing habitat is currently limiting coho salmon recovery and there is a need to protect existing rearing habitat. Projects used to determine the target for this objective include fencing projects in McKinney Creek (tributary of the Upper Klamath), Shackleford Creek and French Creek (tributaries to the Scott River), the mainstem Shasta River and Little Shasta River. In addition to riparian fencing, actual projects undertaken could include riparian leasing, and conservation easements or acquisitions. The actual sites used to achieve this objective may be different than those listed above. However, possible adjustments in sites are expected to result in similar value for coho salmon.

Planning and Selection of Measures

From the specific plans of the Mid Klamath Watershed Council, Karuk Tribe, Shasta Valley Resource Conservation District, Siskiyou County Resource Conservation District, and others in the basin, NMFS and CDFG will jointly recommend final projects and actions that meet this objective. PacifiCorp will then evaluate and approve the selected projects to ensure consistency with this objective, and with applicable license conditions and other regulatory requirements. Projects selected will comply with applicable agency policies, regulations and planning documents relating to salmonid conservation in the Klamath River Basin (i.e., Magnuson-Stevens Reauthorization Act, Klamath River Coho Salmon Recovery Plan, NMFS'

SONCC Coho Salmon Recovery Plan, and CDFG's Recovery strategy for California coho salmon).

Implementation of Measures

The implementation of these measures will be through the Coho Enhancement Fund (as described above under Objective A and in Appendix A of this HCP).

Effects of the Coho Salmon Conservation Strategy

The actions implemented under the Coho Salmon Conservation Strategy will minimize and mitigate the effects of incidental take that may potentially occur as a result of PacifiCorp's implementation of Covered Activities. As described in Chapter V, PacifiCorp's operations have the potential to influence the quality of coho salmon habitat in the Klamath River downstream of Iron Gate dam, water quality conditions in the river, and the incidence of fish diseases. As summarized in Table 4, the various targets and associated measures included in the Coho Salmon Conservation Strategy comprehensively address each category of the potential Project-related effects as described in Chapter V (see Table 3).

Collectively, the measures (including specific projects already being implemented) under the Coho Salmon Conservation Strategy will be consistent with the Recovery Strategy for California Coho Salmon (CDFG 2004c) and will help support and sustain coho salmon populations and contribute to their recovery in the wild. The full suite of measures that will be funded and implemented under the Coho Salmon Conservation Strategy will enhance conditions for coho salmon downstream of Iron Gate dam relative to current conditions. Many of the measures involve habitat construction and restoration actions that will continue to provide benefits beyond the 10-year duration of this HCP (e.g. permanent barrier removal projects which could last into perpetuity).

The following sections specifically describe the anticipated effects of implementing the conservation measures. The measures that are, and will be implemented under the Coho Salmon Conservation Strategy are expected to minimize and mitigate the effects of incidental take that may potentially occur as a result of PacifiCorp's continued operation of its hydroelectric facilities during the interim period, because:

- Potential for take associated with the Project's interim operations will be short in duration;
- HCP measures will provide measurable benefits to coho salmon relative to current conditions over the 10-year period of operations;
- Many of the conservation benefits that will be established via implementation of the HCP will continue beyond the interim period (e.g. disease research findings, passage improvements, etc.); and
- HCP measures will improve habitat conditions for coho salmon during a critical period prior to achieving fish passage upstream of Iron Gate dam.

TABLE 4
Summary of Effects Addressed by Objectives and Targets Under the Coho Salmon Conservation Strategy

Goal	Objective	Target	Measure	Effect Addressed (per Table 3)
I	A. Fish Passage	A1. Maintain and improve access to existing habitat in approximately 60 miles of Upper Klamath tributary habitat between April and November of each year.	Coho Enhancement Fund (annual tributary access improvement program)	1. Blockage of Fish Passage
I	A. Fish Passage	A2. Remove existing fish passage barriers to create permanent access to at least 1 mile of additional spawning and rearing habitat in the Upper Klamath tributaries.	Coho Enhancement Fund (passage barrier removal projects)	1. Blockage of Fish Passage
I	B. Hatchery Production	B1. Release at least 75,000 coho salmon smolts each year from Iron Gate Hatchery under an approved Hatchery and Genetic Management Plan.	HGMP Implementation and Hatchery Funding	1. Blockage of Fish Passage
II	C. Gravel Augmentation	C1. Provide 500 cubic yards of gravel augmentation either annually or 3,500 cubic yards over the term of the ITP downstream from Iron Gate dam.	Coho Enhancement Fund (annual gravel augmentation program)	2. Blockage of Downstream Transport of Sediment and Wood
III	D. Flow	D1. Provide the instream flow releases consistent with requirements contained in the NMFS (2010) BiOp on Reclamation's Klamath Project Operations.	PacifiCorp Operations (Iron Gate flow releases)	3. Flows and Rearing Habitat Conditions Downstream of Iron Gate Dam
III	D. Flow	D2. Implement obligations under the Fall and Winter Flow Variability Program contained in the NMFS (2010) BiOp, which provides for up to 18,600 acre feet of water to be available to simulate natural flow variability at Iron Gate dam.	PacifiCorp Operations (Iron Gate flow releases)	3. Flows and Rearing Habitat Conditions Downstream of Iron Gate Dam
III	D. Flow	D3. Conduct maintenance actions at Iron Gate powerhouse in a manner that adheres to the ramp rates prescribed in the NMFS (2010) BiOp to reduce potential fish stranding.	PacifiCorp Operations (Iron Gate flow releases)	3. Flows and Rearing Habitat Conditions Downstream of Iron Gate Dam
IV	E. Water Quality	E1. Maintain DO concentrations at or above 85 percent saturation in the Klamath River from the dam to the Iron Gate Hatchery bridge during the period from June 15 to September 30.	PacifiCorp Operations (Iron Gate powerhouse turbine venting)	4. Dissolved Oxygen (DO)

TABLE 4
Summary of Effects Addressed by Objectives and Targets Under the Coho Salmon Conservation Strategy

Goal	Objective	Target	Measure	Effect Addressed (per Table 3)
V	F. Disease	F1. Improve understanding of disease mechanisms to be better able to reduce effects from disease within the term of the ITP.	Disease Research Fund	5. Disease
V	F. Disease	F2. Implement measures under Objective C: Gravel Augmentation to improve scour of disease host habitat through the strategic placement of coarse sediment annually in the mainstem Klamath River.	Coho Enhancement Fund (annual gravel augmentation program)	5. Disease
V	F. Disease	F3. Implement measures under Objective D: Flow by facilitating the implementation of fall/winter flow variability.	PacifiCorp Operations (Iron Gate flow releases)	5. Disease
VI	G. Refugia	G1. Improve habitat cover and complexity (to about 30 to 50 percent of the total existing cover) or maintain habitat cover and complexity (if already suitable) at 28 coldwater refugia sites along the mainstem Klamath River.	Coho Enhancement Fund (annual refugia improvement program)	6. Water Temperature
VI	G. Refugia	G2. Increase the extent and/or duration (by about 30 to 50 percent of the total existing extent and/or duration) of nine coldwater refugia sites along the mainstem Klamath River.	Coho Enhancement Fund (refugia enhancement projects)	6. Water Temperature
VI	H. Mainstem Rearing Habitat Enhancement	H1. Enhance rearing habitat in two key rearing sites of the mainstem Klamath River corridor.	Coho Enhancement Fund (tributary rearing habitat enhancement projects)	3. Flows and Rearing Habitat Conditions Downstream of Iron Gate Dam
VI	I. Large Woody Debris (LWD)	I1. Ensure that available LWD pieces (greater than 16 inches in diameter and 15 feet in length) trapped at Project dams are released downstream.	PacifiCorp Maintenance (quarterly LWD retrieval)	2. Blockage of Downstream Transport of Sediment and Wood
VII	J. Connectivity	J1. Restore connectivity in 10 stream reaches of juvenile rearing habitat in tributaries of the Upper Klamath, Scott River, and Shasta River.	Coho Enhancement Fund (tributary rearing habitat enhancement projects)	3. Flows and Rearing Habitat Conditions Downstream of Iron Gate Dam

TABLE 4
Summary of Effects Addressed by Objectives and Targets Under the Coho Salmon Conservation Strategy

Goal	Objective	Target	Measure	Effect Addressed (per Table 3)
VII	J. Connectivity	J2. Fund a water transaction program to provide flow augmentation in key reaches used for coho spawning and juvenile rearing in tributaries of the Upper Klamath, Scott River, and Shasta River.	Coho Enhancement Fund (annual water transaction fund)	3. Flows and Rearing Habitat Conditions Downstream of Iron Gate Dam
VII	K. Tributary Rearing Habitat Enhancement	K1. Enhance rearing habitat in five key rearing tributaries of the Upper Klamath, Scott River, and Shasta River.	Coho Enhancement Fund (tributary rearing habitat enhancement projects)	3. Flows and Rearing Habitat Conditions Downstream of Iron Gate Dam
VII	K. Tributary Rearing Habitat Enhancement	K2. Protect important summer rearing habitat in a total of 10 miles along tributaries of the Upper Klamath, Scott River, and Shasta River.	Coho Enhancement Fund (tributary rearing habitat enhancement projects)	3. Flows and Rearing Habitat Conditions Downstream of Iron Gate Dam

Habitat Access

Project dams have blocked coho salmon access to upstream river and tributary reaches since completion of Copco 1 dam in 1918 and Iron Gate dam in 1962. While blockage of habitat upstream of the dam does not result in direct take of individual coho salmon, it does influence the distribution of the Upper Klamath population and the spatial structure of the ESU. Under interim operations, this condition would persist at its current extent for another 10 years until volitional fish passage is accomplished by removal of the dams as anticipated under the KHSA or through a new FERC license.

Under objective ***A-Fish Passage*** of the Coho Conservation Strategy (as described in the previous section), specific projects will be selected and implemented (under the Coho Enhancement Fund) to create, maintain, or improve access by coho salmon to habitats downstream of Iron Gate dam. These projects will serve to increase the distribution of coho salmon and improve the spatial structure of the population. Increasing available habitat below Iron Gate dam will help ensure that coho salmon populations remain stable and improve while parallel actions are taken to address volitional fish passage issues in the longer term.

The specific access-related projects implemented under objective ***A-Fish Passage*** will collectively improve and maintain access to suitable habitat in approximately 60 miles of tributary habitat. The four specific barrier removal projects will create permanent access for spawning and rearing in at least another mile of currently inaccessible habitat. Collectively, these projects will create, maintain, or improve access to habitats downstream of Iron Gate dam that are equivalent on a per-mile-length basis to currently blocked habitat above the dam. These projects also consist of those access improvement or barrier removal projects in

Upper Klamath tributaries that can be most-feasibly implemented and completed within the interim period. Therefore, the measures that are implemented under this goal will, to the maximum extent practicable, compensate for the inability of Upper Klamath River coho salmon to potentially access blocked habitat upstream of Iron Gate dam during the interim period.

In the longer term, outside the term of this HCP, volitional fish passage will be achieved through dam removal as specified in the KHSA or operation under a new FERC license with fish passage requirements. Therefore, the avoidance and minimization of impacts that would result from volitional passage are not practicable under interim operations, taking into consideration constraints imposed by the several-year timeline yet required for process, planning, design, and implementation steps before volitional passage is fully realized.

Habitat Conditions

The Coho Salmon Conservation Strategy includes several measures as described in the previous section of this HCP that will enhance coho salmon habitat in the Klamath River and tributaries downstream of Iron Gate dam. These measures are targeted to enhance and conserve habitat during the interim period (see Table 4). These measures will provide benefits for coho salmon spawning and rearing habitat in the Klamath River and its tributaries. In combination, the projects implemented under these conservation measures will minimize and mitigate, to the maximum extent practicable, the impact of potential habitat-related take of coho salmon downstream of Iron Gate dam resulting from continued operations over the interim period.

Instream Flows and Flow Variability

Under objective ***D-Flow*** of the Coho Conservation Strategy (as described in the previous section), PacifiCorp will ensure releases of instream flows from Iron Gate dam that adhere to instream flow commitments contained in the current NMFS Biological Opinion for Reclamation's Annual Operations Plan (NMFS 2010). Objective ***D-Flow*** also includes implementation of the fall/winter flow variability program to further enhance flow releases at Iron Gate dam between October and February of each year of the ITP.

NMFS (2010) concludes that their recommended management of flow releases from Iron Gate dam, including both instream flow and flow variability components, will avoid the likelihood of jeopardizing the continued existence of listed SONCC coho salmon and avoid the destruction or adverse modification of its designated critical habitat. These flows are expected to promote an increase in the natural hydrologic function of the mainstem Klamath River and result in essential features of critical habitat for juvenile coho salmon that will improve the fitness of juvenile coho salmon individuals. NMFS (2010) concludes that these flows will ensure juvenile coho salmon benefit from higher spring flows and increased fall flow variability, which will result in improvements to the overall viability of three Klamath River Basin coho salmon population units.

The Coho Salmon Conservation Strategy's measure to help facilitate flow variability downstream of Iron Gate dam enhances Reclamation's ability to implement a flow variability program as directed in the NMFS (2010) BiOp. The flow variability measure commits PacifiCorp to participate in a process with NMFS and Reclamation to implement the Flow Variability Program as outlined in the NMFS (2010) BiOp.

Increased flow variability below Iron Gate dam will provide a more natural hydrograph and beneficially influence fall redistribution of juvenile coho salmon in the upper reach of the Klamath River (i.e., below Iron Gate dam) (NMFS 2010). In addition, increased fall flow variability will enhance transitory habitat for juvenile coho salmon by providing more side-channel and margin habitat areas preferred by juvenile coho salmon (NMFS 2010). NMFS (2010) concludes that this action will enhance the fitness and overwintering survival of juvenile coho salmon in the mainstem Klamath River, particularly in the reach from Iron Gate dam to the Scott River.

Increases in fall and early winter flow variability also are expected to contribute to a reduction of disease risks associated with *P. minibicornis* and *C. shasta* in the Klamath River downstream of Iron Gate dam (NMFS 2010). Adult salmon carry the myxospore life history stage of *C. shasta* and *P. minibicornis*, and following their death, release the spores as the carcasses decompose. Based on information from Stocking and Bartholomew (2007), NMFS (2010) hypothesized that high flow pulses in the fall and winter will have the benefit of redistributing adult salmon carcasses downstream that might otherwise become concentrated in the mainstem below Iron Gate dam. NMFS (2010) further hypothesized that static flow conditions combined with nutrient enrichment in the Klamath River reach favor the proliferation of periphyton (*Cladophora*) habitat preferred by the polychaete intermediate host (*M. speciosa*) of the disease pathogens *C. shasta* and *P. minibicornis*. NMFS (2007a) concludes that an increase in flow variability above required minimum flows could reduce disease outbreaks in the Klamath River downstream of Iron Gate dam by aiding the scour of periphyton.

Increased flow variability resulting from this measure will be greatest in the upper Klamath River proximal to Iron Gate dam. Farther down the Klamath River, the accretions from larger tributaries contribute significantly to the volume of water and flow variability characteristics. NMFS (2010) concludes that, although take, if any, of coho salmon as a result of interim operations cannot be quantified, this measure will provide ecological benefits that will contribute to minimizing and mitigating the impact of any potential take resulting from interim Project operations.

Flow Ramping Rates

Under objective ***D-Flow*** of the Coho Salmon Conservation Strategy (as described in the previous section), PacifiCorp will ensure flow ramping rates of releases from Iron Gate dam that adhere to commitments contained in the current NMFS BiOp for Reclamation's Annual Operations Plan (NMFS 2010). Ramp-down rates below 3,000 cfs are artificially set to minimize risks of stranding juvenile coho salmon (NMFS 2010). Daily and hourly ramp-down rate requirements are set to meter out the reduction in flow volume and avoid flow and water depth reductions that could harm coho salmon.

NMFS (2010) concludes that these flow ramping rates will protect rearing and migrating coho salmon within the Klamath River downstream from Iron Gate dam. The previous NMFS (2002) BiOp also concludes that the ramp-down rates below 3,000 cfs minimize adverse effects to essential features of coho salmon habitat (e.g., rearing, spawning habitat features). Hardy et al. (2006) concurred with NMFS' conclusion that decreases in flows of 150 cfs or less per 24-hour period and no more than 50 cfs per two-hour period when Iron Gate dam flows are 1,750 cfs or less are not likely to adversely affect juvenile coho salmon critical habitat.

The 2010 BiOp (NMFS 2010) does not contain specific daily or hourly ramp rates when the flow release at Iron Gate dam is greater than 3,000 cfs. The 2010 BiOp (NMFS 2010) recommends that the ramp-down of flows greater than 3,000 cfs should mimic natural hydrologic conditions of the basin upstream of Iron Gate dam. NMFS (2010) expects that habitat effects from these ramping rates will be representative of conditions that would be observed under flow conditions without Project influence. PacifiCorp is currently coordinating with Reclamation to ensure that the ramp-down of flows greater than 3,000 cfs is done to be consistent with natural hydrologic conditions, and that is practicable based upon the physical limitations of the Iron Gate facilities as well as other safety considerations.

Water Temperature

The mass of water in the Project reservoirs will continue to cause a "thermal lag" compared to the same location in the Klamath River under a hypothetical "without-dam" or river-only scenario. The natural seasonal trends of warming river temperatures in the spring and cooling temperatures in the fall are expected to be "lagged" about 2 to 4 weeks with the existence of the reservoirs compared to a hypothetical "without-dam" or river-only scenario. This lag could affect the timing (or periodicity) of coho salmon life stages below Iron Gate dam, or affect coho salmon egg pre-spawn viability and juvenile growth (bioenergetics), foraging, and fitness.

As summer ends and transitions into the fall period, the thermal lag resulting from the presence of Iron Gate reservoir likely will cause a more gradual cooling of the river below Iron Gate dam (as compared to a hypothetical "without-dam" or river-only scenario). NMFS (2007a) indicates that warmer temperatures extending into the fall may reduce the ability of coho juveniles to use habitat in the mainstem Klamath River during those periods. This may reduce growth or survival of juvenile coho redistributing into habitats in the mainstem.

During the spring period, the thermal lag resulting from the presence of Iron Gate reservoir likely will cause a more gradual warming of the river below Iron Gate dam (as compared to a hypothetical "without-dam" or river-only scenario). The cooler "lagged" temperatures likely will not adversely affecting juvenile coho present in the river at this time, and may improve conditions and extend the period of suitable temperatures for juvenile coho salmon migrating and rearing during that period in the mainstem.

The thermal lag is a product of presence of the reservoirs in place. Avoidance of this impact, which would require elimination of the reservoirs, is not practicable under interim operations. In the longer term, outside the term of this HCP, temperature impacts will be addressed through dam removal as specified in the KHSA or otherwise addressed under a new FERC license and issuance of a 401 certification. PacifiCorp has investigated options to minimize temperature impacts (e.g., selective withdrawal, curtain barriers). However, these options were determined to be infeasible because of: (1) the limited volume of cold water in

Iron Gate reservoir that could be used for temperature management purposes; and (2) detrimental impacts to the Iron Gate Hatchery, which relies on the limited volume of cold water in Iron Gate reservoir for hatchery production (FERC 2007, PacifiCorp 2004b).

The actions implemented under objective ***G-Refugia*** of the Coho Conservation Strategy will mitigate the continuing effect of the reservoirs on water temperature during the interim period. These actions will improve the quality and carrying capacity of thermal refugia along the mainstem Klamath River downstream of Iron Gate. Thermal refugia are considered a critical habitat feature for coho salmon (and other salmonid species) in the Klamath River. Juvenile coho salmon have been observed residing within thermal refugia in the mainstem Klamath River throughout the summer and early fall when ambient water temperatures in the river are above about 22ºC (NMFS 2010). Mainstem refugia areas are often located near tributary confluences, where water temperatures are 2 to 6°C lower than the surrounding river environment (NRC 2004, Sutton et al. 2004).

Thermal refugia along the Klamath River are used mostly by juvenile coho salmon in the range of the Upper Klamath coho salmon population unit upstream of Portuguese Creek (RM 134). For example, Soto (2007) reported robust numbers of rearing coho salmon within refugia at the mouths of Beaver Creek (RM 162) and Tom Martin Creek (RM 143). Sutton et al. (2004) indicate that juvenile coho salmon have not been documented, or documented in very small numbers, utilizing cold water refugia areas within the Middle and Lower Klamath population areas upstream of Portuguese Creek (RM 134) and the Trinity River (RM 40), respectively. During past refugia studies (Sutton et al. 2004), no coho salmon were observed within extensive cold-water refugia habitat adjacent to lower river tributaries such as Elk Creek (RM 107), Red Cap Creek (RM 53), and Blue Creek (RM 16). However, Naman and Bowers (2007) captured 15 juvenile coho salmon in the Klamath River between Pecwan Creek (RM 24.5) and Blue Creek near cold water seeps and thermal refugia during June and July of 2007.

The specific refugia-related actions implemented under this HCP will collectively improve and maintain the quality and quantity of refugia along the mainstem Klamath River downstream of Iron Gate dam. The HCP is targeting 28 coldwater refugia sites along the mainstem Klamath River for improvement and maintenance of habitat cover and complexity. The HCP also is targeting nine coldwater refugia sites for increases in area and duration. Collectively, these projects will enhance and maintain most of the significant refugia areas downstream of Iron Gate dam to the confluence of the Trinity River (RM 43). This encompasses a distance along the mainstem Klamath River that far exceeds the distance of Project-related influences on water temperatures downstream of Iron Gate dam, which is estimated to extend no farther than about Seiad Valley (about RM 129) (PacifiCorp 2008b). These projects also include those refugia-related projects that can be most-feasibly implemented and completed within the interim period. As a result, the measures that are implemented under this objective will, to the maximum extent practicable, mitigate the temperature-related effects on Klamath River coho salmon during the interim period.

Dissolved Oxygen

Under objective ***E-Water Quality*** of the Coho Salmon Conservation Strategy (as described in the previous section), PacifiCorp will implement turbine venting over the term of the ITP to improve DO conditions for coho salmon in the Klamath River downstream of Iron Gate dam. NMFS (2007a) indicates that low DO concentrations below Iron Gate dam during summer likely limits the ability of over-summer rearing juvenile coho salmon to forage in areas of the mainstem Klamath River outside of cold-water refugial habitats. Turbine venting improves DO by implementing procedures to allow the induction of air into the water passageways containing the turbine to aerate the releases from the Iron Gate powerhouse. As the admitted air travels through the draft tube and into the powerhouse tailwaters, a fraction of the oxygen in the air goes into solution, increasing DO.

PacifiCorp has conducted turbine venting tests that have demonstrated a positive improvement in DO concentration measured in the Klamath River below Iron Gate powerhouse. In summer of 2008, field monitoring of DO monitoring (Carlson and Foster 2008) and turbine efficiency tests (Principia 2008) during turbine venting indicated that DO levels increased by up to 2.5 mg/L and 20 percent saturation as a result of turbine venting at turbine flows of 1,000 cfs to 1,500 cfs. In addition, measurements indicated that turbine venting produced a negligible increase in total dissolved gas in turbine discharges to the river during the tests, and in all cases, total dissolved gas measurements were below 110 percent, which is the criterion established by the U.S. Environmental Protection Agency (EPA) to prevent fish harm from potential gas bubble disease (EPA 1976).

The increases in DO from the 2008 turbine venting tests were seen throughout the reach of the river for a distance of approximately six miles below the powerhouse (Carlson and Foster 2008). Although the 2008 tests indicate that turbine venting can provide enhancement of DO levels, the test results suggest that the amount of enhancement can vary depending time of year (as indicated by the differences between August and October test results) or river flow amount (as indicated by the differences between flow levels during the August test).

In 2009, PacifiCorp conducted further testing of turbine venting using a manifold that can provide additional air flow to the turbine draft tube. This air admission manifold was previously capped off but was opened during the Iron Gate powerhouse annual outage in May 2009. However, mechanical problems with the manifold system prevented an assessment of effectiveness in 2009.

In 2010, PacifiCorp installed a new blower system on the manifold to provide additional aeration to powerhouse discharges and further increase DO levels. PacifiCorp conducted additional testing during periods of low DO below Iron Gate dam to assess the effectiveness under three types of turbine venting and blower operations: (1) turbine venting only; (2) blower operation only; and (3) turbine venting in combination with blower operation (PacifiCorp 2011). The effectiveness of DO enhancement under these three operating conditions was then assessed by comparing DO resulting from these operations to ambient DO levels occurring without any enhancement actions (i.e., no treatment). All three types of operations increased DO levels compared to no treatment (PacifiCorp 2011). The venting and blower combination had the largest effect: DO saturation rose by 14.9 percentage points (a 29 percent increase) and average DO concentration rose by 1.8 mg/L (a 33 percent increase) during the treatment conditions as compared to no treatment. Longitudinal profiles of DO levels measured in the river downstream from Iron Gate indicated that the increases in DO from the treatments were evident over a distance of about six miles (PacifiCorp 2011).

PacifiCorp is currently conducting additional testing and evaluation of turbine venting. Upon completion of evaluations in 2011, PacifiCorp will develop and submit a final turbine venting standard operating procedure to NMFS for review and approval. This standard operating procedure will describe operational plans for on-going turbine venting and concurrent monitoring of DO conditions. PacifiCorp then will implement turbine venting at Iron Gate dam on an ongoing basis (throughout the term of interim operations) in a manner consistent with the standard operating procedure to improve DO concentrations downstream of the dam.

For initial operations under the HCP, the air admission valve will be kept in a fully open setting during periods when DO levels fall below 87 percent saturation[25] in the Klamath River immediately below Iron Gate powerhouse. Even though the extent of potential take, if any, associated with DO concentrations immediately below Iron Gate dam resulting from interim operations cannot be quantified, NMFS (2007a, page 109) suggested that turbine venting that contributes at least 2.2 mg/L to outflow water from Iron Gate dam when operated would not result in an unacceptable level of take. Therefore, implementation of this measure will adequately minimize and mitigate the impact of any potential take resulting from decreased DO under interim operations.

NMFS (2007a) indicates that low DO conditions likely limit the nightly period during which juvenile fish leave refugia habitat to forage within the mainstem Klamath River. NMFS (2007a) also suggests that higher nighttime DO concentrations should afford juvenile coho salmon greater foraging opportunities outside the confines of the existing thermal refugia areas, ultimately resulting in higher survival rates for juvenile coho salmon that rear between Iron Gate dam and Seiad Valley each summer. This measure will increase DO concentrations in the Klamath River in areas up to six miles downstream of Iron Gate dam. NMFS (2007a, page 64) indicated that over-summer survival of juvenile coho salmon should increase with improving DO conditions brought about by turbine venting.

Gravel and LWD

The presence of Project dams and reservoirs will continue to impede the downstream transport of gravel and LWD during the interim period. NMFS (2007) concludes that reduced transport of gravel affects coho salmon downstream of Iron Gate dam by reducing spawning habitat and the scouring ability of flow events, resulting in more favorable habitat conditions for the disease host *M. speciosa*. NMFS (2007) concludes that reduced transport of LWD affects coho salmon downstream of Iron Gate dam by disrupting the beneficial habitat-forming channel, riparian, and floodplain processes influenced by the presence of LWD.

The reduced transport of gravel and LWD is a product of presence of the reservoirs in place. Avoidance of this impact, which would require elimination of the reservoirs, is not

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[25] The saturation level of 87 percent is intended to provide a margin of safety that helps ensure that DO levels do not fall below 85 percent surrogate indicator for DO (as described in chapter VII), which is consistent with the site-specific DO objective for the Klamath River for the April 1-September 30 timeframe (NCRWCB 2010c).

practicable under interim operations. In the longer term, outside the term of this HCP, impacts from reduced transport of gravel and LWD will be addressed through dam removal as specified in the KHSA or otherwise addressed under a new FERC license and issuance of a 401 certification.

Actions implemented under objective ***C-Gravel Augmentation*** of the Coho Conservation Strategy will mitigate the continuing effect of the Project on gravel transport during the interim period. These actions will increase the supply of gravel in the mainstem Klamath River downstream of Iron Gate by augmenting the supply of gravel in the river downstream from Iron Gate dam. Gravel augmentation will be targeted to provide 500 cubic yards of gravel approximately annually in the river to a total amount of 3,500 cubic yards over the term of the ITP.

The targeted amounts will compensate for the estimated effects of Project reservoirs on the reduction in suitable spawning gravel in the reach of the river from Iron Gate dam downstream to the confluence with Cottonwood Creek (at RM 182). Geomorphology analyses suggest that the primary impact of the Project on alluvial features (and therefore on potential salmonid spawning material) is limited to the eight-mile reach from Iron Gate dam downstream to the confluence with Cottonwood Creek (PacifiCorp 2004b, FERC 2007). Near Cottonwood Creek, there is a sharp break in surficial geologic lithologies between the volcanic Cascades Province (west and upstream of Cottonwood Creek area) and the Klamath Province (east and downstream of Cottonwood Creek area). The upstream portion of the Klamath River in the volcanic Cascades Province has naturally low sediment yields, and the river's channel character is mostly steep and bedrock-dominated, with limited accumulations of alluvium. The downstream portion of the Klamath River in the Klamath Province has much higher sediment yields, with alluvial accumulations that progressively increase in abundance and extent with distance downstream.

The augmentation of gravel in the river downstream from Iron Gate dam will enhance conditions for coho salmon spawning in the river during fall, and also will enhance gravel-related scour of the disease host *M. speciosa*, particularly during runoff events. As such, the gravel augmentation will improve the viability of the Upper Klamath coho population by increasing their abundance, productivity, and survival. Improving viability will help conserve coho salmon during the interim period prior to dam removal as specified in the KHSA or other long-term enhancement measures for gravel addressed under a new FERC license and issuance of a 401 certification.

Actions implemented under objective ***I-LWD*** of the Coho Conservation Strategy will minimize and mitigate the continuing effect of the Project on LWD transport during the interim period. These actions will increase the abundance of LWD in the mainstem Klamath River downstream of Iron Gate by ensuring that available LWD pieces (greater than 16 inches in diameter and 15 feet in length) trapped at Project dams are released downstream (or alternatively made available for potential use in downstream habitat enhancement projects).

The amount of LWD trapped at Project dams has not been quantified, but is considered low (i.e., Project maintenance personnel estimate less than a dozen pieces per year). Surveys of LWD conducted along the river in the vicinity of the Project suggest that the density of

LWD in the river channel is consistently low in reaches both upstream and downstream of Project reservoirs (PacifiCorp 2004b). The LWD densities of .01 to .10 LWD pieces/m reported by PacifiCorp (2004b) in Project area reaches of the Klamath River are less than the LWD densities of .05 to .25 LWD pieces/m reported by Lestelle (2006) for similarly-sized rivers in forested areas of Washington.

Although Project dams are assumed to reduce downstream transport of LWD, the consistently low amount of LWD in reaches both upstream and downstream of Project reservoirs suggest that LWD supply is limited by the characteristics of the Klamath River channel and riparian conditions. LWD is not retained as readily in large stream channels than in small channels, because wood is much more easily transported in large channels (Lestelle 2006, Bilby and Bisson 1998). Channel type (i.e., extent of confinement) also influences how much wood is retained in a channel—confined channels with boulder or bedrock substrate contain about half or less number of pieces of wood found in similarly-sized, unconfined reaches with small substrate (Lestelle 2006, Bilby and Wasserman 1989, Bilby and Bisson 1998). The amount and sizes of wood that are recruited into a stream channel also greatly affects the extent of wood retained within a channel. Where riparian forests are composed of small trees, stream channels contain much less wood compared to heavily forested areas with large trees (Montgomery et al. 2003).

By ensuring that targeted LWD pieces trapped at Project dams are released downstream (or alternatively made available for potential use in downstream habitat enhancement projects), this measure will minimize and mitigate, to the maximum extent practicable, the effects of Project on transport of LWD during the interim period. LWD is known to be a valuable feature in juvenile coho salmon rearing habitat. Greater amounts of large wood often equate to more frequent and larger pools, which in turn, results in a greater number of juvenile coho per channel length (Roni and Quinn 2001). LWD provides important refuge sites to avoid higher water velocities and provides cover from predators (Lestelle 2006, Peters 1996). As such, the increase in LWD may improve the viability of the Upper Klamath coho salmon population by increasing their abundance, productivity, and survival. Improving viability will help conserve coho salmon during the interim period prior to dam removal as specified in the KHSA or other long-term enhancement measures for LWD addressed under a new FERC license and issuance of a 401 certification.

Tributary Habitat Enhancement

Substantial additional benefits for coho salmon will be provided by HCP habitat enhancement measures in tributaries to the upper Klamath River, and in the Shasta River and Scott River and their tributaries. Rearing of juvenile coho in the Klamath River system relies extensively on tributary streams (with a gradient of 3 percent or less, although they may move up to streams of 4 percent or 5 percent gradient) (NMFS 2010). Also, spawning of wild coho salmon principally occurs in tributaries to the mainstem Klamath River, but also occurs to a more limited extent in some areas of the mainstem river under certain conditions (Hillemeier et al. 2009). Returning adult coho salmon use tributary streams for spawning from November through January (NMFS 2010).

Actions implemented under objective ***J-Connectivity*** and objective ***K-Tributary Rearing Habitat Enhancement*** of the Coho Salmon Conservation Strategy will enhance flow and habitat conditions in important habitat for coho salmon in tributaries of the Klamath River. These actions will provide additional conservation values thus improving the suitability of habitat for coho salmon in the Klamath River mainstem corridor downstream of Iron Gate dam. Although the habitat conditions in these tributaries are not affected by the Project, the current degraded conditions of these tributary habitats can act to limit their use by coho salmon and require more use of the mainstem Klamath River by coho salmon than would otherwise occur if these tributaries met their habitat needs (Chesney and Yokel 2003).

Creating sufficient high quality tributary rearing habitat will help improve juvenile growth and survival and help bolster the viability of the Klamath River coho salmon. Improvements such as protecting and enhancing existing rearing habitat, improving water quality and flow, and providing connectivity within and to rearing habitat will increase the opportunity and capacity of key tributaries for juvenile rearing. As such, tributary enhancement actions represent a critical component of conservation and recovery of Klamath River coho salmon, and provide important additional conservation benefits during the interim period.

Fish Disease Research and Studies

Disease is a factor affecting the survival and fitness of coho salmon in the Klamath River basin. Research and studies conducted under objective ***F-Disease*** of the Coho Salmon Conservation Strategy will identify actions that would reduce the incidence of fish disease in Klamath River coho salmon. The Klamath River Fish Disease Research Fund provides the mechanism for funding the research and studies to inform management actions in the river to reduce the incidence of fish disease. These actions would be expected to improve the survival of coho salmon (as well as other susceptible salmonids) in the Klamath River.

Actions under objective ***F-Disease*** of the Coho Conservation Strategy address the critical need for more information on the causes and control of fish disease in the Klamath River system, primarily resulting from the myxozoan parasites *C. shasta* and *P. minibicornis*. As described in Chapter V, the infection rate in coho salmon is high, yet the overall level of potential impact caused by Project-related effects is uncertain. Furthermore, the relationships and conditions responsible for the incidence of disease are poorly understood. Klamath River Fish Disease Research Fund actions will address this uncertainty by funding research and studies that will inform and improve management actions to reduce the effects of disease.

PacifiCorp has already initiated the fund and solicitation of research proposals. Research projects are now underway that are investigating management actions to reduce the abundance of the intermediate polychaete host (*M. speciosa*) for disease pathogens *C. shasta* and *P. minibicornis* in the Klamath River through sediment scour and/or flow manipulations. Gaining a better understanding of factors that influence severity of the disease and the host species will inform resource management decisions, including future coho salmon recovery plan efforts in the Klamath River that will endure through and beyond the term of this HCP.

Hatchery Production Improvements

Implementation of the HGMP under objective ***B-Hatchery Production*** of the HCP will result in biologically based hatchery management strategies and practices that ensure the conservation and recovery of coho salmon, as well as other salmon species and steelhead. Through implementation of the HGMP, the Iron Gate Hatchery will be operated to conserve coho salmon during the interim period. Although Iron Gate Hatchery is operated as a mitigation hatchery to compensate for habitat blocked between Iron Gate dam and the Copco developments, the conservation focus for coho salmon under the HGMP program will help to protect the remaining genetic resources of the Upper Klamath River coho population.

The HGMP program will operate in support of the Klamath River basin's coho salmon recovery efforts by conserving a full range of the existing genetic, phenotypic, behavioral and ecological diversity of the run. The program's conservation measures, including genetic analysis, broodstock management, and rearing and release techniques, will maximize fitness and reduce straying of hatchery fish to natural spawning areas. Active broodstock management, based on real-time genetic analysis, will reduce the rate of inbreeding that has occurred in the hatchery population over time. Additionally, the increase proportion of natural-origin fish in the total hatchery spawning population will increase population diversity and fitness. Hatchery culture practices under the HGMP program will increase egg-to-smolt survival rates by increasing survival during egg incubation and covering raceways with netting to reduce bird predation.

Hatchery management under the HGMP, in combination with other conservation actions under this HCP and other ongoing initiatives, will contribute to improving the viability of the affected coho populations by increasing their abundance, productivity, diversity, and spatial structure. Improving viability is important because the natural population is currently experiencing low returns, little or no productivity, limited spatial structure, and limited life history and genetic diversity. Improving viability will help conserve coho salmon during the interim period covered by this HCP prior to reestablishment of fish passage through the Project area by removal of the dams as anticipated under the KHSA or through a new FERC license.

VII. Compliance with Authorized Level of Take

PacifiCorp seeks coverage for potential incidental take of Covered Species that may occur as a result of continued operations of its hydroelectric facilities during the Permit Term. The extent of potential take, if any, associated with these Covered Activities cannot be quantified because of the uncertainty regarding how many fish might be exposed to Project effects and how indirect effects might translate into take. Because of this uncertainty, the extent of potential take was qualitatively described in Chapter V (*Effects of Covered Activities on Covered Species*). NMFS (2007a) similarly concluded that translating these water quality and habitat effects into definitive numbers of fish taken cannot be done due to the current uncertainty regarding coho salmon population numbers and distribution patterns within the Klamath River below Iron Gate dam. As an alternative, NMFS identified water temperature and DO as habitat-based surrogates for potential take of coho salmon from Project operations below Iron Gate dam in its 2007 BiOp (NMFS 2007a). Consistent with this extent-of-take approach, PacifiCorp will monitor both water temperatures and DO to demonstrate that authorized levels of take are not exceeded.

As described in Chapter V, PacifiCorp facilities (dams and reservoirs) and operations potentially influence water quality downstream of Iron Gate dam by creating a temperature lag and influencing local DO concentrations below the dam. Water temperature and DO serve as reasonable surrogates because they represent important water quality components that individually, or in combination with other water quality parameters, have the potential to influence the quality of coho salmon habitat. Monitoring of these parameters will provide an indication of the overall quality of habitat and a mechanism for demonstrating compliance with the authorized level of take. As described further below, significant negative changes in these two parameters during the Permit Term may indicate an increase in the potential for take that may require a response by PacifiCorp. Ultimately, NMFS will be responsible for determining whether PacifiCorp is in compliance with its authorized level of take, as informed by interactions with PacifiCorp and the collection of monitoring data related to habitat-based surrogates, as described below.

Monitoring of Habitat-Based Surrogates

In consultation with NMFS, PacifiCorp has developed an approach to the monitoring of water temperature and DO as habitat-based surrogates as summarized in Table 5 and described below. NMFS and PacifiCorp will annually review the data obtained from the surrogates monitoring, taking into account the surrogate indicators described in the fourth column of the table. In the event these monitoring data show excursions outside the limits defined in Table 5, NMFS and PacifiCorp will confer to determine if the monitoring data, taken as a whole, indicate that incidental take may potentially occur, and adjust the conservation strategy as needed to remain in compliance with the ITP.

TABLE 5
Monitoring Activities used to Evaluate Effects on Surrogate Indicators

Monitoring Measures	Watershed Processes	Habitat Elements	Surrogate Indicators of Habitat Impairment
Temperature Monitoring	Stream Temperature Below Iron Gate Dam	Water Quality	Increases in mean weekly minimum water temperatures (MWMT) below Iron Gate dam of more than 4ºC. This potential increase would be determined from the difference in MWMT as measured at a location in the lower Klamath River as agreed by NMFS and PacifiCorp. This potential increase would be determined when coho salmon are present and when the MWMT is above 16.5ºC [26], and which is directly attributable to Project operations.
Dissolved Oxygen Monitoring	Dissolved Oxygen Levels Below Iron Gate Dam	Water Quality	Decreases in DO concentrations that fall below 85 percent saturation[27] immediately below Iron Gate dam for longer than 7 consecutive days during June 15 to September 30. This potential decrease would be determined when over-summer rearing of juvenile coho salmon is occurring in areas of the Klamath River affected by the Project, and which are directly attributable to Project operations.

Water Temperature

The surrogate for indicating whether the authorized level of incidental take is exceeded will be increases in mean weekly minimum water temperatures (MWMT) below Iron Gate dam of more than 4ºC. During late July, when the effect is likely greatest, modeling suggests that mean daily minimum temperatures below Iron Gate Dam can be up to 4ºC higher as a result of the Project. Therefore, if the MWMT is elevated by a margin greater than 4ºC as a result of the Project and its operations, then authorized incidental take may be exceeded. This potential increase would be determined from the difference in MWMT as measured at a location in the lower Klamath River as agreed by NMFS and PacifiCorp outside the influence of the Project (e.g., Orleans). This potential increase would be determined when coho salmon are present and when the MWMT is above 16.5ºC, and which is directly attributable to Project operations. An MWMT of 16.5ºC is the level at which water temperature is considered fully protective for coho salmon in the Klamath River (NCRWQCB 2010b).

The procedures for the monitoring of the water temperature surrogate would include:

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26 A temperature of 16.5 degrees C is the level at which water temperature is considered fully protective for coho salmon in the Klamath River (NCRWCB 2010b).

27 The 85% saturation value is consistent with the site-specific dissolved oxygen objective for the Klamath River for the April 1-September 30 timeframe (NCRWCB 2010c).

1. Continuous monitoring of water temperature below Iron Gate dam (at the station upstream of hatchery bridge) and at the selected down-river site (e.g., Orleans at the USGS gage)
2. Assessment of data relative to the surrogate level
3. If and when monitoring data indicates the surrogate is not being met, then PacifiCorp, in consultation with NMFS, will:
    - Assess whether and how coho may be affected based on literature review of known coho sensitivities to water temperature, and assess the potential extent and duration of habitat effects
    - Assess whether and how exceedances of the surrogate may be related to Project operations (based on coincident reservoir and powerhouse operations information; modeling information)
    - Confer on changes to priorities of HCP actions, including additional funding for actions, if needed (note: Project-related operations or technical adjustments to modify downstream water temperature below Iron Gate dam will not be possible during the interim period)
4. Development of an annual report of monitoring results during this time period, including discussion of each step above as applicable.

Dissolved Oxygen

The surrogate for indicating whether the authorized level of incidental take is exceeded will be decreases in DO concentrations that fall below 85 percent saturation below Iron Gate dam for longer than 7 consecutive days during the period from June 15 to September 30 when over-summer rearing juvenile coho salmon are present. The 85 percent saturation value is consistent with the site-specific DO objective for the Klamath River during the period from June 15 to September 30 (NCRWQCB 2010c), which is assumed to be fully protective of coldwater biota, including coho salmon.

Turbine venting at Iron Gate Dam is being implemented, tested, and refined with the intention of maintaining DO levels of at least 85 percent, focusing on the summer and early fall period from June 15 to September 30 when DO levels below Iron Gate dam can be stressful to juvenile coho salmon. If DO concentrations fall below 85 percent saturation as a result of the Project and its operations, then authorized incidental take may be exceeded. This potential decrease in DO saturation would be determined when coho salmon are present, and which is directly attributable to Project operations.

The procedures for the monitoring of the DO surrogate would include:

1. Continuous monitoring of DO (in percent saturation) below Iron Gate dam (at the station upstream of hatchery bridge) recorded in 30 minute intervals
2. Assessment of data relative to the surrogate level

3. If and when monitoring data indicate the surrogate is not being met, then PacifiCorp, in consultation with NMFS, will:
   - Conduct additional monitoring along the river and at known or representative juvenile coho rearing locations for several miles downriver (e.g., refugial areas near tributary mouths) to assess extent of potential effects
   - Estimate potential effects to coho based on literature review of known coho sensitivities to DO, and likely distribution of coho in the river at the time
   - Assess whether and how exceedances of the surrogate may be related to Project operations (based on coincident reservoir and powerhouse operations information; modeling information)
   - Determine potential operations/technical adjustments needed (e.g., changes to venting/blower settings; reservoir drawdown, spill patterns)
   - If operations/technical adjustments are not possible to further improve DO below Iron Gate dam, confer on changes to priorities of HCP actions, including additional funding for actions, if needed.
4. Development of an annual report of monitoring results during this time period, including discussion of each step above as applicable

VIII. Monitoring and Adaptive Management

This chapter describes the monitoring and adaptive management program for the HCP. The purpose of the monitoring and adaptive management program is to ensure compliance with the HCP, and to evaluate the effects of actions implemented under the Coho Salmon Conservation Strategy (as described in Chapter VI), such that the conservation strategy, including the biological goals and objectives of the HCP, are achieved.

The NMFS and USFWS Five-Point Policy (65 FR) describes adaptive management as an integrated method for addressing uncertainty in natural resource management and states that management must be linked to measurable biological goals and monitoring. To that end, the monitoring and adaptive management program tiers from the goals, objectives, and targets as described for the Coho Salmon Conservation Strategy (Chapter VI).

A description of the monitoring and adaptive management program for the HCP is provided in the following sections.

Compliance Monitoring

Compliance monitoring will verify that the terms of the HCP, ITP, and Implementation Agreement are being carried out. Compliance monitoring will track implementation, and document completion, of the measures in the conservation strategy. Compliance monitoring elements are summarized in Table 6 for each of the goals, objectives, and targets under the Coho Salmon Conservation Strategy (as described in Chapter VI).

For actions related to habitat enhancements implemented under the Coho Enhancement Fund, compliance monitoring will utilize information supplied to PacifiCorp by NFWF. This will include compliance monitoring elements as summarized in Table 6 for targets A1 and A2 for objective ***A-Fish Passage***, target C1 for objective ***C-Gravel Augmentation***, targets G1 and G2 for objective ***G-Refugia***, target H1 for objective ***H-Mainstem Rearing Habitat Enhancement***, targets J1 and J2 for objective ***J-Connectivity***, and targets K1 and K2 for objective ***K-Tributary Rearing Habitat Enhancement***.

Projects selected for implementation under the Coho Enhancement Fund will be directed to incorporate compliance monitoring as a part of the project design and implementation. The information obtained from compliance monitoring (related to the elements listed in Table 6) will be obtained by NFWF who will produce an annual report to PacifiCorp that summarizes project implementation and compliance. In addition to the compliance monitoring elements summarized in Table 6, the report will summarize: (a) the total number and status of projects authorized under the fund; (b) progress made implementing authorized projects over the previous calendar year; (c) whether projects were completed on schedule and within budget, and any approved variances to the schedule and budget; (d) whether completed projects were built in accordance with original project design and objectives, or how the modified project meets or exceeds original objectives; and (e) the overall financial status of the fund.

For HCP actions related to flow measures, compliance monitoring will utilize information available to PacifiCorp from Reclamation. This will include compliance monitoring elements as summarized in Table 6 for targets D1, D2, and D3 for objective ***D-Flow***, according to monitoring requirements described in the NMFS (2010) BiOp on Reclamation's Klamath Project Operations.

For HCP actions related to fish disease research and studies implemented under the Fish Disease Research Fund, compliance monitoring will utilize information supplied to PacifiCorp by the Fish Health Workgroup and other associated researchers. This will include compliance monitoring elements as summarized in Table 6 for targets F1, F2, and F3 for objective ***F-Disease***.

For HCP actions related to water quality and LWD, compliance monitoring will utilize information obtained by PacifiCorp from water quality monitoring by PacifiCorp and maintenance evaluation of LWD accrual and transport from PacifiCorp maintenance activities. This will include compliance monitoring elements as summarized in Table 6 for target E1 for objective ***E-Water Quality*** and target I1 for objective ***I-LWD***.

PacifiCorp will compile the information and results of the compliance monitoring as described above into an annual report to NMFS. The annual report will describe the results of both compliance monitoring (as above) and effectiveness monitoring (as described in the next section below). These annual reports will contain summaries of all significant HCP-related activities and associated data and information. Report components also will include status of the planning and implementation of measures, expenditures, and any plans or actions related to changed circumstances and/or adaptive management.

TABLE 6
Summary of Compliance and Effectiveness Monitoring for the Coho Salmon Conservation Strategy

Objective	Target	Compliance Monitoring	Effectiveness Monitoring
A. Fish Passage	A1. Maintain and improve access to existing habitat in approximately 60 miles of Upper Klamath tributary habitat between April and November of each year.	Document access-related projects authorized under the Coho Enhancement Fund Document completion of access-related projects, and whether projects were completed in accordance with project objectives	Estimate miles of suitable coho salmon habitat made or kept accessible from completed projects Document and monitor access at or above completed projects using habitat measurements (e.g., depths, velocities, gradients) or, if available, observations of habitat access and use by coho salmon
A. Fish Passage	A2. Remove existing fish passage barriers to create permanent access to at least 1 mile of additional spawning and rearing habitat in the Upper Klamath tributaries.	Document barrier-related projects authorized under the Coho Enhancement Fund Document completion of barrier-related projects, and whether projects were completed in accordance with project objectives	Estimate miles of suitable coho habitat made accessible above barrier-removal projects Document and monitor passage effectiveness at completed projects using habitat measurements (e.g., depths, velocities, gradients) or, if available, observations of passage by coho salmon
B. Hatchery Production	B1. Release at least 75,000 coho smolts each year from Iron Gate Hatchery under an approved Hatchery and Genetic Management Plan.	Comply with the terms of the Section 10(a)(1)(A) Permit.	Comply with the terms of the Section 10(a)(1)(A) Permit.
C. Gravel Augmentation	C1. Provide 500 cubic yards of gravel augmentation either annually or 3,500 cubic yards over the term of the ITP downstream from Iron Gate dam.	Document gravel augmentation projects authorized under the Coho Enhancement Fund Document completion of gravel augmentation projects, and whether projects were completed in accordance with project objectives	Document cubic yards of gravel augmented Document particle size distributions of augmented gravels and relation to known suitability ranges for coho salmon spawning

TABLE 6
Summary of Compliance and Effectiveness Monitoring for the Coho Salmon Conservation Strategy

Objective	Target	Compliance Monitoring	Effectiveness Monitoring
D. Flow	D1. Provide the instream flow releases consistent with requirements contained in the NMFS (2010) BiOp on Reclamation's Klamath Project Operations.	Provide an annual monitoring report to confirm that instream flow releases from Iron Gate dam are adhering to the requirements of the NMFS (2010) BiOp This report will be submitted by Reclamation to NMFS by February 1 of each year, covering the prior October through September time period	Quantify and describe Klamath Project Operations during the year, including average daily and monthly flows at Iron Gate dam, and monthly minimum and maximum daily flows. Provide a review of Klamath Basin water balancing, including inflow and outflow data for key components of the system (e.g., Upper Klamath Lake, Link River, Keno, Iron Gate dam) The above information will be submitted by Reclamation to NMFS by February 1 of each year, covering the prior October through September time period
D. Flow	D2. Implement obligations under the Fall and Winter Flow Variability Program contained in the NMFS (2010) BiOp, which provides for up to 18,600 acre feet of water to be available to simulate natural flow variability at Iron Gate dam.	Provide an annual monitoring report to confirm that fall/winter variable flow releases from Iron Gate dam are adhering to the requirements of the NMFS (2010) BiOp (Reclamation to provide this annual report as described above) Document PacifiCorp's responsibilities for implementation of the fall/winter flow variability program	Estimate volume of water in acre-feet made available for the fall/winter flow variability program Describe benefits to coho salmon and their habitat downstream based on each year's fall/winter flow regime
D. Flow	D3. Conduct maintenance actions at Iron Gate powerhouse in a manner that adheres to the ramp rates prescribed in the NMFS (2010) BiOp to reduce potential fish stranding.	Provide an annual monitoring report to confirm that ramp rates of releases from Iron Gate dam are adhering to the requirements of the NMFS (2010) BiOp (Reclamation to provide this annual report as described above) Document PacifiCorp's maintenance actions and role in ensuring adherence to ramp rates	Document flow ramp rates per 24-hour period. Also document flow ramp rates per 4-hour period when flows exceed 1750 cfs, and 2-hour period when flows are less than or equal to 1750 cfs Describe benefits to coho salmon and their habitat downstream based on each year's ramp rates results

TABLE 6
Summary of Compliance and Effectiveness Monitoring for the Coho Salmon Conservation Strategy

Objective	Target	Compliance Monitoring	Effectiveness Monitoring
E. Water Quality	E1. Maintain DO concentrations at or above 85 percent saturation in the Klamath River from the dam to the Iron Gate Hatchery bridge during the period from June 15 to September 30.	Provide an annual monitoring report that documents turbine venting activities, including dates of turbine venting activities during the year.	Monitor mean daily DO, water temperature, and air pressure Calculate on a monthly basis the minimum daily percent DO saturation Describe effects of turbine venting activities on DO conditions and coho salmon habitat downstream of Iron Gate dam
F. Disease	F1. Improve understanding of disease mechanisms to be better able to reduce effects from disease within the term of the ITP.	Document studies and projects authorized under the Disease Research Fund Document completion of studies and projects, and whether completed in accordance with objectives	Document the results of funded studies and projects, and how they improve understanding of disease mechanisms and effects Describe results of existing disease monitoring efforts (e.g., USFWS Fish Health Center) in relation to funded studies and projects, if applicable Document changes in objectives or priorities, if any, for selection of studies and projects authorized under the Disease Research Fund
F. Disease	F2. Implement measures under Objective C: Gravel Augmentation to improve scour of disease host habitat through the strategic placement of coarse sediment annually in the mainstem Klamath River.	Document gravel augmentation projects authorized under the Coho Enhancement Fund Document completion of gravel augmentation projects, and whether projects were completed in accordance with project objectives	Document cubic yards of gravel augmented Describe the effects of gravel augmentation on improving scour of disease host habitat at selected sites Describe results of existing disease monitoring efforts (e.g., USFWS Fish Health Center) in relation to gravel scour, if applicable Document changes in objectives or priorities, if any, for use of gravel augmentation to enhance scour of disease host habitat

TABLE 6
Summary of Compliance and Effectiveness Monitoring for the Coho Salmon Conservation Strategy

Objective	Target	Compliance Monitoring	Effectiveness Monitoring
F. Disease	F3. Implement measures under Objective D: Flow by facilitating the implementation of fall/winter flow variability.	Provide an annual monitoring report to confirm that fall/winter variable flow releases from Iron Gate dam are adhering to the requirements of the NMFS (2010) BiOp (Reclamation to provide this annual report as described above) Document PacifiCorp's responsibilities for implementation of the fall/winter flow variability program	Estimate volume of water in acre-feet made available for the fall/winter flow variability program Describe the effects of the fall/winter flow variability program on improving scour of disease host habitat at selected sites Describe results of existing disease monitoring efforts (e.g., USFWS Fish Health Center) in relation to flow variability, if applicable Document adjustments, if any, in the fall/winter flow variability program to enhance scouring effects on disease host habitat
G. Refugia	G1. Improve habitat cover and complexity (to about 30 to 50 percent of the total existing cover) or maintain habitat cover and complexity (if already suitable) at 28 coldwater refugia sites along the mainstem Klamath River.	Document projects to improve or maintain refugia cover authorized under the Coho Enhancement Fund Document completion of such refugia projects, and whether projects were completed in accordance with project objectives	Document the number and location of projects undertaken to improve or maintain refugia cover Document increases in cover and complexity of refugia habitat based on pre- and post-treatment habitat surveys of project sites Describe results of existing monitoring of juvenile coho salmon use of these enhanced habitats, if applicable to project sites (e.g., monitoring of juvenile coho salmon movement in the Klamath River by the Yurok Tribal Fisheries Program and Karuk Tribal Fisheries Program using passive integrated transponder (PIT) tags)

TABLE 6
Summary of Compliance and Effectiveness Monitoring for the Coho Salmon Conservation Strategy

Objective	Target	Compliance Monitoring	Effectiveness Monitoring
G. Refugia	G2. Increase the extent and/or duration (by about 30 to 50 percent of the total existing extent and/or duration) of 9 coldwater refugia sites along the mainstem Klamath River.	Document projects to increase the extent of refugia (in area or time) authorized under the Coho Enhancement Fund Document completion of such refugia projects, and whether projects were completed in accordance with project objectives	Document the number and location of projects undertaken to increase the extent of refugia (in area or time) Document increases in extent of refugia habitat based on pre- and post-treatment habitat surveys of project sites Describe results of existing monitoring of juvenile coho use of these enhanced habitats, if applicable to project sites (e.g., PIT tag monitoring of habitat use by juvenile coho salmon as described above)
H. Mainstem Rearing Habitat Enhancement	H1. Enhance rearing habitat in two key rearing sites of the mainstem Klamath River corridor.	Document projects to enhance mainstem rearing habitat authorized under the Coho Enhancement Fund Document completion of such mainstem rearing habitat projects, and whether projects were completed in accordance with project objectives	Document the number and location of projects undertaken to enhance mainstem rearing habitat Document enhancements in habitat conditions based on pre- and post-treatment habitat surveys of project sites Describe results of existing monitoring of juvenile coho salmon use of these enhanced habitats, if applicable to project sites (e.g., PIT tag monitoring of habitat use by juvenile coho salmon as described above)

TABLE 6
Summary of Compliance and Effectiveness Monitoring for the Coho Salmon Conservation Strategy

Objective	Target	Compliance Monitoring	Effectiveness Monitoring
I. Large Woody Debris (LWD)	I1. Ensure that available LWD pieces (greater than 16 inches in diameter and 15 feet in length) trapped at Project dams are released downstream.	Document number of pieces of LWD trapped and transported downstream Document locations where transported LWD were reintroduced to the river downstream	Document locations where transported LWD was reintroduced to the river downstream Document approximate range-of-sizes of LWD pieces Describe the likely effects of increased LWD recruitment from released pieces on enhancing coho salmon habitat and habitat-forming processes Describe results of existing monitoring of juvenile coho salmon use of habitats containing LWD, if present at monitored sites (e.g., PIT tag monitoring of habitat use by juvenile coho salmon as described above)
J. Connectivity	J1. Restore connectivity in 10 stream reaches of juvenile rearing habitat in tributaries of the Upper Klamath, Scott River, and Shasta River.	Document projects involving protection and restoration of connectivity authorized under the Coho Enhancement Fund Document completion of such connectivity projects, and whether projects were completed in accordance with project objectives	Document locations of reaches affected by implemented projects Estimate miles of suitable coho salmon habitat made or kept accessible from completed projects Document protection and restoration of connectivity based on pre- and post-treatment habitat surveys of project sites Monitor ability of coho salmon to access and move within reaches using habitat observations or measurements (e.g., depths, velocities, gradients) or, if available, observations of habitat access and use by coho salmon

TABLE 6
Summary of Compliance and Effectiveness Monitoring for the Coho Salmon Conservation Strategy

Objective	Target	Compliance Monitoring	Effectiveness Monitoring
J. Connectivity	J2. Fund a water transaction program to provide flow augmentation in key reaches used for coho salmon spawning and juvenile rearing in tributaries of the Upper Klamath, Scott River, and Shasta River.	Document funds authorized under the Coho Enhancement Fund for actions under the Emergency Water Transaction Program	Document number, location, and timing of water transactions completed Estimate total amounts of water allocated for instream purposes from these transactions Estimate reaches or total miles of suitable coho salmon habitat that are benefitted by the water provided
K. Tributary Rearing Habitat Enhancement	K1. Enhance rearing habitat in five key rearing tributaries of the Upper Klamath, Scott River, and Shasta River.	Document projects to enhance rearing habitat in key tributaries authorized under the Coho Enhancement Fund Document completion of such tributary rearing habitat projects, and whether projects were completed in accordance with project objectives	Document the number and location of projects undertaken to enhance rearing habitat in key tributaries Document enhancements in habitat conditions based on pre- and post-treatment habitat surveys of project sites Describe results of existing monitoring of juvenile coho salmon use of these enhanced habitats, if applicable to project sites (e.g., PIT tag monitoring of habitat use by juvenile coho salmon as described above)
K. Tributary Rearing Habitat Enhancement	K2. Protect important summer rearing habitat in a total of 10 miles along tributaries of the Upper Klamath, Scott River, and Shasta River.	Document projects to protect critical summer rearing habitat authorized under the Coho Enhancement Fund Document completion of such summer rearing habitat projects, and whether projects were completed in accordance with project objectives	Document the number and location of projects undertaken to protect critical summer rearing habitat Document enhancements in habitat conditions based on pre- and post-treatment habitat surveys of project sites Describe results of existing monitoring of juvenile coho salmon use of these enhanced habitats, if applicable to project sites (e.g., PIT tag monitoring of habitat use by juvenile coho salmon as described above)

Effectiveness Monitoring

Effectiveness monitoring will evaluate the effects of the permitted HCP actions, and will determine whether HCP actions as implemented are providing benefits to habitat and other conditions for coho salmon as assumed when the HCP was developed and approved. Effectiveness monitoring primarily will evaluate the implemented measures of the conservation strategy and progress toward their intended goals and objectives. Various types of information will be used to evaluate the effectiveness of HCP actions. These include biological and physical data developed through implementation of conservation measures as well as information from other, ongoing research and monitoring. Effectiveness monitoring elements are summarized in Table 6.

For actions related to habitat enhancements implemented under the Coho Enhancement Fund, effectiveness monitoring will utilize information supplied to PacifiCorp by NFWF. This will include effectiveness monitoring elements as summarized in Table 6 for targets A1 and A2 for objective ***A-Fish Passage***, target C1 for objective ***C-Gravel Augmentation***, targets G1 and G2 for objective ***G-Refugia***, target H1 for objective ***H-Mainstem Rearing Habitat Enhancement***, targets J1 and J2 for objective ***J-Connectivity***, and targets K1 and K2 for objective ***K-Tributary Rearing Habitat Enhancement***.

Where applicable to project sites, effectiveness monitoring will utilize available monitoring data of actual coho salmon presence, abundance, and habitat use. For example, such available monitoring data may include observations on juvenile coho salmon movement in the Klamath River from the Yurok Tribal Fisheries Program and Karuk Tribal Fisheries Program using passive integrated transponder (PIT) tags.

Projects selected for implementation under the Coho Enhancement Fund will incorporate effectiveness monitoring as a part of the project implementation and evaluation. The information obtained from effectiveness monitoring (related to the elements listed in Table 6) will be obtained by NFWF who will produce an annual report to PacifiCorp that summarizes project implementation and performance. In addition to the compliance monitoring elements summarized in Table 6, the report will describe whether completed projects were built in accordance with original project design and objectives, or how the modified project meets or exceeds original objectives.

For HCP actions related to flow measures, effectiveness monitoring will utilize information available to PacifiCorp from Reclamation. This will include effectiveness monitoring elements as summarized in Table 6 for targets D1, D2, and D3 for objective ***D-Flow***, according to monitoring requirements described in the NMFS (2010) BiOp on Reclamation's Klamath Project Operations.

For HCP actions related to fish disease research and studies implemented under the Fish Disease Research Fund, effectiveness monitoring will utilize information supplied to PacifiCorp by the Fish Health Workgroup and other associated researchers. This will include effectiveness monitoring elements as summarized in Table 6 for targets F1, F2, and F3 for objective ***F-Disease***.

For HCP actions related to water quality and LWD, effectiveness monitoring will utilize information obtained by PacifiCorp from water quality monitoring by PacifiCorp and maintenance evaluation of LWD accrual and transport from PacifiCorp maintenance activities. This will include effectiveness monitoring elements as summarized in Table 6 for target E1 for objective ***E-Water Quality*** and target I1 for objective ***I-LWD***.

PacifiCorp will compile the information and results of effectiveness monitoring as described above into an annual report to NMFS (as described above).

Adaptive Management

The adaptive management program includes two components: (1) convening of the Technical Review Team; and (2) an adaptive responses process.

Technical Review Team

PacifiCorp, with NMFS, will convene meetings of the Technical Review Team[28] annually or as often as the Team determines necessary. The Technical Review Team will assist in reviewing progress and priorities for specific projects and actions. Although adaptive management will be discussed at these meetings and adaptive management recommendations might be made, final adaptive management decisions will be made between PacifiCorp and NMFS.

The results of compliance and effectiveness monitoring (as compiled in the annual reports) will be provided to the Technical Review Team for review and discussion. Based upon feedback obtained from the Technical Review Team, measures may be modified or discontinued with the agreement of CDFG, NMFS, and PacifiCorp.

In its review, the Technical Review Team will evaluate the habitat enhancement program at two levels. First, it will examine the effectiveness of individual projects to evaluate their performance relative to expectations and to recommend project-specific adjustments as needed. Second, the team will annually review the habitat enhancement program as a whole to determine whether goals and objectives are being met. If sufficient projects are not available to meet specific goals and objectives (e.g., failure to find willing landowners or project proponents), the team will consider other projects that provide benefits to coho salmon and recommend adjustments in the program as necessary. The team may also make recommendations to adjust the program if other projects or actions that provide greater benefits to coho salmon are identified over the Permit Term as long as the projects adhere to the biological goals and objectives identified in this HCP. All adjustments must remain within the funding limits of the Coho Enhancement Fund and associated matching NFWF contributions.

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[28] As described in Chapter VI, PacifiCorp has established the Coho Enhancement Fund to be administered in consultation with a Technical Review Team consisting of PacifiCorp, CDFG, NMFS, and affected Tribes.

Adaptive Responses Process

Circumstances Triggering Adaptive Responses

Adaptive management responses will occur in the following circumstances during the Permit Term:

1. A particular objective cannot be implemented as planned

2. Effectiveness monitoring indicates that an objective is not effective

If appropriate, given new information, PacifiCorp and NMFS, with the input of the Technical Review Team, may also reconsider specific project and actions that have not yet been identified or implemented. In those cases, the merits and feasibility of substituting newly identified projects or actions could be discussed. The necessary adaptive response in these situations will be discussed by PacifiCorp and NMFS on a case-by-case basis.

Guidelines for Types of Adaptive Responses

If implementation of a different or substitute project/action is necessary, PacifiCorp and NMFS will use guidelines to aid prioritization and implementation. For example, revisions or replacement of projects or actions would be done in a manner that adheres to original objectives that emphasize similar actions at similar locations, or that achieves the same or equivalent habitat benefit for the same coho salmon populations.

Adaptive Response Decision-Making

An important element of the annual Technical Review Team meeting (as described above) will be to discuss and consider possible adaptive management responses (for final adaptive management decisions made between PacifiCorp and NMFS). For the purposes of identifying and recommending possible adaptive management responses, the meeting participants will discuss:

- Updated information on status and trends of Klamath basin coho salmon populations
- Updated information on environmental factors (e.g., specific habitat conditions, disease, water quality) affecting coho salmon populations
- Compliance record to date for implementing HCP measures
- Effectiveness of HCP measures implemented to date
- New opportunities available to improve habitat in accordance with the Coho Salmon Conservations Strategy
- New or additional opportunities for partnership efforts (e.g., to use PacifiCorp funds to leverage additional resources from other sources)
- Verification or revision of priorities of projects under the Coho Enhancement Find
- Need (if any) for adaptive management to meet HCP obligations.

PacifiCorp and NMFS will confer with the Technical Review Team on the science underlying the conservation measures. The focus will be on whether or not the preponderance of the available scientific literature indicates that the original assumptions (or working hypotheses) for the conservation measures have changed enough to warrant an adaptive response.

Following the meetings with the Technical Review Team, PacifiCorp and NMFS will define the adaptive management actions necessary (if any) to maintain compliance with the HCP. PacifiCorp and NMFS will decide whether new measures should be selected and implemented, and if so to determine the specific measures. Final decisions will be made by PacifiCorp and NMFS based on what is required to maintain compliance with the HCP.

Costs for Implementing Adaptive Management Actions

Costs for implementing the adaptive response, when the original measure was not implemented, or is to be revised or replaced, will be paid with the funding allocated for the original measure.

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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 that can reasonably be anticipated by plan developers and NMFS 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 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 that could not reasonably have been anticipated by plan developers and NMFS 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 is assumed to have a negative impact on salmonids throughout the Pacific Northwest due to large reductions in available freshwater habitat (Battin et al. 2007). Bartholow (2005) found that the Klamath River is increasing in water temperature by 0.5°C/decade, which may be related to warming trends in the region. Changes in the timing of peak spring discharge, and decreases in water quantity in the spring and summer may affect salmonids of the Klamath River. In their natural state, anadromous salmonids become adapted to the specific conditions of their natal river like water temperature and hydrologic regime (Taylor 1991, NRC 2004). Therefore, NMFS (2010) concludes that the extent and speed of changes in water temperatures and hydrologic regimes of the Klamath River and associated tributaries will determine whether or not coho salmon of the Klamath River are capable of adapting to changing river conditions.

NMFS (2010) concludes that climate change is expected to negatively impact one or more of the VSP criteria for the Klamath River coho population units. Climate change can reduce the spatial structure by shrinking the amount of freshwater habitat available to coho salmon. Diversity could also be impacted if one specific life history strategy is disproportionately affected by climate change. Population abundance can also be reduced if fewer juveniles survive to adulthood. NMFS (2010) also concludes that climate change affects critical habitat by decreasing water quantity and quality, and limiting the amount of space available for summer juvenile rearing.

Climate change has the potential to influence the status of coho salmon over the long term. However, climate change will not likely produce a discernable 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 coho salmon can be reasonably anticipated during the Permit Term. These events could influence coho salmon in the following ways:

- Severe drought and a reduction in flow have the potential to adversely influence the availability and quality of habitat for coho salmon. Reduced flows could contribute to the deterioration of water quality and incidence of fish disease in the Klamath River downstream of Iron Gate dam. Severe droughts could also reduce or eliminate access to spawning and rearing areas due to dewatered tributary stream reaches.
- Significant flood events, although likely providing habitat benefits for the coho salmon, may damage or destroy certain habitat enhancement projects implemented under the Coho Enhancement Fund.
- Significant disease outbreaks, which may or may not be associated with drought, also could substantially affect one or more year classes of coho salmon.
- 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 Section 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. 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.

Measures for Changed Circumstances

The HCP was developed in consideration of environmental conditions in the Klamath River that are reasonably certain to occur over the term of the ITP. For example, habitat conservation projects to be implemented under the Coho Enhancement Fund will meet specific biological criteria to address factors limiting recovery of these species. Projects will be selected, implemented, and monitored in consultation with the Technical Review Team to ensure such projects achieve identified goals and objectives.

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. Coho salmon disease incidence above 90% in the mainstem Klamath River.

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, NMFS may, in consultation with CDFG and PacifiCorp, adjust habitat enhancement priorities under the Coho Enhancement Fund to address these changed circumstances;
2. If a disease outbreak occurs rising to the level of a changed circumstance, NMFS may, in consultation with PacifiCorp, adjust priorities under the Fish Disease Research Fund and Coho Enhancement Fund to address changed circumstance; and
3. If a drought occurs rising to the level of a changed circumstance, PacifiCorp will meet with Reclamation and NMFS to discuss changes to flow releases at Iron Gate dam 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, NMFS 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 ITP. 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 committed through a 2008 letter agreement with NMFS to commence implementing ICP measures described in this HCP. To date, PacifiCorp has provided in excess of $2,560,000 for implementation of these measures demonstrating its commitment and financial ability to implement these measures for the duration of the Permit Term. Through discussions with NMFS in the development of this HCP, PacifiCorp has agreed to make annual payments of $510,000 into the Coho Enhancement Fund for each year that the permit is in effect even though PacifiCorp has already made payments of $510,000 per year into the Coho Enhancement Fund for 2009, 2010, 2011 and 2012. This agreement results in an increase in PacifiCorp's funding commitment for HCP activities by $1.53 million over the anticipated 10-year Permit Term.

In addition to the more than $2,560,000 in funding already provided to implement ICP measures, PacifiCorp estimates ongoing implementation costs for the HCP to be in excess of $750,000 per year. Expected costs to implement the HCP are based upon the following elements:

- Annual funding of $510,000 to implement measures benefitting coho salmon through the Coho Enhancement Fund.
- Funding to develop and implement an HGMP for Iron Gate Hatchery.
- Costs to implement flow operations 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 the opportunity to recover the costs through retail electricity sales to its customers. In any event, funds to implement the HCP will be included in PacifiCorp's operating budget.

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 NMFS with a letter from PacifiCorp's general manager with authority over Covered Activities verifying that funding has been deposited in the Coho Enhancement Fund in an amount adequate to ensure compliance with the Plan. PacifiCorp is also required to submit annual reports prepared by third party administrators detailing expenditure made during the preceding calendar year and the current balance of the funds. The third party administrators and PacifiCorp shall each certify the accuracy of information contained in such reports. These reports are intended to help NMFS 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.

XI. Other Alternative Actions Considered

The conservation measures described above were developed through lengthy discussions between PacifiCorp and NMFS, and are directly based upon findings contained in NMFS' BiOp on Project relicensing (NMFS 2007). Consequently, such measures are intended to address specific impacts previously identified by NMFS as potentially rising to the level of take of coho salmon.

The following alternative permitting actions have been contemplated by PacifiCorp and NMFS in addition to issuance of ITP as proposed by PacifiCorp. Additional alternatives are discussed in the Environmental Assessment prepared by NMFS:

No Action Alternative 1

Under No Action Alternative 1, NMFS 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 NMFS, 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 NMFS. These effects described by NMFS include:

- Loss of access to aquatic habitat due to water quality conditions such as elevated temperatures and low levels of DO.
- Increased incidence of fish diseases resulting from impaired water quality and other conditions.
- Loss of access to aquatic habitat due to low flows below Iron Gate dam and in the smaller Klamath River tributaries.
- Inadequate amount of usable physical habitat such as gravel beds and areas with riparian vegetation.
- 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.

Measures were developed by FERC, NMFS, and the 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 Acton Alternative 2, PacifiCorp would continue to implement certain proposed conservation measures, but would do so in the absence of an ITP from NMFS authorizing take associated with such measures. Failing to obtain an ITP may prevent PacifiCorp's full implementation of certain conservation deemed beneficial by NMFS, including flow variability below Iron Gate dam. Further, PacifiCorp has justified expenditures associated with the interim conservation measures on the basis that it would obtain an ITP from NMFS in a timely manner that provides additional regulatory certainty. Consequently, it is uncertain whether PacifiCorp could continue expenditures on conservation without issuance of an ITP by NMFS.

XII. References

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Appendices

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