UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

In response refer to:
2007/02422

DEC 21 2007

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

Dear Ms. Bose:

This letter transmits NOAA's National Marine Fisheries Service's (NMFS) biological opinion (Opinion) for the Federal Energy Regulatory Commission's (FERC) proposed issuance of a license to PacifiCorp for the Klamath Hydroelectric Project (Project, FERC No. 2082-027), located principally on the Klamath River in Klamath County, Oregon and Siskiyou County, California, between Klamath Falls, Oregon, and Yreka, California. FERC proposes to issue a license that includes its staff alternative with mandatory conditions, as identified within its March 21, 2007, letter requesting formal consultation. The enclosed Opinion addresses the effects of the Project on Southern distinct population segment (DPS) of green sturgeon (*Acipenser medirostris*), and Southern Oregon/Northern California Coast (SONCC) coho salmon (*Oncorhynchus kisutch*) and its designated critical habitat, in accordance with section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

After reviewing the best available scientific and commercial information, current status of Southern DPS green sturgeon, SONCC coho salmon and its designated critical habitat, and environmental baseline for the action area, and after assessing and considering the effects of the Project, NMFS concludes that the license for the Project is not likely to adversely affect the Southern DPS of green sturgeon, is not likely to jeopardize the continued existence of SONCC coho salmon, and is not likely to result in the destruction or adverse modification of SONCC coho salmon critical habitat. In the Opinion, NMFS determined that the Project would result in the incidental taking of SONCC coho salmon. Therefore, an incidental take statement is provided, containing reasonable and prudent measures, and terms and conditions to monitor and minimize the impact of incidental take.

Pursuant to the Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996, each Federal agency is mandated to consult with NMFS with respect to any action authorized, funded, or undertaken, or proposed to be, by such agency that may adversely affect any Essential Fish Habitat [EFH, 16 U.S.C. §1855(b)(2)]. As of this date, NMFS has not received from FERC an EFH assessment regarding the Project. However, NMFS has determined the Project would adversely affect designated Pacific Coast Salmon EFH within the Klamath River basin. Because of staffing constraints, NMFS will not be issuing EFH

Conservation Recommendations concurrently with this Opinion, but instead, will issue the Conservation Recommendations in the future.

Please contact Mr. Rick Rogers at (707) 825-5167, or via e-mail at rick.rogers@noaa.gov, if you have any questions concerning these consultations.

Sincerely,

Rodney R McInnis

Rodney R. McInnis
Regional Administrator

Enclosure

cc: Copy to file – ARN #151422SWR2003AR8914

Endangered Species Act - Section 7
Consultation

BIOLOGICAL OPINION

Klamath Hydroelectric Project License (FERC No. 2082-027)

ACTION AGENCY:	Federal Energy Regulatory Commission (FERC)
CONSULTATION CONDUCTED BY:	National Marine Fisheries Service Southwest Region
FILE NUMBER:	151422SWR2003AR8914
DATE ISSUED:	DEC 21 2007

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I. BACKGROUND AND CONSULTATION HISTORY

The Klamath Hydroelectric Project (Project) is located on the Upper Klamath River, spanning approximately 64 river miles (rm) within Klamath County, Oregon and Siskiyou County, California (figure 1). The existing Project consists of eight developments, seven of which reside on the mainstem Klamath River between rm 190 and 254.3 -- the lone facility outside the mainstem river is the Fall Creek powerhouse upstream of rm 196. The Project has operated under an existing 50-year permit issued in March, 1956, although the first hydropower structure (Copco Dam) was constructed in 1918. Endangered Species Act (ESA) consultation was never performed with regard to the initial license. None of the Project's dams were constructed with fish ladders sufficient to pass anadromous fish and, as a result, salmon and steelhead have effectively been blocked from accessing the upper reaches of the basin for close to a century. With anadromous fish relegated to the river section below the Project, flows emanating from Iron Gate Dam have been, and continue to be, critical toward maintaining productive runs of salmon and steelhead within the lower river. Beginning in 1956, Iron Gate Reservoir flow releases were governed by guidelines outlined within the original Federal Energy Regulatory Commission (FERC) license, with the releases commonly referred to as "FERC minimum flows." The Bureau of Reclamation's (Reclamation) Klamath Project, which diverts large volumes of Klamath River water from the upper basin for farmland irrigation and the flooding of wildlife refuges, began consultation with NOAA's National Marine Fisheries Service (NMFS) during 1998 regarding potential impacts of the irrigation project on Southern Oregon/Northern California Coast (SONCC) coho salmon (*Oncorhynchus kisutch*), a species once common to the Klamath River basin that was listed under the ESA in 1997. Since 1999, ESA consultations between NMFS and Reclamation have guided flow releases below Iron Gate Dam.[1]

A. FERC Re-licensing History

NMFS has actively participated in the three-phase traditional licensing process for the Project since PacifiCorp Power Company (hereafter referred to as PacifiCorp) distributed the First Stage Consultation Document on December 18, 2000. NMFS provided written comments on the First Stage Consultation Document on March 23 and April 18, 2001. These comments addressed Project-related effects on ESA-listed and tribal trust species, NMFS resource goals and objectives, and recommended studies.

In the second and third phases of the process, NMFS participated extensively with PacifiCorp and the stakeholder group in plenary and technical subcommittee meetings in study plan development, analysis of study results, and data interpretation. The stakeholder group included representatives of affected tribes, resource agency representatives, and non-governmental organizations. NMFS provided written comments in response to PacifiCorp's Second Stage Consultation Document on August 13, 2001. NMFS' comments and participation in stakeholder meetings focused on the evaluation of anadromous fish passage into the Project area, including current fish passage facilities, potential habitat benefits of fish passage, instream flows and water quality issues.

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[1] PacifiCorp and Reclamation operate under an agreement that PacifiCorp release flows at Iron Gate Dam that comply with any ESA-related flow requirements.

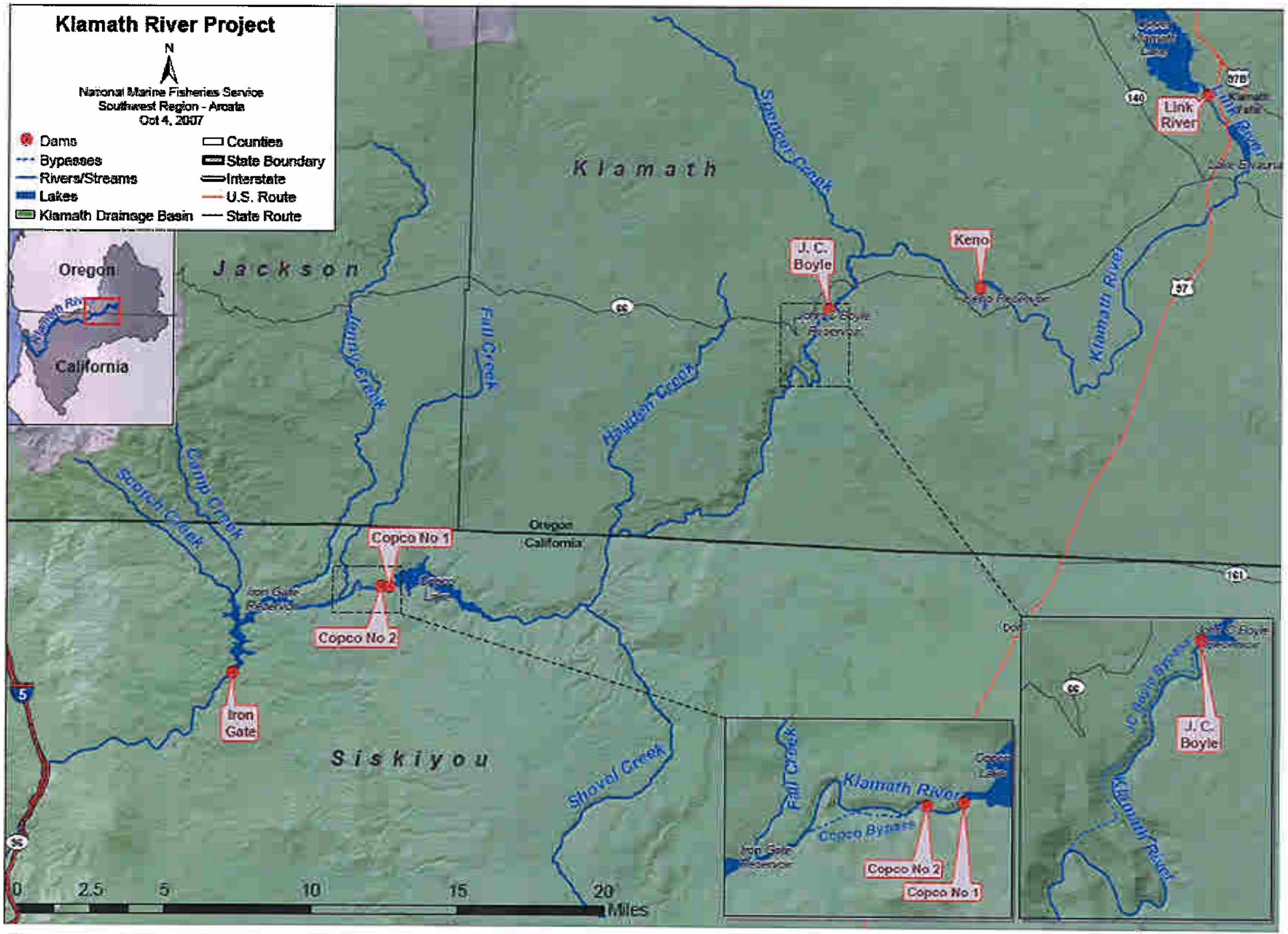

Figure 1. Project Location

On June 24, 2003, PacifiCorp distributed the Draft License Application (DLA) for the Project. NMFS, along with a total of 58 organizations, provided written comments on the DLA. NMFS' comments on the DLA included draft Preliminary Prescriptions for Fishways and an assessment of increased habitat for various anadromous fish passage alternatives. In these comments, NMFS also stated its concern that PacifiCorp was not on pace to develop a complete administrative record upon which to base NMFS' prescriptions and recommendations within statutory filing deadlines. NMFS stated that without the additional information, NMFS would recommend precautionary, conservative measures in order to ensure adequate protections are prescribed as part of the licensing process.

In February 2004, PacifiCorp filed a Final License Application (FLA) for the Project. PacifiCorp's FLA did not include passage provisions for anadromous fish. On April 23, 2004, NMFS filed comments, additional study requests, and a revised Preliminary Prescription for Fishways. NMFS' comments on PacifiCorp's DLA and FLA again included detailed descriptions of Project impacts on NMFS' trust species as well as NMFS' resource goals and objectives.

On April 16, 2004, FERC issued Scoping Document 1 for the Project. NMFS provided scoping comments and additional information in a filing dated July 20, 2004. FERC issued a Notice of Application Accepted for Filing and Soliciting Comments, Motions to Intervene, and Protests Concerning the Project FLA on August 16, 2004. NMFS filed a Motion to Intervene on October 5, 2004, that detailed NMFS' interest in these proceedings. FERC provided a Draft Environmental Impact Statement (DEIS, FERC 2006) in response to PacifiCorp's FLA on September 25, 2006 (FERC 2006). NMFS provided comments on the DEIS on November 29, 2006. On December 28, 2006, FERC issued a Notice of Application Ready for Environmental Analysis.

Between 2001 and 2006, NMFS worked with Karuk, Yurok, Hoopa Valley and Klamath Tribe biologists, attorneys and representatives in the collaborative stakeholder group in the relicensing process. On November 16, 2005, the Hoopa Valley Tribe formally requested Government-to-Government consultation on our fishway prescriptions. Between this date and March 24, 2006, NMFS and the United States Fish and Wildlife Service (USFWS, jointly referred to as the Services) exchanged drafts and information with tribes relative to the Preliminary Prescriptions for Fishways.

NMFS filed final Preliminary Prescriptions for Fishways for the Project on March 24, 2006, pursuant to section 18 of the Federal Power Act. The preliminary fishway prescriptions were developed jointly with, and were consistent with, prescriptions concurrently filed by the Department of the Interior (DOI). The Services filed a joint administrative record with FERC in support of these filings at the same time. NMFS also filed recommendations pursuant to section 10(a) and (j) of the Federal Power Act. NMFS filed Corrections to the Comments, Recommended Terms and Conditions, and Preliminary Prescriptions for the Project on April 28, 2006.

In April 2006, the Services received Requests for Hearing and Alternate Prescriptions from PacifiCorp concerning the jointly filed Preliminary Prescriptions for Fishways. NMFS also received a Request for Hearing and Alternate Prescriptions from the Hoopa Valley Tribe. The Bureau of Land Management (BLM) also received a Request for Hearing from PacifiCorp on its preliminary conditions under provisions of section 4(e) of the Federal Power Act.

After discussions, NMFS provided a letter to the Hoopa Valley Tribe expressing its intent to include clarifying language in its Modified Prescriptions for Fishways regarding the Hoopa Valley Tribe's concern. The Hoopa Valley Tribe subsequently withdrew its Request for Hearing. After numerous meetings, PacifiCorp withdrew certain issues identified for the hearing and agreed to stipulations on others.

Between August 21 and 25, 2006, a trial-type hearing was held on the remaining disputed issues of material fact between PacifiCorp and the Services. This was the first trial-type hearing to be held according to Energy Policy Act of 2005 amendments to the Federal Power Act. The hearing was presided over by Coast Guard Administrative Law Judge (ALJ) Parlen L. McKenna in Sacramento, California. In this hearing, the Services' issues were identical. The hearing was consolidated to also include disputed issues of material fact between PacifiCorp and BLM regarding BLM's preliminary conditions under provisions of section 4(e) of the Federal Power Act.

On September 27, 2006, the ALJ issued a Decision on the proceedings of the trial-type hearing. Those findings were rendered after review of expert scientific and technical data, and are consistent with the agencies' interpretations of the best available data. The ALJ's Ultimate Findings of Fact and Conclusions of Law found decisively in favor of the Services on all disputed issues of material fact concerning the Services' Preliminary Prescriptions for Fishways. The disputed issues concerned fish passage and the availability of suitable stocks, disease and residualization issues, current Project impacts on resident fishery resources (including entrainment), the amount of suitable habitat for anadromous fish within the Project reach, and whether access to habitat within the Project reach would benefit resident and anadromous species, including lamprey[2] and Federally-listed SONCC coho salmon.

Subsequent to filing the Preliminary Prescriptions for Fishways, NMFS received various sources of information that were considered in the development of the modified prescription, including the results of the trial-type hearing, alternative prescriptions, comments concerning the Preliminary Prescriptions, and FERC's DEIS. The Modified Prescriptions explain in detail how this information was considered.

On January 26, 2007, the Services issued Joint Modified Prescriptions for Fishways and alternatives analysis pursuant to sections 18 and 33 of the Federal Power Act. This included a joint Supplemental Administrative Record, filed by DOI. In addition, DOI's filing included BLM's modified conditions under provisions of section 4(e) of the Federal Power Act. The Services' Modified Prescriptions for Fishways are based on the best biological and engineering information available, including consideration of the ALJ's Decision as the Federal Power Act and implementing regulations require. These prescriptions were developed over a period of

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[2] While in USFWS/NMFS Issue 8 it was decided that the evidence is inconclusive as to whether Pacific lamprey were historically present above Iron Gate Dam, it was also decided that the record evidence shows that access to habitat would benefit that species of fish by providing it with additional spawning and rearing grounds

several years by the biological and engineering staff of the Services, in consultation with PacifiCorp, BLM, the California Department of Fish and Game (CDFG), Oregon Department of Fish and Wildlife (ODFW), affected tribes (Klamath, Karuk, Hoopa Valley, and Yurok Tribes), the Klamath Intertribal Fish and Water Commission, and other entities that participated in this relicensing proceeding. NMFS filed an Erratum to the Modified Prescriptions on July 23, 2007, concerning a missing citation and minor corrections to the text for additional clarity and specificity in the description of certain references cited.

B. Consultation History

A species list with regard to the Project was requested by FERC on May 31, 2006, and NMFS responded with said list on June 23, 2006. FERC originally requested formal consultation on its proposed relicensing of the Project by letter dated October 5, 2006. On October 31, 2006, NMFS responded that there was insufficient information to begin formal consultation because the proposed action for the license was not fully developed or described. Certain activities bearing on the proposed action had not occurred. Also, the request did not specify one proposed action, but instead proposed two.

On March 21, 2007, NMFS received FERC's second request to initiate formal consultation on its proposed relicensing of the Project using the staff alternative, as modified by the agencies' mandatory conditions, described in FERC (2006). Although NMFS acknowledged that the information FERC provided was sufficient to initiate consultation, it requested additional information to better understand the potential effects of the Project on SONCC coho salmon. From April to July 2007, NMFS, FERC, and PacifiCorp staff met to discuss the additional information that NMFS requested. On August 3, 2007, NMFS requested from FERC a 60-day extension on the time frame to complete formal consultation. FERC granted the extension by letter dated September 13, 2007. A second 60-day extension was requested on October 2, 2007, with FERC granting the second extension by letter dated October 3, 2007. A draft biological opinion was provided to FERC and PacifiCorp on November 6, 2007. In their comment letters responding to the draft biological opinion, both FERC and PacifiCorp specified the proposed action did not include the Keno, Eastside, or Westside facilities. In response to these comments, NMFS clarified the proposed action to exclude Keno, Eastside and Westside facilities.

This biological opinion analyzes the effect of FERC's relicensing PacifiCorp's Project [utilizing the staff alternative, as modified by the Services' mandatory conditions (DOI 2007) and supplemented by NMFS (2007)] on the Southern distinct population segment (DPS) of green sturgeon, and SONCC coho salmon and its designated critical habitat. Because this section 7 consultation only considers effects on ESA-listed threatened Southern DPS green sturgeon and SONCC coho salmon within the action area, issues and concerns regarding other anadromous species in the action area managed by NMFS (*e.g.*, Chinook salmon), but not listed under the ESA, will not be considered within this biological opinion. A complete administrative record for this consultation is on file at the Arcata Area Office of NMFS.

II. DESCRIPTION OF THE PROPOSED ACTION

FERC proposes to reissue a license to PacifiCorp for the Klamath Hydroelectric Project for a term of 30 to 50 years. The proposed action includes the staff alternative, as modified by NMFS and DOI mandatory conditions, described in FERC (2006). Because of the wide range in duration of the proposed license, and for the purposes of the analyses conducted in this consultation, NMFS assumes the license will be issued for a term of 50 years. The following subsections provide a general description of the Project and specific environmental measures included in the Project.

A. General Description of the Project

The Project consists of five mainstem dams (four of which supply powerhouses), two powerhouses at the Federal Link River Dam, and one tributary facility (figure 1). PacifiCorp also proposes to continue funding the operation of Iron Gate Hatchery. The Project's dams range from 25 to 173 feet in height, and impound small to medium sized, narrow reservoirs. The segment of the Klamath River between Link River Dam and Iron Gate Dam is approximately 64 miles long and consists of about 28 miles of river reaches and about 36 miles of reservoirs, as follows:

- At Reclamation's Link River Dam (rm 254), at the lower end of Upper Klamath Lake, the Eastside and Westside Powerhouses receive water diverted into canals on each side of the river. The Link River flows into Lake Ewauna, which is the upper end of an impounded reach of the Klamath River that is also known as Keno Reservoir, controlled by Keno Dam.
- Keno Dam is at rm 233, approximately 20 miles downstream from Link River Dam. Below Keno Dam, the 4.7-mile long Keno Reach flows into J.C. Boyle Reservoir (also known as Topsy Reservoir), created by J.C. Boyle Dam.
- J.C. Boyle Dam is at rm 224.7. Here, most of the flow is diverted out of the river through a canal around the 4-mile J.C. Boyle Bypassed River Reach. The canal extends to the J.C. Boyle Powerhouse at rm 220.4. Below the powerhouse, the 17-mile J.C. Boyle Peaking Reach of the Klamath River receives a daily peaking regime, with daily flows varying between approximately 300 and 1,500 cubic feet per second (cfs, one turbine operating) or 3,000 cfs (both turbines operating).
- Near rm 209, the river crosses into California, and enters Copco Reservoir near rm 204. Copco Reservoir is impounded by Copco 1 Dam at rm 198.7, where flow is diverted into the adjacent Copco 1 Powerhouse. About one-half mile below this powerhouse, Copco 2 Dam diverts almost the entire flow from Copco 2 Reservoir into a penstock around the 1.4-mile Copco Bypassed River Reach to Copco 2 Powerhouse at rm 196.8. The water from the powerhouse re-enters the Klamath River where it transitions into the upper reach of Iron Gate Reservoir.
- Iron Gate Dam (rm 190) is the furthest downstream of the Project facilities. Here the flow passes through the Iron Gate Powerhouse, and the Klamath River continues for 190 miles to the Pacific Ocean.

- The Fall Creek development is the smallest in terms of generation, the oldest, and the only development not on the mainstem Klamath River. Flow from Spring Creek (in the Jenny Creek watershed) is diverted into Fall Creek, and these waters flow through the Fall Creek Powerhouse about 1 mile above Fall Creek's juncture with the upper end of Iron Gate Reservoir. PacifiCorp proposes to include existing diversion facilities at Spring Creek as part of the Fall Creek development.

PacifiCorp proposes to not operate and to exclude from the new license both Keno Dam and the Eastside and Westside powerhouses at Link Dam. Eastside and Westside powerhouses are proposed for decommissioning, which is detailed on page 2-17 of the DEIS (FERC 2006). FERC does not explain what the ultimate disposition of Keno Reservoir will be in the future, but only notes Keno Dam will continue to be operated "as it is currently, only under the jurisdiction of the state of Oregon."[3] NMFS does not consider Keno, Eastside and Westside facilities to be interrelated or interdependent to the proposed action, since each facility could continue to operate in the absence of the Project as proposed. For instance, Keno Reservoir, which in the past was used to shape flow releases through the downstream Project reach, has lost much of that function due to Reclamation's mandatory flow releases at Iron Gate Dam. Instead, Keno Dam is now largely operated to maintain a constant surface elevation in Keno Reservoir and facilitate agricultural surface diversions. If the larger Project was removed from the landscape, NMFS believes Keno Dam would still be operated in much the same way as it is now. A similar basis exists for both the Eastside and Westside facilities. Because the Keno, Eastside and Westside facilities are not part of the proposed action, nor are they interrelated or interdependent to the proposed action, they will not be analyzed within this biological opinion.

B. Environmental Measures Included in the Proposed Action

FERC's Project for section 7 consultation is the FERC staff alternative with mandatory conditions as provided in its DEIS (FERC 2006). DOI (2007) provides details on the modified terms, conditions, and prescriptions. Following is a summary of the environmental measures specific to fisheries and aquatic habitat included in the Project. Subsections 1 and 2, below, incorporate PacifiCorp's proposed environmental measures. Subsection 3, below, provide additional measures proposed by FERC staff.

1. Water Resources

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

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

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[3] Should FERC decide to include the Keno facility and/or the Eastside and Westside powerhouses in the Project license, such changes to the proposed action may warrant reinitiation of consultation if they cause effects to SONCC coho salmon or their designated critical habitat that were not considered in this Opinion. Reconsultation may also be necessary upon the final disposition of Keno Reservoir.

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

- Evaluate potential adverse effects associated with implementing a reservoir oxygen diffuser as part of a reservoir implementation plan (see below). Implement turbine venting at Iron Gate development (Mobley Engineering 2005 *op cit.* FERC 2006), and monitor and evaluate the response of the downstream DO regime.

- Develop a single, comprehensive water quality management plan for all project-affected waters. The plan will include: (1) consideration of spillage of warm water at Iron Gate dam during late spring; (2) consideration of spillage at Copco 1, Copco 2, and Iron Gate Dams during the summer to enhance DO released at Iron Gate development; (3) consideration of turbine venting at Copco 1 and 2 powerhouses to increase DO in the epilimnion of Iron Gate reservoir and, potentially, downstream of Iron Gate development; (4) specification of water quality monitoring that would be used to evaluate the effectiveness of any implemented water quality management measures; (5) specification of long-term water quality monitoring programs (*e.g.*, temperature and DO) that would enable adaptive management decisions to occur; and (6) provisions for periodically updating the water quality management plan.

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

2. Aquatic Resources

- Consult with NMFS, DOI, and Reclamation during development of the decommissioning plan for the East Side and West Side facilities to ensure that PacifiCorp's actions to safely secure the developments and restore the landscape in proximity to both developments would not forestall the future installation of a smolt collection facility at this site.

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

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

- Limit flow down-ramp rates to 125 cfs per hour (equivalent to less than 2 inches per hour in most of the expected flow ranges) in the Copco 2 bypassed reach, except for flow conditions beyond PacifiCorp's control.

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

- Divert no flow from Spring Creek from June 1 to September 15, and release 1 cfs, or inflow, downstream of the Spring Creek diversion dam for the remainder of the year; install a Parshall flume to measure the minimum flow.

- Maintain the instream flow schedule and ramp rates downstream of Iron Gate dam according to Reclamation's Klamath Project Operations Plans consistent with biological opinions issued by the USFWS and NMFS.

- Increase the level of Iron Gate Hatchery funding from 80 to 100 percent.

- Purchase, construct, and operate a mass-marking facility at the Iron Gate Hatchery that provides for marking 100 percent of all Chinook salmon and coho salmon released.

3. Additional Measures Identified by FERC Staff

a. Geology and Soils

- Develop and implement a sediment and gravel resource management plan that includes mapping and evaluating gravel distribution in Project reaches and the Klamath River from Iron Gate Dam to the confluence of the Shasta River, determining specific amounts and locations for gravel augmentation based on the mapping; monitoring gravel and spawning use after placement; and supplementing gravel placement based on monitoring results. This measure does not apply to the BLM-managed river section near J.C. Boyle Reservoir, which is addressed by section 4(e), condition 4D, described below.

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

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

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

b. Water Quantity and Quality

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

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

- Release 70 cfs or inflow, whichever is less, from Copco 2 Dam into the Copco 2 bypassed reach.

c. Aquatic Resources

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

- Allow state and Federal resource agency personnel access to project developments to inspect fishways and records to monitor compliance with license conditions.

- Develop and implement a decommissioning plan for East Side and West Side developments that includes addressing public safety at the sites following decommissioning.

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

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

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

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

Table 1. Summary of Modified Fishway Prescriptions and Timetable for the Klamath Hydroelectric Project (FERC Project #2082)

Development	Target Species	Timeframe from License Issuance to Functional Development (in Chronological Order)	Tailrace Barrier[a]	Screens and Bypass	Spillway Modifications[a]	Interim, Seasonal Trap and Haul
Copco 2 Bedrock Sill	Salmonids (includes Resident trout), lamprey	2 yrs (Bypass Barrier/Impediment Elimination)	Not Applicable (NA)	NA	NA	NA
J.C. Boyle (Bypass)	Salmonids, lamprey	2 yrs (Bypass Barrier/Impediment Elimination)	NA	NA	NA	NA
Fall Creek	Resident trout	3 yrs (0.5 ft/drop and ≤ 10%)	5 yrs[d]	3 yrs	NA	NA
Spring Creek	Resident trout	3 yrs (0.5 ft/drop and ≤ 10% slope)	NA	3 yrs	NA	NA
J.C. Boyle	Salmonids, lamprey	4 yrs (0.5 ft/drop and ≤ 10% slope)	4 yrs	4 yrs	4 yrs	NA

Table 1. Summary of Modified Fishway Prescriptions and Timetable for the Klamath Hydroelectric Project (FERC Project #2082) continued.

Development	**Target Species**	**Timeframe from License Issuance to Functional Development (in Chronological Order)**	**Tailrace Barrier**[a]	**Screens and Bypass**	**Spillway Modifications**[a]	**Interim, Seasonal Trap and Haul**
Iron Gate	Salmonids, lamprey	5 yrs (0.5 ft/drop and ≤ 10% slope)	NA	5 yrs	5 yrs	Modify existing trapping facility
Copco 2	Salmonids, lamprey	6 yrs (0.5 ft/drop and ≤ 10% slope)	8 yrs[d]	6 yrs	6 yrs	NA
Copco 1	Salmonids, lamprey	6 yrs (0.5 ft/drop and ≤ 10% slope)	8 yrs[d] (if adults in C2 pool)	6 yrs	6 yrs	NA

[a] As described in detail below, in accordance with a stipulation with PacifiCorp, the Services have revised the prescriptions for spillway modifications and tailrace barriers in the Modified Prescriptions to allow PacifiCorp to conduct site-specific studies on the need for and design of spillway modifications

[b] Study of impacts to and the potential design and construction of tailrace barrier are given priority due to the presence of Federally listed suckers

[c] Screen and bypass system given priority due to the presence of Federally listed suckers

[d] Timing of tailrace barrier design and construction deferred for study to determine optimal design

4. U.S. Fish and Wildlife Service Modified Fishway Prescriptions

The Services' Modified Fishway Prescriptions are summarized in table 1. For a complete description, see DOI (2007).

5. BLM Modified 4(e) Conditions

BLM modified 4(e) conditions for this Project that pertain to natural resources are listed below. For a complete description of these conditions, see DOI (2007).

River Corridor Management

A. J.C. Boyle Bypassed River Reach

1. Required Minimum Streamflows – The Licensee shall, within 1 year after license issuance, operate J.C. Boyle Development to accomplish the following:
   (a) Proportional flow requirement: Provide no less than 40 percent of the inflow to J.C. Boyle Reservoir to the J.C. Boyle Bypassed River Reach, to be measured at a new gage below the J.C. Boyle Dam near RM 225. Inflow to J.C. Boyle Reservoir shall be calculated by averaging the previous three days of the combined daily flows as measured at the Keno gage #11509500 and Spencer Creek gage #11510000 (Calculated Inflow).
   (b) Minimum base flow requirement: When Calculated Inflow is less than 1,175 cfs, no less than 470 cfs shall be provided to the J.C. Boyle Bypassed River Reach, except that when the Calculated Inflow is less than 470 cfs, then flow shall be provided to the J.C. Boyle Bypassed River Reach in an amount equal to the Calculated Inflow.
   (c) Seasonal high flow requirement: When Calculated Inflow to J.C. Boyle Reservoir exceeds 3,300 cfs during the period between February 1st and April 15th, diversion to the J.C. Boyle Power Canal shall be suspended at least once and continued for a minimum of 7 days.

2. Ramping During Controlled Events – The Licensee shall, within 1 year after license issuance, operate J.C. Boyle Development to not exceed an up-ramp rate or down-ramp rate of 2 inches per hour as measured at the new gage below J.C. Boyle Dam when conducting controlled flow events (*e.g.*, scheduled maintenance and changes in minimum flow requirements), except when implementing the seasonal high flow or when turbine capacity is exceeded. The Licensee, in consultation with the BLM, shall develop and implement an appropriate ramp rate to follow after the seasonal high flow to prevent stranding fish in the J.C. Boyle Bypassed Reach.

B. J.C. Boyle Peaking Reach

1. Streamflow Requirements – The Licensee shall, within 1 year after license issuance, operate the J.C. Boyle Development from May 1st to October 31st to provide a minimum streamflow of 1,500 cfs a maximum of once a week, such that these flows occur at the Spring Island Boat Launch between 0900 and 1400 hours from Friday through Sunday, in the priority of Saturday, Sunday, and then Friday.

2. Ramping During Controlled Events – The Licensee shall, within 1 year after license issuance, operate the J.C. Boyle development to not exceed an up-ramp rate or down-ramp rate of 2 inches per hour when conducting controlled flow events (*e.g.*, scheduled maintenance, power generation, changes in streamflow requirements), except during implementation of the seasonal high flow, as measured at the J.C. Boyle Powerhouse gage [U.S. Geological Survey (USGS) #11510700].

3. Flow Continuation Measure – The Licensee shall, within one year of license issuance, implement a flow continuation measure at the J.C. Boyle canal and powerhouse to provide a minimum of 48 hours of continuous flow under powerhouse shutdown conditions.

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

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

2. Instream Flow Reporting - The Licensee shall, within 1 year after license issuance:
   (a) Provide instantaneous 30-minute real time streamflow data in cfs via remote access that is readily available and accessible to the public.
   (b) Design and maintain a database, similar to the most current version of the USGS National Water Information System (NWIS) for reporting on surface water. The database shall store gage network data and streamflow tracking procedures. BLM shall review and approve the database.

3. The Licensee shall, within two years after license issuance, submit a report for each water year (*i.e.*, October 1 through September 30) of streamflow data reported in cfs to the BLM. The report shall be filed with the BLM within 6 months of the end of each water year.

Adaptive Management Plan (AMP)

Within 1 year of license issuance, the Licensee shall develop, in consultation with BLM, an AMP and file the AMP with FERC for approval.

The AMP, at a minimum, shall:

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

Vegetation Resources Management Plan (VRMP)

Within 1 year of license issuance, the Licensee shall develop, in consultation with the BLM, a VRMP and file the VRMP with FERC for approval.

The VRMP, at a minimum, shall include:
1. Provisions to re-survey lands affected by the Project, including, at a minimum, BLM-administered lands affected by Project-related activities, according to accepted protocols to determine or verify the distribution of threatened, endangered, and sensitive (TES) species.
2. Provisions for establishing a weed management area that includes the Project area and interested stakeholders.
3. Provisions for surveying, documenting, managing and monitoring noxious weed and invasive plant species, including periodic review of Federal, state and local noxious weed lists in the Project area.
4. Provisions for surveying, documenting, monitoring and protecting TES plants, including periodic review of BLM sensitive species, Oregon Natural Heritage Information Center, California Natural Diversity Database, and California Native Plant Society records.
5. Proposed vegetation management activities for, at a minimum, the J.C. Boyle Powerhouse and canal, maintenance of transmission line and road rights-of-way, and use of Project-related roads on or affecting BLM-administered lands.
6. Proposed remediation measures and subsequent monitoring program for the eroded area below the J.C. Boyle emergency spillway.
7. A geospatial map (*e.g.*, Geographic Information System map) and digital database to store information on species occurrence, distribution, status, and timing of last survey.
8. Proposed treatments, mitigations, and best management practices for managing weeds on BLM-administered lands that are impacted by Project-related activities.
9. Descriptions as to how the VRMP is consistent with BLM guidance for integrated pest management.
10. Principles of integrated pest management that include prevention and detection, application of integrated control methods, education, coordination, native plant

community restoration, monitoring, and evaluation. Integrated control methods may include cultural, physical, biological, and chemical control techniques.

11. Provisions for annual review and periodic modifications or revisions of the VRMP.

6. Sediment Management Plan (SMP)

Within 1 year of license issuance, the Licensee shall develop, in consultation with and approval of the BLM, an SMP and file the SMP with FERC for approval. The SMP shall be designed to meet the following objectives:

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

The SMP, at a minimum, shall adhere to the following:

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

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

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

a. In one large introduction effort establish bed-stored sediment to its potential in the J.C. Boyle Bypassed River Reach. Determine capacity for gravel and cobble sediment to be trapped in boulder pockets and pools and capacity for sand and gravel trapped on bar surfaces and along the channel margins. An estimate of the large introduction quantity for gravel/cobble in spawning pockets and pools is 1 foot of gravel depth in pockets likely to trap coarse sediment, which covers approximately 1/3 of the low flow channel. Similar estimates for bar top and channel margin trapping of sands and gravels to meet riparian goals need to be developed. If restoring seasonal high flows mobilizes and distributes the sediment accumulated at the J.C. Boyle emergency spillway deposit sufficiently to meet the capacity of the bypassed river reach downstream from that deposit, then the sediment introduction criteria can be reduced by a corresponding quantity to attain the potential for the bypassed river reach upstream from the emergency spillway.

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

c. Establish a sediment monitoring program, using standardized techniques, that adaptively manages the program over time and evaluates whether the sediment augmentation program is effective. Effectiveness shall be determined based on the

Performance Measures (see part 4 below). The monitoring results shall be reported to sufficiently inform annual adaptive management decisions for sediment infusion quantities and qualities after the initial large sediment input. Monitoring results may also be used to adapt additional aspects of the augmentation, including, but not limited to, timing, location, augmentation methods, and particle size composition.

d. Maintain sediment continuity per grain size in the J.C. Boyle bypassed river reach through adaptive infusions of sediment quantities sized to replace sediment exported from the reach.
e. Develop spawning habitat suitability criteria for the J.C. Boyle bypassed river reach for steelhead, coho salmon, Chinook salmon, and resident trout by modeling the quantity and quality of salmonid spawning habitat for a flow of 470 cfs plus accretion flows. Establish a periodic monitoring program to validate model estimates of spawning habitat quantity and quality.
f. Annually monitor and identify locations of salmonid spawning activity in the bypass reach for each salmonid species or stock.

(4) Performance Measures – The following shall be considered for inclusion in the SMP:
  a. Achieve the determined capacity for gravel and cobble sediment to be trapped in boulder pockets and pools within three years of SMP approval.
  b. Achieve the determined capacity for sand and gravel trapped on bar surfaces and along the channel margins within three years of SMP approval.
  c. Maintain sediment continuity and a balanced sediment budget, such that gravel/cobble spawning patches and sand/gravel riparian bar surfaces remain within an average of +/- 10 percent of the estimated sediment trap capacity.

(5) Reporting -
  a. The Licensee shall submit to the BLM and FERC an annual report on the activities of the SMP implementation during the previous year. The report shall include a description of the quantities, sizes, composition, timing, method(s), and location of sediment added and any monitoring data. The report shall integrate data from year to year, such that an analysis of trends is included.
  b. At least every 5 years, the Licensee shall consult with the BLM to review and update or revise the SMP as appropriate. Upon FERC approval, the Licensee shall implement the revised SMP.

7. Reclamation Modified Conditions

Following is a summary of Reclamation's seven 4(e) conditions. Please see DOI (2006, 2007) for specific details associated with each condition.

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

Klamath Water or lands surrounding Upper Klamath Lake, and (6) operate Keno Dam ensuring continued operations consistent with irrigation and endangered species requirements.

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

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

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

Condition 5: Cause no affect to Reclamation's Klamath Project unless approved by Reclamation.

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

Condition 7: Reserves FERC authority to require the Licensee to implement such conditions for the protection and utilization of Reclamation reservations. This general reservation of authority allows the Secretary to consider additional data as it becomes available; to respond to changed circumstances, and modify the existing section 4(e) conditions as may be necessary. The Secretary's reservation of mandatory authorities under the Federal Power Act has been accepted by FERC and judicially affirmed. *Wisconsin Public Services Corp.*, 62 FERC ¶ 61,905 (1993), *aff'd*, *Wisconsin Public Serv. Corp. v. FERC*, 32 F.3d 1165 (7th Cir. 1994).

C. Implementation Schedule

As discussed above, NMFS assumes that FERC will license the Project for a term of 50 years. The licensing decision is expected to occur in late 2008. After licensing, construction of fishways will begin according to the schedule outlined in the *Description of the Proposed Action* section, above, and will be completed 6 years later. Throughout the term of the license, endangered or threatened species are expected to be protected as described in this Opinion, and if new species are determined to be endangered or threatened within the action area, consultation will be reinitiated to ensure that these species are not likely to be jeopardized by the continuing effects of the action and that the effects of incidental take would be minimized. In addition, if critical habitat is designated within the action area, consultation will be reinitiated to ensure that the continuing effects of the action are not likely to destroy or adversely modify the designated critical habitat.

D. Description of the Action Area

The action area is defined at 50 CFR 402.02 to mean "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action." The appropriate scale to analyze effects is project specific and depends on numerous factors including the scope of the Project. The action area is the mainstem Klamath River from Spencer Creek (rm 228) to the estuary, inclusive. The action area includes the Upper Klamath River [Spencer Creek (inclusive) downstream to Portuguese Creek (non-inclusive)], Middle Klamath River [Portuguese Creek (inclusive) downstream to the confluence of Trinity River], and Lower Klamath River (confluence of Trinity River downstream to the mouth of the Klamath River) population unit boundaries. The action area also includes the following tributaries upstream of Iron Gate Dam: (1) Spring Creek and Jenny Creek from the Spring Creek diversion downstream to Iron Gate Reservoir, (2) Fall Creek from the Fall Creek powerhouse downstream to Iron Gate Reservoir, and (3) Shovel Creek and Negro Creek from PacifiCorp's instream water diversions downstream to the Klamath River. The Shasta River and Scott River watersheds were not included within the action area, as they are not affected by the Project. However, because juvenile coho salmon forced out of these tributaries each spring by poor water quality/quantity are directly affected by the Project as they rear within the Klamath River mainstem, the effects on these fish will be analyzed within the action area.

III. ANALYTICAL APPROACH

Pursuant to section 7(a)(2) of the ESA, Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The purpose of the analysis in this Opinion is to determine if it is reasonable to expect that the direct and indirect effects of the Project and any interrelated and interdependent actions, when added to the environmental baseline and any cumulative effects of future non-Federal actions, are likely to appreciably reduce the likelihood of both the survival and recovery in the wild of SONCC coho salmon or likely to destroy or adversely modify designated critical habitat [16 USC 1536(a)(2), 50 CFR 402.02 and 402.14(g)]. This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02, which has been invalidated by the 9th Circuit Court of Appeals. *Gifford Pinchot Task Force v. USFWS*, 378 F.3d 1059 (9th Cir. 2004). Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.

The analytical approach that we will use in this consultation uses the viable salmonid populations (VSP) concept[4], and specifically, the parameters for evaluating populations (population size, population growth rate, spatial structure and diversity) described by McElhany *et al.* (2000) at various spatial scales, as described below.

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[4] A viable salmonid population, or a population's viability, is an independent population of any Pacific salmonid (genus *Oncorhynchus*) that has a negligible risk of extinction due to threats from demographic variation (random or directional), local environmental variation, and genetic diversity changes (random or directional) over a 100-year time frame (McElhany *et al.* 2000).

Characterization of the historical population structure, as well as the temporal and spatial scales relevant to this structure, is necessary to understand the population characteristics that contribute to a population's viability, to aid in subsequent development of recovery plans, and consequently, to determine the persistence of the SONCC coho salmon Evolutionarily Significant Unit (ESU, Bjorkstedt *et al.* 2005). Most recently, Williams *et al.* (2006) described the structure of historic populations of SONCC coho salmon using information and assumptions related to habitat quality, carrying capacity and historic distributions. Williams *et al.* (2006) characterized the SONCC coho salmon ESU as containing 45 historical populations, of which 9 historical populations are within the Klamath River basin. Hereafter, reference to "historical population" pertains to the current population associated with the population units identified in Williams *et al.* (2006). The term "population unit" will be used to identify the geographic area of those historical populations. The term "Klamath River meta-population" refers to the Klamath River and Trinity River basin populations of coho salmon, which is comprised of nine historical populations, as described above.

A. Jeopardy Analysis

In the following *Status of the Species* section, we describe SONCC coho salmon in terms of its reproduction, numbers, and distribution at the ESU scale, evaluate the current viability parameters, and determine the overall trend of habitat conditions at the ESU scale.

Much of the effects of the action are ongoing effects of the continued operation of the Project. Therefore, the *Environmental Baseline* section describes in detail the current and ongoing impacts of Project operations on SONCC coho salmon and their habitat (*e.g.,* water quality, water quantity, and other factors), and the likely factors that caused the current state of the habitat within the action area. The discussion in the *Environmental Baseline* section is organized into three parts. First, we describe the seasonal periodicity and life history traits of coho salmon within the Klamath River. Next, a synopsis of the general factors currently affecting coho salmon and its habitat within the entire Klamath River basin is presented. Finally, we describe in greater detail the current habitat conditions within each of the three mainstem Klamath River populations units (Lower, Middle and Upper) in the action area, the past and current impacts that precipitated those conditions, and each population unit's current viability.

To assess the effects of the proposed action, we ask the following series of questions, which are followed by brief discussions that summarize the approach we took to answer each question and the assumptions or assessments we made to complete the analysis. To answer these questions, we utilized information provided in FERC (2006) as well as information gained from numerous literature searches.

(1) What are the physical, chemical, and biotic resources contained in the aquatic ecosystems of the action area that are likely to be directly or indirectly exposed to the activities associated with the Project over the 50-year duration of the Project?

> Our assessment is structured around the physical (*e.g.*, riparian function, substrate composition, and flow volume) and chemical (*e.g.*, water quality) processes that dictate habitat conditions in the action area. We determined whether the Project activities in

aggregate with baseline conditions, affect water quantity/quality and instream habitat conditions in the action area, which indicate the physical, chemical, and biotic resources exposed to the proposed action, as they largely dictate freshwater habitat conditions that coho salmon depend on for their survival. Flow releases at Iron Gate Dam were recently amended based upon a ruling by the U.S. Ninth Circuit Court of Appeals [*PCFFA v. Reclamation* (9th Cir. 2006)]. The March 27, 2006, ruling ordered Reclamation to "limit Klamath Project irrigation deliveries if they would cause water flows in the Klamath River at and below Iron Gate Dam to fall below 100% of the Phase III flow levels" specifically identified in the Klamath Project Biological Opinion (NMFS 2002). Therefore, NMFS assumes that the flow regimes below Iron Gate Dam will be the same as a result of implementing the Project.

(2) How are those water quantity/quality and instream habitat parameters likely to respond to that exposure?

The temporal and spatial characteristics of water quantity/quality and instream habitat and their interactions with stream reaches in the action area will be influenced by many of the activities proposed in the Project. The effects analysis predicts the temporal and spatial deliveries and quality of water, and changes to instream habitat, and how they affect coho salmon and their habitat within the action area.

For example, many of the proposed activities in the Project will improve water quantity/quality and instream habitat versus current conditions if they are implemented in accordance with the proposed action. Thus, we look at the various activities that have the potential to affect water quantity/quality and instream habitat. We then consider these activities collectively to predict overall water quantity/quality and instream habitat. In many cases, water quantity/quality and instream habitat are expressed relative to existing (environmental baseline) conditions. The *Environmental Baseline* section discusses the effects of the current operations of the Project. The *Effects of the Action* section acknowledges and analyzes the continued effect of operating the Project based on the proposed action. Given the environmental baseline and the expected response of the habitat parameters, we then determine if water quantity/quality and instream habitat as a result of implementing the Project will result in habitat conditions that meet the species' life history needs.

For purposes of the jeopardy and adverse modification analyses, the expected changes are also added to the existing impacts of the environmental baseline to determine whether habitat trends will change as a result of the proposed Project. Proposed activities under the Project that are more protective or conservative of salmonid habitat features than current operations would be expected to either maintain or improve the quantity or quality of coho salmon habitat. As discussed in question #5, we then determine whether the expected habitat improvements or degradations will result in conditions that meet the biological requirement of the species to assess effects on the fitness and viability of the species and the conservation value of critical habitat, and to determine instances or habitat conditions that are likely to result in incidental take.

(3) How are the responses of those water quantity/quality and instream habitat parameters likely to affect the quantity, quality, and availability of the habitat conditions for coho salmon in the action area?

> Water quantity/quality and instream habitat dictate the condition of habitat in the action area. Thus, understanding the changes in water quantity/quality and instream habitat from question #2, above, is critical to understanding the response of various in-stream habitat types to the proposed action.
>
> A key component in this assessment is the quantity, quality, and availability of existing habitat as described in the *Environmental Baseline* section. Any adverse changes in habitat expected under the proposed action would have to be further examined to determine whether the changes in water quantity/quality and instream habitat result in continued poor habitat conditions (in the case where existing habitat is degraded), with potential adverse effects on coho salmon, or if they are expected to be sufficient to maintain or promote functional habitat. To further refine our estimates of habitat conditions as a result of the proposed action, we use best scientific and commercial data available for the Klamath River basin, and where it is lacking, we utilize best scientific and commercial data from other study locales that describe stream channel conditions resulting from effects on water quantity/quality and instream habitat.

(4) Which life history stages of SONCC coho salmon are likely to be exposed to the changes in the quality, quantity, and availability of their habitat conditions, and how are they likely to respond, expressed in terms of their fitness (specifically, the growth, survival, and lifetime reproductive success)?

> Given the habitat conditions resulting from the proposed action (question #3), we determine whether the habitat conditions resulting from the proposed action would meet the life history stage specific biological requirements for coho salmon, then determine whether those changes in habitat conditions would reduce or improve growth, survival, or reproductive success of exposed individuals. The assessment focuses on the following life history stages: egg incubation and emergence, juvenile rearing and out-migration, and adult migration and spawning. We estimate the likely response of individual coho salmon to the anticipated habitat changes, as well as the more direct impacts arising from operation of the hydropower system (*e.g.,* entrainment, predation within reservoirs, *etc.*), and determine how each impact is likely to affect their survival and essential behavior patterns.

(5) What are the probable consequences of any changes in the fitness of these individuals on the viability of the populations and the species?

> This analytical approach assumes that SONCC coho salmon, in general, will experience demographic changes [that is, changes in abundance, population growth rates (productivity), spatial structure and diversity] commensurate with the changes in the habitat-related variables described above. We extrapolate the effects of the action and individual life history stage responses to the population unit scale, and evaluate whether

the effects of the Project and any interrelated and interdependent actions, when added to the environmental baseline and any cumulative effects of future non-Federal actions, appreciably reduce the likelihood of both the survival and recovery in the wild of SONCC coho salmon. The analysis will qualitatively assess how the viability of the Lower, Middle, and Upper Klamath River population units would likely change after implementing the Project. The analysis will also include an investigation of the Project's effect on the viability parameters of SONCC coho salmon within the Scott River and Shasta River historical populations. Studies have shown that especially following the beginning of irrigation season (around April 1 of each year) and subsequent water withdrawals from the Scott and Shasta Rivers, juvenile coho salmon are forced out of those rivers to rear in the mainstem Klamath River. Therefore, the Shasta and Scott River populations are affected by mainstem Klamath River habitat conditions to a greater degree than other tributary populations.

If the effects of the action likely influence any of the population viability parameters, then NMFS must determine whether the effects on the affected populations will increase the species' risk of extinction. Any change in viability noted at the population unit scale will be evaluated as to its impact on the larger Klamath River meta-population (comprised of nine population units), with a similar determination of how its viability will likely change as a result of the Project. We will conclude with an analysis to determine whether the Project will reduce SONCC coho salmon's reproduction, numbers, or distribution at the larger Klamath River meta-population and ESU scales. If the viability, as represented by the four viability parameters, weakens as a result of the Project, NMFS will evaluate whether this state of lower viability will reduce appreciably the likelihood that the SONCC coho salmon ESU will survive and recover (*i.e.*, jeopardize the continued existence). If, on the other hand, viability is expected to improve, the likely conclusion would be that the Project would not jeopardize the continued existence of the SONCC coho salmon ESU.

B. Adverse Modification Analysis

To determine if the Project is likely to result in the destruction or adverse modification of designated critical habitat for SONCC coho salmon, NMFS will analyze the effects of the action on the essential habitat types of critical habitat identified as essential to the conservation of the species. We analyze the effects of the Project as they may influence the essential features of habitat that support the biological and ecological requirements for the conservation of the species. This analysis builds on the jeopardy analysis described above. That is, using the best scientific and commercial data available, we estimate the effect of the Project on water quantity/quality and instream habitat as they may influence substrate and sediment levels, water quality conditions, flow, stream temperatures, physical habitat elements, channel condition, nutrients, habitat accessibility, and the general condition of watersheds that support the biological and ecological requirements for the conservation of the species. The purpose of the assessment is to determine whether critical habitat in the action area would remain functional for the conservation of the species or retain the current ability for the essential habitat types to be functionally established. If the effects of the Project, when combined with the cumulative effects and added to the environmental baseline, do not destroy or adversely modify the value of constituent elements essential to the conservation of SONCC coho salmon in the action area, then the adverse modification or destruction threshold is not exceeded. Conversely, if the conservation value of the affected essential habitat types in the action area is destroyed or adversely modified, NMFS must determine whether the impacts result in an appreciable diminishment of the value of the overall critical habitat for the conservation of the species. Many activities can take place within designated critical habitat without diminishing the value of constituent elements for the species' conservation. On the other hand, the adverse modification threshold may be exceeded if an action diminishes the constituent elements in a manner likely to appreciably diminish or preclude the role of those habitat elements in the conservation of the species.

IV. STATUS OF THE SPECIES/CRITICAL HABITAT

This Opinion analyzes the effects of the proposed Project on threatened Southern DPS of green sturgeon (*Acipenser medirostris*; April 7, 2006, 71 FR 17757), threatened SONCC coho salmon (June 28, 2005, 70 FR 37160), and critical habitat for SONCC coho salmon (May 5, 1999, 64 FR 24049).

A. Southern DPS Green Sturgeon

On April 7, 2006, NMFS listed Southern DPS green sturgeon as threatened under the ESA (71 FR 17757). The Southern DPS currently consists of a single spawning population in the Sacramento River basin. Southern DPS green sturgeon travel long distances along the coasts of California, Oregon, and Washington and have been regularly observed as far north as the southern edge of Vancouver Island. Bays and estuaries for which NMFS has data on the presence of Southern DPS green sturgeon are: Humboldt Bay, Columbia River, Willapa Bay, and Grays Harbor. For most estuaries on the West Coast, there are either no data available and the presence of Southern DPS green sturgeon is uncertain, or data indicating presence of green sturgeon is available, but uncertainty exists whether the sturgeon are Southern DPS green sturgeon. In the meantime, NMFS expects that green sturgeon may be present in the following California bays and estuaries: Klamath River, Mad River, Eel River, Rogue River, Noyo Harbor, Tomales Bay, Half Moon Bay, Monterey Bay, and Morro Bay. This finding is based on NMFS' examination of the available data and inference of likely sturgeon presence based on the physical and chemical characteristics of these estuaries. Individuals of Southern DPS green sturgeon carry the listing beyond the described boundaries of their DPS, and NMFS must consider agency actions that may affect Southern DPS green sturgeon in areas where Southern DPS green sturgeon may occur.

In summer and fall, Southern DPS green sturgeon may enter estuarine habitat, including the Klamath River, to forage on prey organisms. However, they are not anticipated to migrate beyond the estuarine habitat within the Klamath River. As described in the *Lower and Middle Klamath River Population Units* subsection of the *Effects of the Action* section, below, the Project is not expected to affect the physical, chemical and biological resources within the lower Klamath River in the Lower and Middle Klamath River Population Units. Therefore, NMFS concludes the Project is not likely to adversely affect Southern DPS green sturgeon; and thus, the Southern DPS of green sturgeon will not be considered further in this Opinion.

B. SONCC Coho Salmon

1. General Life History

Coho salmon generally exhibit a relatively simple 3-year life cycle. Most coho salmon enter rivers between September and February. Coho salmon river entry timing is influenced by many factors, one of which appears to be river flow. In addition, many small California stream systems have their mouths blocked by sandbars for most of the year except winter. In these systems, coho salmon and other Pacific salmonids are unable to enter the rivers until sufficiently strong freshets open passages through the bars (Weitkamp *et al.* 1995). Coho salmon spawn from November to January (Hassler 1987), and occasionally into February and March (Weitkamp *et al.* 1995).

Although each native population appears to have a unique time and temperature for spawning that theoretically maximizes offspring survival, coho salmon generally spawn at water temperatures within the range of 10-12.8°C (Bell 1991). Bjornn and Reiser (1991) and Nickelson *et al.* (1992) found that spawning occurs in a few third-order streams, but most spawning activity was found in fourth- and fifth-order streams with a gradient less than 3 percent. Spawning occurs in clean gravel ranging in size from that of a pea to that of an orange (Nickelson *et al.* 1992). Spawning is concentrated in riffles or in gravel deposits at the downstream end of pools featuring suitable water depth and velocity (Weitkamp *et al.* 1995). In summarizing suitable particle size distributions for spawning, Spence *et al.* (1996) stated that mortality of coho salmon and steelhead occurs when fine sediment (<0.85 mm) exceeds 13 percent of the substrate composition. The favorable range for coho salmon egg incubation is 10-12.8°C (Bell 1991). Coho salmon eggs incubate for approximately 35 to 50 days, and start emerging from the gravel 2 to 3 weeks after hatching (Hassler 1987, Nickelson *et al.* 1992). Following emergence, fry move into shallow areas near the stream banks. As coho salmon fry grow, they disperse upstream and downstream to establish and defend territories (Hassler 1987).

Juvenile rearing usually occurs in tributary streams with a gradient of 3 percent or less, although they may move up to streams of 4 percent or 5 percent gradient. Juveniles have been found in streams as small as one to two meters wide. At a length of 38-45 mm, the fry may migrate upstream a considerable distance to reach lakes or other rearing areas (Godfrey 1965 *op. cit.* Sandercock 1991, Nickelson *et al.* 1992). Rearing requires temperatures of 20°C or less, preferably 11.7-14.4°C (Bell 1991, Bjornn and Reiser 1991, Reeves *et al.* 1987). Coho salmon fry are most abundant in backwater pools during spring. During the summer, coho salmon fry prefer pools greater than 1 m in depth featuring adequate cover such as large woody debris (LWD), undercut banks, and overhanging vegetation. Juvenile coho salmon prefer to over-winter in large mainstem pools, backwater areas and secondary pools with LWD, and undercut bank areas (Hassler 1987, Heifetz *et al.* 1986). Coho salmon rear in fresh water for up to 15 months, then migrate to the sea as smolts between March and June (Weitkamp *et al.* 1995). Adult and smolt coho salmon utilize the mainstem of the Klamath River for upstream spawning migration and downstream outmigration, respectively. There is very little, if any, spawning with the Klamath River mainstem downstream of Iron Gate Dam because coho salmon are typically tributary spawners, and because of the lack of spawning gravels in the mainstem Klamath River immediately downstream of Iron Gate Dam. Juvenile coho salmon that rear along the mainstem Klamath River typically congregate within available cold-water refugia near tributary mouths, springs and deep pools.

Little is known about residence time or habitat use in estuaries 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 have noted that most yearling coho salmon move through estuarine habitat fairly quickly (Miller and Sadro 2003 *op. cit* Wallace 2003, Myers and Horton 1982). Growth is very rapid once the smolts reach the estuary (Fisher *et al.* 1983). In preparation for their entry into a saline environment, juvenile salmon undergo physiological transformations known as smoltification that adapt them for their transition to salt water (Hoar 1976). These transformations include different swimming behavior and proficiency, lower swimming stamina, and increased buoyancy that also make the fish more likely to be passively transported by currents (Folmar and Dickhoff 1980, Saunders 1965, Smith 1982). In general, smoltification is timed to be completed as fish are near the freshwater to saltwater transition. Too long a migration delay after the process begins is believed to cause the fish to miss the "biological window" of optimal physiological condition for the transition (Walters *et al.* 1978).

While living in the ocean, coho salmon remain closer to their river of origin than do Chinook salmon (Weitkamp *et al.* 1995). Nevertheless, coho salmon have been captured several hundred to several thousand kilometers away from their natal stream (Hassler 1987). After about 12 months at sea, coho salmon gradually migrate south and along the coast, but some appear to follow a counter-clockwise circuit in the Gulf of Alaska (Sandercock 1991). Coho salmon typically spend two growing seasons in the ocean before returning to their natal streams to spawn as 3 year-olds. Some precocious males, called "jacks," return to spawn after only 6 months at sea.

2. Range-Wide (ESU) Status and Trends of SONCC Coho Salmon

For a summary of historical and current distributions of SONCC coho salmon in northern California, refer to CDFG's (2002) coho salmon status review, as well as the presence and absence update for the northern California portion of the SONCC coho salmon ESU (Brownell *et al.* 1999). NMFS summarized the available historic SONCC coho salmon abundance information in a coast-wide status review (Weitkamp *et al.* 1995) and status review updates (Good *et al.* 2005, NMFS 2001). All SONCC coho salmon stocks between Punta Gorda and Cape Blanco are depressed relative to past abundance (Weitkamp *et al.* 1995). NMFS (2001) concluded that population trend data for SONCC coho salmon taken from 1989-2000 show a continued downward trend throughout most of the California portion of the SONCC coho salmon ESU.

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). 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 into the wild population (NMFS 2001). Mad River and Iron Gate Hatcheries have both reduced production in recent years (NMFS 2001). The apparent decline in wild production in these rivers, in conjunction with significant hatchery production, suggests that natural populations of coho salmon are not self-sustaining (Weitkamp *et al.* 1995).

Brown *et al.* (1994) surveyed 115 of the 396 streams within the SONCC coho salmon ESU identified as once having coho salmon runs and reported that 42 (36 percent) of those streams - all within the Eel and Klamath River systems - have lost their runs. Table 2 provides summary statistics of historical and current presence-absence data for SONCC coho salmon. NMFS (2001) reported that the percent of streams within the California portion of the SONCC coho salmon ESU with at least one brood year of coho salmon present has declined from 80 percent of the streams surveyed between 1989 and 1995, to 69 percent in the most recent 3-year interval. Nehlsen *et al.* (1991) considered all but one coho salmon population in Oregon south of Cape Blanco to be at "high risk of extinction."

No regular spawning escapement estimates exist for natural SONCC coho salmon in California streams. Brown and Moyle (1991) suggested that naturally-spawned adult coho salmon runs in California streams were less than 1 percent of their abundance at mid-century, and estimated that wild coho salmon populations in California did not exceed 100 to 1,300 individuals. CDFG (1994) summarized most information for the northern California portion of this ESU, and concluded that "coho salmon in California, including hatchery stocks, could be less than 6 percent of their abundance during the 1940's, and have experienced at least a 70 percent decline in numbers since the 1960's." Further, CDFG (1994) reported that coho salmon populations have been virtually eliminated in many streams, and that adults are observed only every third year in some streams, suggesting that two of three brood cycles may already have been eliminated.

Table 2. Summary statistics of historical and current presence-absence data for SONCC coho salmon.

Area	**Percent of Streams with Coho Salmon Present**	
	Brown *et al.* (1994)	**More recent data (refer to Schiewe 1997 for data sources used)**
Del Norte County	55	46
Humboldt County	69	55
Both Counties	63	52

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.

Based on the very depressed status of current coho salmon populations discussed above, as well as insufficient regulatory mechanisms and conservation efforts over the ESU as a whole, NMFS concluded that the ESU was likely to become endangered in the foreseeable future (May 6, 1997, 62 FR 24588).

A recent status update (Good *et al.* 2005) included limited new information for SONCC coho salmon and a continued low abundance, with no apparent upward trends in abundance and possible continued declines in several California populations. The relatively strong 2001 brood year, likely due to favorable conditions in both freshwater and marine environments was viewed as a positive sign, but was a single strong year following more than a decade of generally poor years (Good *et al.* 2005). The Biological Review Team (BRT) ultimately determined that "none of these data contradict the conclusions the BRT reached previously. Nor do any recent data (1995 to present) suggest any marked change, either positive or negative, in the abundance or distribution of coho salmon within the SONCC ESU." For a discussion of the current viability of the SONCC coho salmon ESU, please see section 5, below.

3. Factors Responsible for SONCC Coho Salmon Decline

The SONCC coho salmon ESU was listed as threatened due to numerous factors including several long-standing, human-induced factors (*e.g.,* habitat degradation, harvest, water diversions, and artificial propagation) that exacerbate the adverse effects of natural environmental variability (*e.g.,* floods, drought, poor ocean conditions). Habitat factors that contributed to the decline of SONCC coho salmon included changes in channel morphology, substrate changes, loss of instream roughness and complexity, loss of estuarine habitat, loss of wetlands, loss and/or degradation of riparian areas, declines in water quality, altered stream flows, impediments to fish passage, and elimination of habitat. The major activities identified as responsible for the decline of coho salmon in Oregon and California by degrading their habitat included logging, road building, grazing, mining, urbanization, stream channelization, dams, wetland loss, beaver trapping, artificial propagation, over-fishing, water withdrawals, and unscreened diversions for irrigation (May 6, 1997, 62 FR 24588).

Disease and predation were not believed to have been major causes in the species decline; however, they may have had substantial impacts in local areas. For example, Higgins *et al.* (1992) and CDFG (1994) reported that Sacramento River pikeminnow have been found in the Eel River basin and are considered to be major threats to native coho salmon. Furthermore, California sea lions and Pacific harbor seals, which occur in most estuaries and rivers where salmonid runs occur on the West Coast, are known predators of salmonids. Coho salmon may be vulnerable to impacts from pinniped predation. However, in the final rule first listing the SONCC coho salmon ESU (May 6, 1997, 62 FR 24588), NMFS indicated that it was unlikely that pinniped predation was a significant factor in the decline of coho salmon on the west coast, although they may be a threat to existing depressed local populations. NMFS (1997) determined that although pinniped predation did not cause the decline of salmonid populations, in localized areas where they co-occur with salmonids (especially where salmonids concentrate or passage may be constricted), predation may preclude recovery of these populations. Specific areas where predation may preclude recovery cannot be determined without extensive studies.

Artificial propagation is also a factor in the decline of coho salmon due to the genetic effects on indigenous, naturally-reproducing populations, disease transmission, predation of wild fish, depletion of wild stock to enhance brood stock, and replacement rather than supplementation of wild stocks through competition and the continued annual introduction of hatchery fish. Artificial propagation and other human activities such as harvest and habitat modification can genetically change natural populations so much that they no longer represent an evolutionarily significant component of the biological species (Waples 1991). Artificial propagation may also have been a factor in the decline of coho salmon in California, although the degree of impact is unknown. The Trinity River basin historically supported abundant coho salmon runs (Weitkamp *et al.* 1995). The State of California operates Trinity River Hatchery on the Trinity River, which was constructed to mitigate for lost habitat upstream due to dam construction. The vast majority of coho salmon runs in the Trinity River consist of those with recent hatchery heritage. Competition may occur among hatchery and native adults for spawning sites, and may lead to decreased production. Hatchery fish may outnumber wild fish and monopolize available spawning habitat when wild stocks are small and hatchery supplementation occurs. The negative effect of such competition can be magnified by naturally spawning hatchery stocks having lower spawning success than do wild fish. Hatchery stocks may also produce fewer smolts and returning adults. Competition might be occurring in the mainstem of the Klamath and Trinity Rivers among hatchery and wild salmonids, resulting in low survival of both. When non-native hatchery strays spawn in the wild, young fish with some non-native genes may result. The impact of stock transfers may increase dramatically if non-native salmonids are planted on top of wild populations for several generations, and a loss of local adaptations may lead to extirpation of that local stock. Large differences in the genetic structure of wild and hatchery stocks may potentially lead to lower survival rates. Further, supplementation with hatchery stocks can have differing effects depending on the size of the wild population.

Existing regulatory mechanisms, including land management plans (*e.g.,* National Forest Land and Resource Management Plans, State Forest Practice Rules), Clean Water Act section 404 activities, urban growth management, and harvest and hatchery management all contributed by varying degrees to the decline of coho salmon due to lack of protective measures, the inadequacy of existing measures to protect coho salmon and/or its habitat, or the failure to carry out established protective measures. Since the listing of the SONCC coho salmon ESU, no new threats have been identified.

4. Environmental Influences on Salmonid Populations

a. Climate Change

The acceptance of global warming as a scientifically valid and anthropogenically driven phenomenon has been well established by the United Nations Framework Convention on Climate Change (2006) and Davies *et al.* (2001). These changes are inseparably linked to the oceans, the biosphere, and the world's water cycle. Changes in the distribution and abundance of a wide array of biota confirm a warming trend is in progress, and that it has great potential to affect species' survival (Davies *et al.* 2001, Schneider and Root 2002). In general, as the magnitude of climate fluctuations increases, the population extinction rate also increases (Good *et al.* 2005). Global warming is likely to manifest itself differently in different regions and considerable uncertainty exists on the longer term evolution of climatic patterns. For example, in California, the overall amount of precipitation may increase, but will also be coupled with an increase in critically dry years, which suggests that storms may become more intense (Cayan *et al.* 2006). Many of the threats to Pacific salmonids are related to poor streamflow conditions, elevated water temperatures and excessive sediment. Changes in the precipitation regime would be expected to alter these processes and potentially increase extinction risks to Pacific salmonids across their range.

b. Ocean Conditions

Variability in ocean productivity has been shown to affect salmon production both positively and negatively. Beamish and Bouillion (1993) showed a strong correlation between North Pacific salmon production and marine environmental factors from 1925 to 1989. Beamish *et al.* (1997) noted decadal-scale changes in the production of Fraser River sockeye salmon that they attributed to changes in the productivity of the marine environment. They also reported the dramatic change in marine conditions occurring in 1976-77 (an El Niño year), when an oceanic warming trend began. These El Niño conditions, which occur every 3 to 5 years, negatively affect ocean productivity. Johnson (1988) noted increased adult mortality and decreased average size for Chinook salmon and coho salmon in Oregon during the strong 1982-83 El Niño. Of greatest importance is not how salmonids perform during periods of high marine survival, but how prolonged periods of poor marine survival affect the viability of populations. Salmon populations have persisted over time, under pristine habitat conditions, through many such cycles in the past.

c. Reduced Marine-Derived Nutrient Transport

Reduction of marine-derived nutrients (MDN) to watersheds is a consequence of the past century of decline in salmon abundance (Gresh *et al.* 2000). MDN are nutrients that are accumulated in the biomass of salmonids while they are in the ocean and are then transferred to their freshwater spawning sites where the salmon die. Salmonids likely play a critical role in sustaining the quality of habitats essential to the survival of their own species. MDN (from salmon carcasses) has been shown to be vital for the growth of juvenile salmonids (Bilby *et al.* 1996, 1998). The return of salmonids to rivers makes a significant contribution to the flora and fauna of both terrestrial and riverine ecosystems (Gresh *et al.* 2000). Evidence of the role of MDN and energy in ecosystems suggests this deficit may result in an ecosystem failure contributing to the downward spiral of salmonid abundance (Bilby *et al.* 1996). The loss of this nutrient source may perpetuate salmonid declines in an increasing synergistic fashion.

5. Population Viability

One prerequisite for predicting the effects of a proposed action on a species is the understanding of whether the broad population (note that "broad population" and "ESU" are used synonymously throughout this discussion) is likely to experience long-term viability, *i.e.*, when extinction risk of the broad population is negligible, and whether the proposed action can be expected to reduce this likelihood. In order to determine the current viability of the SONCC coho salmon ESU, we use the historical population structure of SONCC coho salmon presented in Williams *et al.* (2006) and the concept of VSP and the parameters for evaluating populations described by McElhany *et al.* (2000). 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 or dependent; figure 2). Nineteen historical populations were characterized as Functionally Independent, defined as those sufficiently large to be historically viable-in isolation and whose demographics and extinction risk were minimally influenced by immigrants from adjacent populations. Twelve historical populations were characterized as Potentially Independent, defined as those that were potentially viable-in-isolation, but that were demographically influenced by immigrants from adjacent populations. Seventeen historical populations were characterized as Dependent, which are believed to have had a low likelihood of sustaining themselves over a 100-year time period in isolation and that received sufficient immigration to alter their dynamics and extinction risk. Finally, two historical populations were characterized as Ephemeral, defined as populations that were both small enough and isolated enough that they were only intermittently present. There are nine population units within the Klamath River basin, as follows: (1) The Lower Klamath River, Upper Klamath River, Scott River, Shasta River, South Fork Trinity River, and Upper Trinity River population units are Functionally Independent; and (2) the Middle Klamath River, Salmon River, and Lower Trinity River population units are Potentially Independent (Williams *et al.* 2006).

Williams *et al.* (2007) proposes the minimum number of spawners for each population to be categorized as a low risk for extinction, or considered a viable salmonid population (based on spatial structure and diversity). The abundance of spawners is just one of several criteria that must be met for a population to be considered viable. A population must meet all the criteria low-risk thresholds to be considered viable. Williams *et al.* (2007), however, acknowledged that a viable salmonid population at the ESU scale is not merely a quantitative number (*i.e.*, the additive spawner numbers of all of the populations within the ESU) that needs to be attained, but rather, for an ESU to persist, populations within the ESU must be able to track changes in environmental conditions. When the location or distribution of an ESU's habitat changes, a species can avoid extinction either by adapting genetically to the new environmental conditions, or by spatially tracking the environmental conditions to which it is adapted (Pease *et al.* 1989 *op. cit.* Williams *et al.* 2007). An ESU persists in places where it is able to track environmental changes, and becomes extinct if it fails to keep up with the shifting distribution of suitable habitat (Thomas 1994 *op. cit.* Williams *et al.* 2007). Therefore, Williams *et al.* (2006) provides a set of rules that will result in certain configurations of populations that they believe will result in a viable ESU. First, using the historical populations, Williams *et al.* (2007) organized the independent and dependent populations of coho salmon in the SONCC ESU into diversity strata largely based on the geographical arrangement of the populations and basin-scale environmental and ecological characteristics. In order for the SONCC coho salmon ESU to be viable, each of the diversity strata needs to be viable. Second, in order for a diversity stratum to be viable, at least two, or 50 percent of the independent populations (Functionally Independent or Potentially Independent), whichever is greater, must be viable, and the abundance of these viable independent populations collectively must meet or exceed 50 percent of the abundance predicted

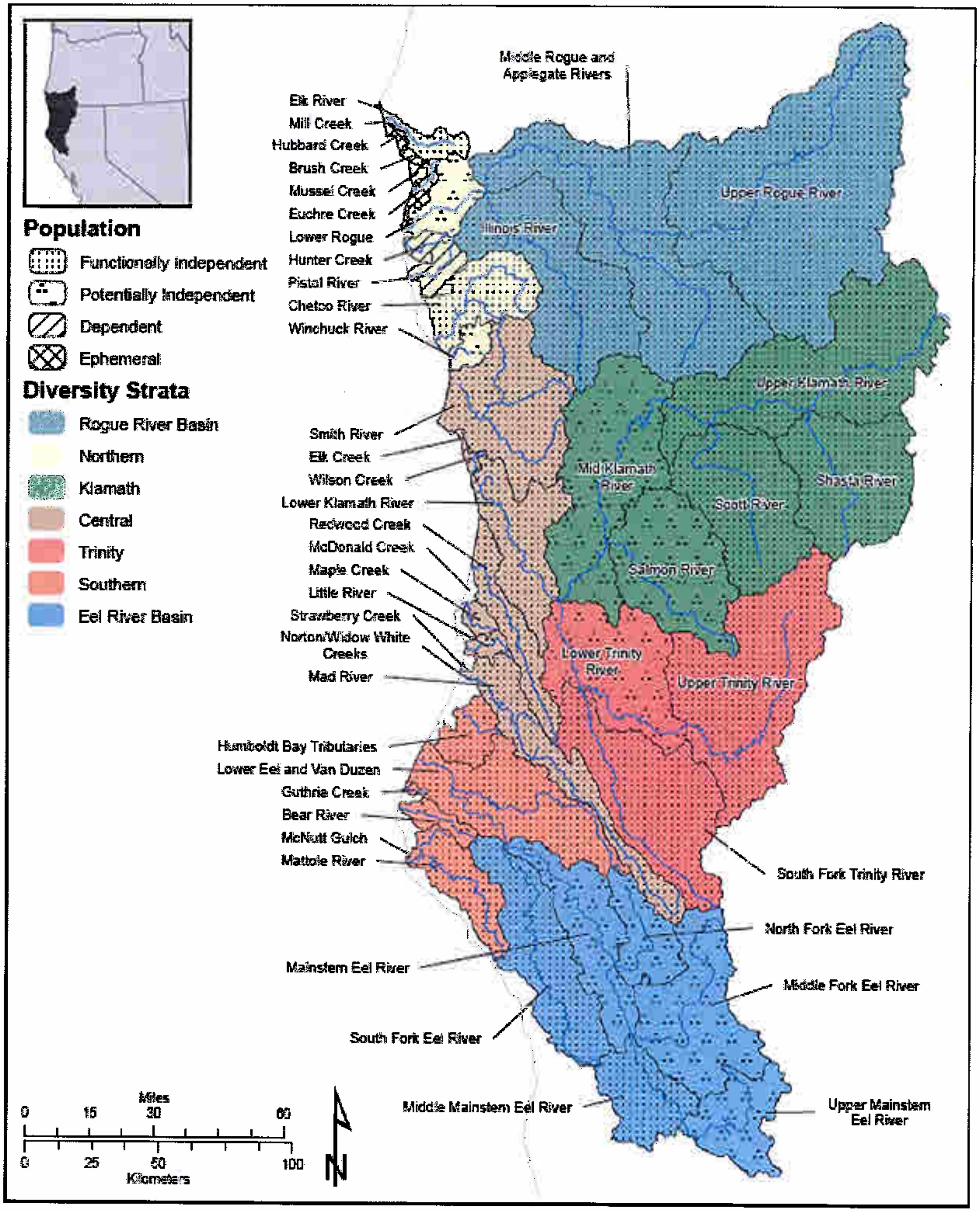

Figure 2. Diversity strata for populations of coho salmon in the SONCC ESU. From Williams *et al.* (2007).

within the diversity stratum when it is at low risk of extinction (table 3). Third, all dependent and independent populations not expected to meet the low-risk threshold within a diversity stratum must exhibit occupancy patterns that indicate sufficient immigration is occurring from the "core populations." Finally, the distribution of extant populations, both dependent and independent, needs to maintain connectivity within and among diversity strata.

Four principal parameters were used to evaluate the extinction risk for threatened SONCC coho salmon: population size, population growth rate, spatial structure, and diversity. These specific parameters are important to consider because they are predictors of extinction risk, and the parameters reflect general biological and ecological processes that are critical to the growth and survival of salmon (McElhany *et al.* 2000). Guidelines have been defined for each of the four parameters to further the viability evaluation. Because some of the guidelines are related or overlap, the evaluation is at times necessarily repetitive. The following provides the evaluation of viability for the threatened SONCC coho salmon ESU.

Table 3. Diversity strata of the SONCC coho salmon ESU, including population type (F: functionally independent, P: potentially independent, D: dependent, and E: ephemeral), population unit name, the low-risk Spatial Structure and Diversity threshold value of number of spawners for independent populations (both functionally and potentially independent populations), and the number of spawners needed to satisfy the 50 percent of the total number of spawners in a strata needed to meet stratum viability. Data taken from Williams *et al.* (2007).

Stratum	Pop. type	Population Unit	Spawner Threshold Low Risk N_a
Central Coastal Basins	F	Lower Klamath River	5,900
		10 other population units	21,500
		50 percent total stratum N_a	13,200
Interior - Klamath	P	Middle Klamath River	3,900
	F	Upper Klamath River	8,500
	P	Salmon River	4,000
	F	Scott River	8,800
	F	Shasta River	10,600
		50 percent total stratum N_a	17,900
Interior - Trinity	F	South Fork Trinity River	6,400
	P	Lower Trinity River	3,900
	F	Upper Trinity River	2,400
		50 percent total stratum N_a	12,700

a. Population Size

Information about population size provides an indication of the sort of extinction risk that a population faces. For instance, small populations are at a greater risk of extinction than large populations because the processes that affect populations operate differently in small populations than in large populations (McElhany *et al.* 2000). Variation in environmental conditions leading to low levels of species survival or fecundity for extended time can cause extinction of small populations. McElhany *et al.* (2000) provides the following viable population size guidelines that must be met in order for an ESU to be considered viable with regard to the population size parameter.

1. A population should be large enough to have a high probability of surviving environmental variation of the patterns and magnitudes observed in the past and expected in the future
2. A population should have sufficient abundance for compensatory processes to provide resilience to environmental and anthropogenic perturbations
3. A population should be sufficiently large to maintain its genetic diversity over the long term
4. A population should be sufficiently abundant to provide important ecological functions throughout its life cycle

The BRT remained concerned about low population abundance throughout the SONCC coho salmon ESU relative to historical numbers and long-term downward trends in abundance. However, risk assessments continue to be hindered by the paucity of data on escapement of naturally produced spawners in most basins (Weitkamp *et al.* 1995). Short- and long-term trends in mean spawner abundance are upward in the Rogue River. However, the positive trends reflect effects of reduced harvest, rather than improved freshwater conditions (Weitkamp *et al.* 1995). Less reliable indices of spawner abundance in several California populations reveal no apparent trends in some populations and suggest possible continued declines in others (Weitkamp *et al.* 1995).

The number of individuals required to provide ecological functions depend mostly on the structure of the species' habitat and biology (McElhany *et al.* 2000). With regard to the species' habitat, a variety of anthropogenic factors have reduced the quality and quantity of habitat for coho salmon (Good *et al.* 2005; Weitkamp *et al.* 1995; May 7, 1997, 62 FR 24588), and certain habitat functions have been either eliminated or reduced (*e.g.*, in the case of a dam blocking migration of coho salmon to historical spawning and rearing habitats, or in the case of water releases from dams that are not compatible with the life history and habitat requirements of coho salmon). The BRT considered the relatively low occupancy rates of historical coho salmon streams (between 37 and 61 percent from broodyears 1986 to 2000) as an indication of continued low abundance in the California portion of this ESU (Weitkamp *et al.* 1995).

Genetic variability is important because differing genetic traits favor a population being able to survive and reproduce under changing environmental conditions. With regard to the SONCC coho salmon ESU, anthropogenic activities (including migration barriers, *e.g.*, Iron Gate Dam on the Klamath River and Lewiston Dam on the Trinity River) have eliminated portions of some coho salmon populations from the broad population. In addition, runs of coho salmon within the Klamath River basin are now composed largely of hatchery fish from Iron Gate and Trinity River Hatcheries. An assessment of the effects of the Rogue River Hatchery, Iron Gate Hatchery, and Trinity River Hatchery on the viability of the SONCC coho salmon ESU in-total concluded that they decrease risk of extinction by contributing to increased ESU abundance, especially in the Rogue and Trinity Rivers (June 28, 2005, 70 FR 37160).

b. Population Growth Rate

The productivity of a population (*i.e.*, the number of individuals generated over a specified time interval) can reflect conditions (*e.g.*, environmental conditions) that influence the dynamics of a population and determine abundance. In turn, the productivity of a population allows an understanding of the performance of a population across the landscape and habitats in which it exists and its response to those habitats (McElhany *et al.* 2000). McElhany *et al.* (2000) provides the following population growth rate guidelines that must be met in order for an ESU to be considered viable with regard to the population size parameter.

1. A population's natural productivity should be sufficient to maintain its abundance above the viable level
2. A viable population that includes naturally spawning hatchery fish should exhibit sufficient productivity from naturally-produced spawners to maintain population abundance at or above viability thresholds in the absence of hatchery subsidy
3. A viable population should exhibit sufficient productivity during freshwater life-history stages to maintain its abundance at or above viable thresholds – even during poor ocean conditions
4. A viable population should not exhibit sustained declines in abundance that span multiple generations and affect multiple brood-year cycles
5. A viable salmonid population should not exhibit trends or shifts in traits that portend declines in population growth rate
6. Population status evaluations should take into account uncertainty in estimates of population growth rate and productivity-related parameters

Natural productivity can be measured as the ratio of naturally-produced spawners born in one brood year to the number of fish spawning in the natural habitat during that brood year. Under the foregoing scenario, the spawner-to-spawner ratio should fluctuate around 1.0 or higher to maintain abundance, *i.e.*, cohorts should be replacing one another at least equally. Information regarding natural productivity of SONCC coho salmon is lacking. However, the magnitude of the decline in the abundance of adult coho salmon in the ESU (Good *et al.* 2005, Weitkamp *et al.* 1995), by itself, indicates the number of spawners has not been replenished. The apparent decline in wild production in these rivers, in conjunction with significant hatchery production, suggests that natural populations of coho salmon are not self-sustaining (Weitkamp *et al.* 1995). In contrast, both long- and short-term productivity trends for Rogue River natural spawners are above replacement (June 14, 2004, 69 FR 33102).

NMFS determined that the Coles River Hatchery, Trinity River Hatchery, and Iron Gate Hatchery coho salmon hatchery programs are considered to be part of the ESU, and that these artificially propagated stocks are no more divergent relative to the local natural populations than what would be expected between closely related natural populations within the ESU (June 28, 2005, 70 FR 37176). However, in both the Klamath River and Trinity River systems, runs have been greatly diminished and are now composed largely of hatchery fish, although there may be small wild runs remaining in some tributaries (CDFG 1994). An assessment of the effects of the Rogue River Hatchery, Iron Gate Hatchery, and Trinity River Hatchery on the viability of the SONCC coho salmon ESU in-total concluded that they have a positive effect on abundance, and neutral or uncertain effect on the productivity, spatial structure and diversity of the ESU (June 28, 2005, 70 FR 37160).

c. *Spatial Structure*

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 following guidelines focus on key processes that are likely to be important in maintaining a viable spatial structure.

1. Habitat patches should not be destroyed faster than they are naturally created
2. Natural rates of straying among subpopulations should not be substantially increased or decreased by human actions
3. Some habitat patches should be maintained that appear to be suitable or marginally suitable, but currently contain no fish
4. Source subpopulations should be maintained

Relatively low levels of observed presence in historically occupied coho salmon streams (32-56 percent from 1986 to 2000) indicate continued low abundance in the California portion of the SONCC coho salmon ESU. The relatively high occupancy rate of historical streams observed in broodyear 2001 suggests that much habitat remains accessible to coho salmon (June 14, 2004, 69 FR 33102). Brown *et al.* (1994) found survey information on 115 streams within the SONCC coho salmon ESU, of which 73 (64 percent) still supported coho salmon runs while 42 (36 percent) did not. The streams Brown *et al.* (1994) identified as presently lacking coho salmon runs were all tributaries of the Klamath River and Eel River systems. The BRT was also concerned about the loss of local populations in the Trinity, Klamath, and Rogue River basins (June 14, 2004, 69 FR 33102). CDFG (2002) reported a decline in SONCC coho salmon occupancy, the percent reduction dependent on the data sets used. Although there is considerable year-to-year variation in estimated occupancy rates, it appears that there has been no dramatic change in the percent of coho salmon streams occupied from the late 1980s and early 1990s to 2000 (Good *et al.* 2005). On the negative side was the modest percentage of historical streams still occupied by coho salmon (suggestive of local extirpations or depressed populations). On the positive side, extant populations can still be found in all major river basins within the ESU (June 14, 2004, 69 FR 33102).

Anthropogenic activities have reduced the number of streams and amount of habitat available to SONCC coho salmon. Man-made barriers constructed on numerous streams have rendered the streams unavailable to adult SONCC coho salmon. Within the 10 historical populations that have dams, 26.4 percent of historical habitat is currently located upstream of the dams, including Iron Gate Dam on the Klamath River and Lewiston Dam on the Trinity River (table 5 in Williams *et al.* 2007).

Throughout the California portion of the SONCC coho salmon ESU, many road crossing culverts have impeded fish passage and precluded access to many miles of spawning and rearing habitat. Since implementation of the Northwest Forest Plan began in 1994, there has been a concerted effort among the Klamath, Six Rivers, Mendocino, and Shasta-Trinity National Forests to improve fish passage at road-stream crossings. These activities have resulted in both increased access for the listed salmonids to previously inaccessible habitat, and also reductions in the probability of stream crossing failure during flood flows. In addition, in 1999, the Five Counties Salmonid Conservation Program (2006) began to inventory migration barriers on County roads within Mendocino, Humboldt, Del Norte, Siskiyou, and Trinity Counties. A total of 208 migration barriers were identified on county roads. As barriers were identified in each county, they were ranked in an order from high to low priority to fix, using site-specific information weighted heavily towards the biological considerations of anadromous salmonids. As of November 2006, 48 fish passage improvement projects have been implemented within the five-county area that provided access to 118.84 miles of anadromous salmonid habitat, including up to 83.2 miles of coho salmon spawning and rearing habitat (Five Counties Salmonid Conservation Program 2006).

Finally, when irrigation season begins and diversions degrade instream water quality and flow levels, coho salmon parr are pushed out of their rearing habitat and forced to rear elsewhere (*e.g.*, Chesney and Yokel 2003).

As a result of the anthropogenic activities, described above, that suggest that the spatial structure of SONCC coho salmon has been reduced, coho salmon straying into non-natal streams has likely increased. The rationale is based on the simple fact that because streams (or habitats needed for specific life-history functions) that used to support adult and juvenile coho salmon are no longer accessible to the species, coho salmon would need to enter streams that are accessible. Increased stray rates would be expected to reduce population viability, particularly if the strays are accessing unsuitable habitat or are inbreeding with genetically unrelated individuals (McElhany *et al.* 2000).

An assessment of the effects of the Rogue River Hatchery, Iron Gate Hatchery, and Trinity River Hatchery on the viability of the SONCC coho salmon ESU in-total concluded that they have a neutral or uncertain effect on the spatial structure of the ESU (June 14, 2004, 69 FR 33102).

d. Diversity

Salmon possess a suite of life history 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 following are diversity guidelines.

1. Human-caused factors such as habitat changes, harvest pressures, artificial propagation, and exotic species introduction should not substantially alter variation in species' traits
2. Natural processes of dispersal should be maintained – human-caused factors should not substantially alter the rate of gene flow among populations
3. Natural processes that cause ecological variation should be maintained
4. Population status evaluations should take uncertainty about requisite levels of diversity into account

As discussed above, under *Spatial Structure*, SONCC coho salmon have been either eliminated or severely reduced in many drainages due to a variety of anthropogenic factors, including the construction of fish passage impediments. Within the 10 historical populations that have dams, 26.4 percent of historical habitat is currently located upstream of the dams (table 5 in Williams *et al.* 2007). Loss of or limiting spawning and rearing opportunities are expected to adversely affect the species' basic demographic and evolutionary processes, causing a reduced potential that the ESU can withstand environmental fluctuations. Activities that affect evolutionary processes (*e.g.*, natural selection) have the potential to alter the diversity of the species. Although extant populations reside in all major river basins within the ESU, the BRT was concerned about the loss of local populations in the Trinity River, Klamath River, and Rogue River systems (June 14, 2004, 69 FR 33102).

The high hatchery production in these systems may mask trends in ESU population structure and pose risks to ESU diversity (June 14, 2004, 69 FR 33102). An assessment of the effects of the Rogue River Hatchery, Iron Gate Hatchery, and Trinity River Hatchery on the viability of the SONCC coho salmon ESU in-total concluded that they have a neutral or uncertain effect on the diversity of the ESU (June 14, 2004, 69 FR 33102).

6. Status Summary

To summarize the status of SONCC coho salmon, we use the concept of VSP and the parameters for evaluating populations described by McElhany *et al.* (2000). The parameters are abundance, population growth rate, spatial structure and population diversity.

a. Abundance. In general, smaller populations face a host of risks intrinsic to their low abundance levels. Our review of the status of SONCC coho salmon indicates that populations have declined well below historical levels. A host of factors has been responsible for these declines.

b. Population Growth Rate. The most recent data indicate continued declines in several populations of the SONCC coho salmon ESU (reduced or negative population growth rate), and no apparent trends in the other remaining coho salmon populations.

c. Population Spatial Structure. 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, extant populations can still be found in all major river basins within the ESU (June 14, 2004, 69 FR 33102).

d. Diversity. The primary factors affecting the diversity of SONCC coho salmon appear to be the influence of hatcheries and out-of-basin introductions. 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.

e. 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). Due to data limitations, Williams *et al.* (2007) were not able to assess the viability of the SONCC coho salmon ESU with the quantitative approach they proposed, however, they agree with the previous assessments in CDFG (2002), Good *et al.* (2005), and Weitkamp *et al.* (1995) that SONCC coho salmon are likely to become endangered in the foreseeable future. Based on the above descriptions of the population viability parameters, and qualitative viability criteria presented in Williams *et al.* (2007), NMFS believes that the SONCC coho salmon ESU is currently not viable and is at moderate risk of extinction.

C. SONCC Coho Salmon Critical Habitat

This Opinion describes the effects of the Project on designated critical habitat for SONCC coho salmon, which includes all accessible waterways, substrate, and adjacent riparian zones within the Klamath River watershed. Excluded are: (1) areas above specific dams identified in the federal register (FR) notice, including 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. Within the range of SONCC coho salmon, the species' life cycle can be separated into five essential habitat types: (1) juvenile summer and winter rearing areas, (2) juvenile migration corridors, (3) areas for growth and development to adulthood, (4) adult migration corridors, and (5) spawning areas. In designating critical habitat, NMFS considers the following requirements of the species: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring; and, generally, (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species [see 50 CFR 424.12(b)]. In addition to these factors, NMFS also focuses on the known physical and biological features (primary constituent elements) within the designated area that are essential to the conservation of the species and that may require special management considerations or protection. These essential features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

1. Conservation Value of Designated Critical Habitat

The condition of SONCC coho salmon designated critical habitat reflects the legacy of impacts to the ESU. Land management activities have led to widespread habitat degradation. In particular, habitat elements for access, rearing, and reproduction have been impacted due to the combination of timber harvest and alterations in the natural flow regimes of larger rivers. Access has been restricted due to a number of large dams that form a total migration blockage. On a more localized scale, excessive sedimentation has led to aggraded stream reaches that dry up sooner and may prevent migration of juveniles. Similarly, excessive sedimentation and lack of woody debris has led to declines in the quantity and quality of pools and substrate quality necessary for juvenile rearing. Reproductive success has declined due to excessive sediment which has filled spawning gravels and reduced the quantity of suitable spawning habitat. Under these conditions, fry emergence rates have declined.

Although watershed restoration activities have improved freshwater critical habitat conditions in isolated areas, reduced habitat complexity, poor water quality, and reduced habitat availability as a result of continuing land management practices continue to persist in many locations and are likely limiting the conservation value (*i.e.*, limiting the numbers of salmonids that can be supported) of designated critical habitat within these freshwater habitats at the ESU scale.

V. ENVIRONMENTAL BASELINE

The environmental baseline includes "the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process" (50 CFR 402.02). The environmental baseline provides a reference condition to which we add the effects of operating the Project, as required by regulation ("effects of the action" in 50 CFR 402.02).

As previously discussed, the action area is primarily restricted to the mainstem Klamath River and adjacent riparian habitat extending from the Klamath River estuary upstream to Spencer Creek (rm 228); the exception is short sections of Jenny Creek, Spring Creek, Fall Creek, Shovel Creek and Negro Creek as described within the *Description of the Action Area* section.

The biological requirements of SONCC coho salmon in the action area vary depending on the life history stage present and the natural range of variation present within that system (Groot and Margolis 1991, Spence *et al.* 1996). For this consultation, the biological requirements for SONCC coho salmon are the habitat characteristics that would support successful adult spawning, embryonic incubation, emergence, juvenile rearing, holding, migration and feeding in the action area. Generally, during salmonid spawning migrations, adult salmon prefer clean water with cool temperatures and access to thermal refugia, DO near 100 percent saturation, low turbidity, adequate flows and depths to allow passage over barriers to reach spawning sites, and sufficient holding and resting sites. Anadromous fish select spawning areas based on species-specific requirements of flow, water quality, substrate size, and groundwater upwelling. Embryo survival and fry emergence depend on substrate conditions (*e.g.,* gravel size, porosity, permeability, and DO concentrations), substrate stability during high flows, and, for most species, water temperatures of 13°C or less. Habitat requirements for juvenile rearing include seasonally suitable microhabitats for holding, feeding, and resting. Migration of juveniles to rearing areas requires access to these habitats. Physical, chemical, and thermal conditions may all impede movements of adult or juvenile fish.

The Klamath River basin covers approximately 1,531 square miles of the mainstem Klamath River and associated tributaries (excluding the Trinity, Salmon, Scott and Shasta River sub-basins) from the estuary to Link River Dam. Although anadromous fish passage is currently blocked at Iron Gate Dam (rm 190), coho salmon are thought to have populated the basin at least up to and including Spencer Creek at rm 228 (Hamilton *et al.* 2005). Today, coho salmon occupy a small fraction of their historical area [National Academy of Sciences (NAS) 2004].

This *Environmental Baseline* section is organized into three parts. First, we describe the seasonal periodicity and life history traits of coho salmon within the Klamath River. Next is a synopsis of the general factors currently affecting coho salmon and its habitat within the entire Klamath River basin, followed by a detailed description of the current habitat conditions within each of the three mainstem Klamath River Population Units (Lower, Middle and Upper) and the past and current impacts that precipitated those conditions. The final section will detail the current viability of the Lower, Middle, and Upper Klamath Population Units, as well as the Shasta and Scott Population Units.

A. Periodicity of Coho salmon within the Action Area

As detailed within the *Status of the Species* section, coho salmon were once numerous and widespread within the Klamath River basin, but now the small populations that remain occupy limited habitat within tributary watersheds and the mainstem Klamath River below Iron Gate Dam (NAS 2004). Coho salmon utilize varied freshwater habitat largely based upon life-stage and season. However, habitat use can also be influenced by the quality of existing habitat and watershed function (or lack thereof), factors which likely play a large role in coho salmon survival within the impaired Klamath River basin. This section outlines suspected life-history traits and seasonal periodicities of coho salmon inhabiting the Klamath River, specifically within the action area (*i.e.*, mainstem Klamath River; figure 3).

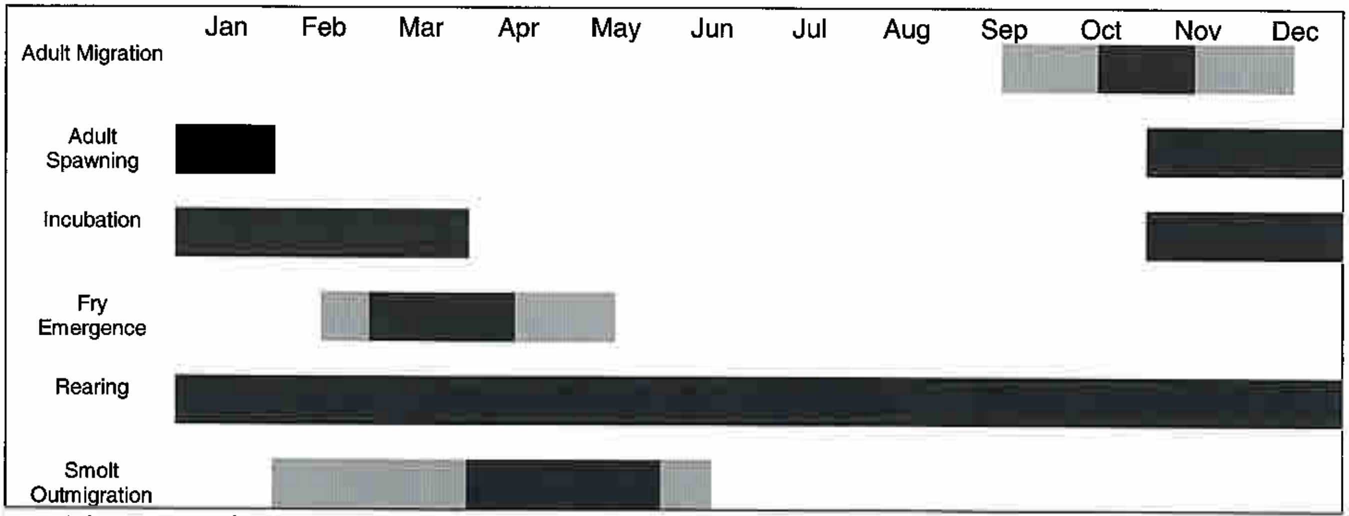

Figure 3. Life stage periodicities for coho salmon within the Klamath River basin. Black areas represent peak use periods, whereas those shaded gray indicate non-peak periods (Sources: Leidy and Leidy 1984, NAS 2004, USFWS 1998).

1. Adult Migration and Spawning

Adult coho salmon typically begin entering the lower Klamath River in late September, with peak migration between late October and mid-November (NAS 2004). Late arrivals continue to show within the Iron Gate Dam to Seiad Valley reach through late December (USFWS 1998). A small percentage of the adult spawning run is made up of precocious males, or "jacks," which return to spawn as 2-year olds. 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 with unimpeded access, functional riparian corridors and clean spawning gravel. Coho salmon spawning within the Klamath River basin usually commences within a few weeks after arrival at the spawning grounds (NAS 2004), and is thought to occur between November and January (Leidy and Leidy 1984).

Although uncommon, coho salmon spawning has been documented within the mainstem Klamath River. From 2001 to 2005, Magnuson and Gough (2006) documented a total of 38 coho salmon redds (egg "pockets" within the streambed gravels) between Iron Gate Dam (rm 190) and the Indian Creek confluence (rm 109), although over two-thirds of the redds were found within 12 rm of the dam. Many of these fish likely originated from Iron Gate Hatchery, which annually releases a large number of captured coho salmon back to the river once broodstock needs are met. Progeny of mainstem spawning coho salmon likely experience reduced survival compared to fish produced from tributary spawners (Simondet 2006). Accordingly, Simondet (2006) suggested the survival of these fish would be higher if the fish could utilize tributary habitat upstream of Iron Gate Dam rather than mainstem habitat below. Magneson and Gough (2006) suggest the high incidence of coho salmon redds near Iron Gate Dam indicate adult fish are unsuccessfully attempting to access and utilize upper basin habitat within the Project.

The condition of spawning habitat within the lower basin (*i.e.,* Iron Gate Dam to the ocean) is generally poor, with many tributaries suffering from elevated instream sediment concentrations and impeded upstream passage (usually resulting from poorly functioning road crossings, see NMFS 2007a for overview). However, suitable spawning and rearing habitats exist within each of the three mainstem population units. For instance, several mid-size tributaries within the Lower and Middle Klamath Population Units contain accessible, high quality coho salmon habitat, including Bluff, Red Camp, Boise, Camp, and Blue Creek (NMFS 2007a). The Shasta and Scott Rivers were once highly productive coho salmon watersheds, but agriculture and timber operations have severely degraded instream habitat conditions within both basins. Mainstem spawning habitat below Iron Gate Dam is currently limited, since the introduction of spawning gravel from upstream sources has been interrupted by the Project's dams.

2. Egg Incubation and Fry Emergence

Coho salmon eggs typically hatch within 8 to 12 weeks following fertilization, although colder water temperatures may lengthen the process (Bjornn and Reiser 1991). Upon hatching, coho salmon alevin (newly hatched fish with yolk sac attached) remain within the redd 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 (NAS 2004). Within the Klamath River, fry begin emerging in mid-February and continue through mid-May (Leidy and Leidy 1984).

3. Juvenile Rearing

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). As coho salmon fry grow larger, they transform physically (developing vertical dark bands or "parr marks"), and behaviorally begin partitioning available instream habitat through aggressive interactions with other juvenile fish (Groot and Margolis 1991). At this time, these 50-60 mm fish are commonly referred to as "parr," and will remain at this stage until they migrate to the sea the following spring. Typical parr rearing habitat consists of slow moving, complex pool habitat commonly found within small, heavily forested tributary streams. 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). This can be especially true within the Klamath River, where millions of Chinook salmon fry are released annually each spring from Iron Gate Hatchery and likely compete with juvenile coho salmon for food and shelter.

Tributary rearing habitat currently accessed by Klamath River coho salmon is largely compromised to some degree, most commonly by high instream sediment concentrations or dysfunctional riparian function (see NMFS 2007a for review). High instream sediment concentrations can fill in pools and simplify instream habitat, whereas impaired riparian habitat can exacerbate streamside erosion rates and hinder wood input to the stream environment (Spence *et al.* 1996). Both of these processes are common within the Middle and Lower Klamath Population Units, where wide-scale timber harvesting has occurred in many tributary basins.

Despite documented coho salmon preference for tributary rearing habitat, significant numbers of juvenile coho salmon have been observed residing within the mainstem Klamath River downstream of Iron Gate Dam within the Upper Klamath Population Unit throughout the summer and early fall. 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 (NAS 2004, Sutton *et al.* 2004). The majority of rearing coho salmon have been documented within Beaver and Tom Martin Creeks (rm 163 and 143, respectively; Soto 2007), whereas juvenile coho salmon have not been documented, or documented in very small numbers, utilizing cold water refugial areas within the Middle and Lower Klamath Population Units. No coho salmon were observed within extensive cold-water refugial habitat adjacent to lower river tributaries such as Elk Creek (rm 107), Red Cap Creek (rm 53), and Blue Creek (rm 16) during past refugial studies (Sutton *et al.* 2004). More recently, beach seining of the Pecwan Creek (rm 25) and Blue Creek refugial areas on a semi-daily basis between June and August 2007 captured 15 wild coho salmon parr (Naman and Bowers 2007). Yet, these 15 coho salmon made up just 0.18 percent of the total number of juvenile salmonids sampled (juvenile Chinook salmon accounted for over 90 percent of the total). These findings suggest summer rearing by juvenile coho salmon within the mainstem Klamath River occurs primarily within the reach between Iron Gate Dam and Seiad Valley and is rare within areas downstream.

Redistribution of 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 in the downstream direction in search of suitable winter habitat (Lestelle 2007). 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). Although the number of juvenile coho salmon relocating within the Klamath River basin is unknown, Ackerman and Kramer (2006) assumed 3-11 percent of the population emigrated from tributary habitat into the mainstem.

4. Smolt Outmigration

Each spring, 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. Within the Klamath River, at least 11 percent of wild coho salmon smolts exhibited rearing-type behavior during their downstream migration (Stutzer *et al.* 2006). Both actively migrating and rearing coho salmon smolts were observed most often within large pools and other low velocity habitat (Stutzer *et al.* 2006). Salmonid smolts may further delay their downstream migration by residing in the lower river and estuary for several weeks, slowly acclimating to the saline environment before entering the ocean. Sampling indicates coho salmon smolts are largely absent from the Klamath River estuary by July (NAS 2004).

B. General Factors Affecting SONCC Coho Salmon in the Action Area

The Klamath River basin suffers from much natural and anthropogenic impairment that limits coho salmon production. Foremost is the over-allocated nature of water resources throughout the mainstem Klamath River and major sub-basins, which is generally acknowledged as a major contributor to the poor water quality, elevated disease incidence, and impaired passage conditions common to much of the Klamath River basin (NAS 2004). Water management and flow modifications within the upper Klamath River basin (*e.g.,* Reclamation's Klamath Project, agricultural diversions from the Williamson and Sprague Rivers) and major subbasins (*i.e.,* agricultural diversions in the Scott and Shasta Rivers, Reclamation's Trinity Project at Lewiston Reservoir) have fundamentally altered the annual hydrograph of the Klamath River basin. A comparison of pre-Project (1905-1912) and post-Project (1961-1996) hydrologic records shows a marked shift in annual peak runoff each spring from April to March, causing the earlier onset and longer duration of summer low flow conditions (Hardy and Addley 2001). Project dams appear to warm water temperatures 3 to 5°C (as compared to a "without dams" scenario) during the months between August and early October, and cool water temperatures a few degrees Celsius from February through June (Dunsmoor and Huntington 2006). Without the dams in place, modeling has demonstrated that instream temperatures would more closely track ambient air temperatures, including wider diel fluctuations during summer months (*i.e.*, higher daily temperatures and lower night-time temperatures; Bartholow *et al.* 2005, Dunsmoor and Huntington 2006).

Water quality is usually poor throughout the entire Klamath River basin from late spring to early fall, especially in Project reservoirs and the river sections directly below them (for detailed analysis, see *Effects of the Action* section). The cause of the poor water quality within and downstream of the Project is largely the result of the naturally eutrophic source waters of Upper Klamath Lake, although nutrient inputs from agricultural and municipal sources throughout the watershed likely augment the naturally high nutrient load. Historically, water from the highly productive upper basin was likely filtered and improved by the vast wetland acreage that once surrounded Upper and Lower Klamath Lakes. Today, much of that wetland has been reclaimed for agriculture and other uses (NAS 2004). Presently, the river's water chemistry is shaped through complex nutrient cycling mechanisms during the summer months. Massive aquatic algae communities within the reservoirs and mainstem river assimilate and transform the high concentration of nitrogen and phosphorus entering the Project, altering the natural water chemistry balance. Very high levels of primary production throughout the Project reach cause wide swings in reservoir and mainstem DO and pH levels, as the massive plant communities alternate between daytime photosynthesis and nighttime respiration.

Project reservoirs appear to be a net sink on an annual basis, but can act as both a source and sink for these nutrients, based largely upon the time of year and the cycling mechanisms occurring at that time (Kann and Asarian 2007). Source/sink patterns appear to be variable between years. For example, alternating source/sink periods were not as apparent in May 2005 - May 2006 as they were April-November 2002 (Kann and Asarian 2007). Mass-balance nutrient budgets have shown that during the algal growing season, there were more periods (*i.e.* sampling intervals of ~14-30 days) when Project reservoirs functioned as nutrient sinks than nutrient sources (particularly for nitrogen, less so for phosphorus; Kann and Asarian 2007); however, nutrient budgets also show that river reaches downstream of Iron Gate Dam, particularly the Iron Gate to Seiad Valley reach immediately downstream of the reservoirs, are also typically net sinks during the algal growing season (Asarian and Kann 2006). Thus, an accurate assessment of the reservoirs' effects on nutrients must also examine how current conditions compare to the natural riverine nitrogen retention processes that would occur in currently impounded reaches following dam removal. For example, in the months of June-September 2002 when there were periods of negative nitrogen retention (release) in the reservoirs, total nitrogen retention was higher in the Iron Gate to Seiad River reach than in Iron Gate and Copco reservoirs (Asarian and Kann 2006); however, in summer 2005 when periods of negative retention were less pronounced, total nitrogen retention in reservoirs was higher than typically observed is the river reach downstream.

The Project has blocked fish access into the upper reaches of the Klamath River basin since completion of Copco 1 Dam in 1918. Historically, coho salmon accessed approximately 58 miles of mainstem and tributary habitat above the site of Iron Gate Dam, the current limit of upstream passage at rm 190. The dams also physically block the flow of gravel and wood from upstream sources (FERC 2006), which have likely limited salmonid spawning habitat and generally simplified available instream habitat below Iron Gate Dam.

The five mainstem impoundments also influence water quality within and downstream of the Project boundary, although a relatively large portion of nutrients that enter the Project can be attributed to the hypereutrophic condition of Upper Klamath Lake (NAS 2004). Water quality (*e.g.,* water temperature, DO, pH and nutrient levels) within downstream riverine reaches are influenced by Project operations, although the extent of influence is difficult to determine since other factors, such as meteorological conditions, tributary inflows, and the nutrient rich source water entering the Project reach, play a significant role (PacifiCorp 2006). A notable exception would be Project-related water temperature effects, upon which much modeling and analysis has recently been focused (*e.g.*, Bartholow *et al.* 2005; Dunsmoor and Huntington 2006). Temporally, the Project's effect on downstream habitat is greatest during summer and fall, when tributary inflows are low and Project releases dominate the hydrologic regime (NAS 2004). Conversely, Project effects are generally small during winter and spring as high tributary accretions dominate the mainstem hydrograph.

Two fish hatcheries operate within the Klamath River basin, Trinity River Hatchery near the town of Lewiston and Iron Gate Hatchery on the mainstem Klamath River near Hornbrook, California. Both hatcheries mitigate for anadromous fish habitat lost as a result of the construction of dams on the mainstem Klamath and Trinity Rivers, and production focuses on Chinook and coho salmon, and steelhead. The large scale release of hatchery fish are generally theorized to negatively impact wild fish populations through mechanisms including, but not limited to, increased competition, disease introgression, and genetic dilution of wild populations [National Research Council (NRC) 1996]. NMFS' assessment of these hatcheries concluded that they decrease the risk of extinction by increasing coho salmon abundance, but otherwise have a neutral or limited impact on diversity, spatial structure, and productivity (June 28, 2005, 70 FR 37160).

Finally, fish disease mechanisms are poorly understood within the Klamath River basin, yet researchers believe modifications to the river's historical hydrologic regime have created instream conditions that favor disease proliferation and fish infection (Stocking and Bartholomew 2007). High water temperatures can stress adult salmon and slow upstream migration rates, facilitating parasite transmission between healthy and sick fish as they crowd into the few cold water refugial areas of the lower Klamath River (USFWS 2003). High water temperature was one of several factors that likely contributed to a massive die-off of Klamath River salmon in 2002 – other factors include run timing, run size, and meteorological conditions (USFWS 2003). Of the over 34,000 fish estimated to have died during the event, approximately 344 were coho salmon (CDFG 2004). Similarly, juvenile infection rates have increased as instream conditions suited to the parasites (*Ceratomyxa shasta* and *Parvicapsula minibicornis*) and their intermediate host (*Manayunkia speciosa*) respond to the altered hydrology of the basin. Preliminary disease monitoring of juvenile salmonids on the mainstem Klamath River (April 15 through July 14) documented a 33 percent and 66 percent infection rate of sampled coho salmon for *C. shasta* and *P. minibicornis*, respectively (USFWS 2007). The high level of *C. shasta* infection within salmonids migrating from areas below Iron Gate Dam appears to be indirectly influenced by the presence of the Project's impoundments (Stocking and Bartholomew 2007).

C. Current Habitat Conditions within the Action Area

The following is a more detailed explanation of current habitat conditions within the action area. Both the USFWS and North Coast Regional Water Quality Control Board (NCRWQCB) are currently crafting detailed, multi-year analyses of measured water quality parameters within the Klamath River basin. However, both analyses are due for release in early 2008, and therefore, could not be utilized for this consultation. In their absences, NMFS has instead summarized existing water quality conditions by utilizing both empirical field data from annual Yurok Tribal water quality monitoring in the lower Klamath River and water quality modeling within the upper Klamath River performed by PacifiCorp and other entities. NCRWQCB staff provided information regarding water quality conditions in areas outside of those covered by the Yurok Tribe and PacifiCorp analyses. The most recent published water quality data from the Yurok Tribe (2005) is for the 2004 water year. Similarly, habitat suitability criteria presented by PacifiCorp (2006) is based on 2000 and 2001 water quality modeling results. Flow regimes below Iron Gate Dam during those 3 years were lower than the current Phase III[5] minimum flow levels outlined in the Klamath Project biological opinion (NMFS 2002) and implemented in 2006. Therefore, pre-Phase III values reported below for certain water quality parameters that are exacerbated under lower flow conditions (*e.g.,* water temperature) may slightly overestimate the current baseline condition.

Table 4 provides properly functioning conditions guidelines against which the current baseline water quality conditions may be compared. The table focuses on temperature, DO, and pH, three of the water quality variables critical to salmonid survival and appreciably affected by Project operations. Nutrient concentrations (*e.g.,* nitrogen and phosphorus) within the Klamath River mainstem can be influenced by water impoundments within the Project reach, but often the effect of nutrient fluctuation within downstream riverine reaches is manifested in changes to DO and pH levels.

1. Lower Klamath River (Estuary to Trinity River Confluence)

This lowest section of the Klamath River extends from the river mouth to its confluence with the Trinity River. Yurok Tribal lands extend upslope for 1 mile from each river bank in this reach; beyond tribal land, much of the tributary habitat extends into timber production land owned by Green Diamond Resource Company. Water temperatures throughout the entire Klamath River mainstem have historically been high, although upstream diversions of cool tributary flow within large basins such as the Shasta and Scott Rivers have undoubtedly hindered river cooling during summer months (NAS 2004). Higher water temperatures combine with the nutrient rich source water leaving Iron Gate Dam to create instream conditions conducive to increased primary production and excessive growth of aquatic algae and benthic macrophytes, which in turn cause wide diel swings in mainstem DO levels.

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[5] Flow releases at Iron Gate Dam were recently amended based upon a ruling by the U.S. Ninth Circuit Court of Appeals [PCFFA v. Reclamation (9th Cir. 2006)]. The March 27, 2006, ruling ordered Reclamation to "limit Klamath Project irrigation deliveries if they would cause water flows in the Klamath River at and below Iron Gate Dam to fall below 100% of the Phase III flow levels" specifically identified in the Klamath Project Biological Opinion (NMFS 2002).

Table 4. Temperature, DO and pH guidelines for coho salmon within the Klamath River basin

Water Quality Parameter	Suitable	Low to Moderate Stress	High Stress
Temperature (°C)[a]			
Adult	<17	18-21	>21
Juvenile	<15	16-23	>23
Egg to Emergence	<12	13-14	>14
DO (mg/L)[b]			
Adult/Juvenile	>8.0	7.0-8.0	<7.0
Egg to Emergence	>10.0	9.0-10.0	<9.0
pH[b]	6.75 – 8.0	6.5-6.75 and 8.0-8.5	<6.5 and >8.5

[a] From PacifiCorp 401 certification application (PacifiCorp 2006)

[b] From Bjornn and Reiser (1991), Watershed Planning Chapter of North Coast Basin Plan (NCRWQCB 2005) and Hoopa Tribal Water Quality Control Plan (Hoopa Valley Tribe Environmental Protection Agency 2006)

Several large tributaries in the lower Klamath River historically supported healthy coho salmon populations, but timber harvesting and construction of the associated road network have impaired instream habitat conditions throughout much of the area. For example, McGarvey, Tarup, Tectah, and Ah Pah Creeks all suffer from excessive sediment input that has simplified instream habitat, limited food production, and impaired spawning and rearing success. In some tributaries, large sediment loads have accumulated at their confluence with the Klamath River, potentially interrupting tributary dispersal of juvenile coho salmon during winter months (Voight and Gale 1998). As part of his ongoing coho salmon overwintering study, Voight (2007) documented substantial use of off-channel habitat by juvenile coho salmon within non-natal tributaries of the Klamath River estuary. Poor habitat conditions within the estuary and impaired passage at tributary mouths could disrupt this important coho salmon life-history adaptation.

Blue Creek is one of the few lower Klamath River tributaries that is relatively intact with regard to habitat function. The confluence of Blue Creek with the Klamath River regularly provides a plume of coldwater within the adjacent mainstem river that functions as refugial habitat for adult salmon migrating through the lower Klamath River during late summer/early fall.

a. Water Quality Conditions

(1) Temperature. The Klamath River basin's unusual geographic layout is arguably the overriding influence on the basin's water temperature regime. The Klamath River basin is sometimes referred to as being an "upside down" system, given that the system's low gradient, dry upper watershed and steep, high rainfall lower portion are inverted with regard to classic watershed structure. As a result, the maritime climate and cool tributary inflow emanating from heavily forested tributaries can moderate water temperatures in the Lower Klamath River section, often leaving water temperatures slightly cooler (although still warm) than those further upstream. However, meteorological conditions can be severe throughout the basin for extended periods from June through September, and water temperatures will rise appreciably with ambient air temperatures.

The Klamath River estuary is relatively undeveloped as compared to most river estuaries within California. As a result, degradation with regard to Klamath River estuary function or habitat quality may arise from poor water quantity and quality emanating from the upper basin and tributaries, although further study is needed to document this effect (NAS 2004). Nevertheless, water quality within the Klamath River estuary is generally believed suitable to support anadromous fish (Wallace 1998). Monthly monitoring of surface water temperature by Wallace (1998) indicates a range from 6°C in winter to summer highs approaching 24°C; other research has documented a maximum summer temperature of 26.6°C (Bartholow 2005). However, bottom temperatures within the underlying salt wedge are typically 5 - 8°C cooler than surface temperatures and are thought to be integral to salmonid survival during late summer and early fall periods (Wallace 1998). Maximum water temperatures at three mainstem gauging stations located between the estuary and Trinity River confluence [Terwar Creek (rm 5.6), Blue Creek (rm 16.0), and Tully Creek (rm 38.9)] exceeded 24°C for several days in late July 2004, and were above 22°C for most of July and August (Yurok Tribe 2005). By late September, maximum daily water temperatures were generally below 21°C at all three sites. Late summer water temperatures at Tully Creek were likely cooled a few degrees in 2004 by a pre-emptive pulse flow release from Lewiston Dam (Trinity River) designed to prevent crowding of fall run Chinook salmon in the lower river.

Overall, water temperatures within the lower river are largely supportive of coho salmon survival. The Project's reservoirs cause a "thermal lag" in downstream water temperatures due to their large masses of water. Water temperatures within Iron Gate Reservoir tend to warm slower than the river in the spring and cool at a slower rate during the fall. Thus, fall river temperatures can remain slightly warmer as a result of Iron Gate Dam releases, but this effect is largely attenuated by the time flows reach the Shasta River (PacifiCorp 2006). Mainstem water temperatures below the Trinity River confluence are largely below the upper threshold of 22°C by mid-September (Fadness 2007), which coincides with the start of the adult coho salmon migration (NAS 2004). Water temperatures are typically below 17°C when coho salmon migration peaks between late October and mid-November (Fadness 2007). Coho salmon smolts typically migrate downstream and into the Klamath River estuary during April and May, and have largely outmigrated by July when water quality degrades and water temperatures rise (USFWS 1998). Summer rearing within the lower Klamath River by coho salmon juveniles is likely rare.

(2) ***Dissolved oxygen.*** DO concentrations vary considerably both spatially and temporally within the Klamath River mainstem, and are influenced primarily by high nutrient levels emanating from the upper basin (PacifiCorp 2006). Project reservoirs appear to be a net sink on an annual basis, but can act as both a source and sink for these nutrients, based largely upon the time of year and the cycling mechanisms occurring at that time (Kann and Asarian 2007). Highly enriched water also likely arises from mainstem tributaries that support large agricultural operations. Currently (and perhaps historically), the Klamath River mainstem supports a

significant benthic algae community as a result of the warm water, abundant solar input, and highly nutrified water chemistry. As the large aquatic plant community undergoes complex diel cycles of photosynthesis and respiration during summer months, instream DO concentrations can fall to levels stressful to coho salmon adults and juveniles.

Wallace (1998) reported DO concentrations within the Klamath River estuary are generally "adequate to support salmonids," although his reported values of 6 – 7 mg/L would be highly stressful to coho salmon based upon table 4 guidelines. Limited Klamath River estuary sampling by the Yurok Tribe (2005) in summer 2004 indicates that diel DO concentrations fluctuate greatly, but are largely above 7 mg/L for most of the summer. Very low DO levels (*e.g.*, 2 - 5 mg/L) were noted by Wallace (1998) in a few isolated deep areas and vegetated side channels, but those conditions were thought to be infrequent and transient as a result of strong tidal mixing from the relatively large freshwater inflow to the estuary and frequent breaching of the estuary sandbar. Upstream of the estuary, DO levels typically exhibit an inverse relationship with water temperature, decreasing from the spring onset of the sampling season until bottoming out in late July/early August, then increasing again into fall (Yurok Tribe 2005). During July and August of 2004, DO levels at Terwar, Blue Creek and Tully Creek were slightly below 7 mg/L for 12, 7, and 16 days, respectively.

DO concentrations below 7 mg/L occur on a regular basis within segments of the lower Klamath River during late summer/early fall. However, coho salmon are not expected to be exposed to these conditions since mainstem rearing by juvenile coho salmon is thought to be rare below the Seiad Valley area. DO concentrations within the lower river generally range from 7 - 8 mg/L as adult coho salmon begin entering the system in mid-September (Fadness 2007).

(3) ***pH.*** Given that the Klamath River below Iron Gate Dam remains in a weakly buffered state, pH levels throughout the river can experience wide diel fluctuations as a result of high primary production (*i.e.*, algae and benthic macrophyte growth) during summer months. Photosynthesis and associated uptake of carbon dioxide by aquatic plants result in high pH (*i.e.*, basic) conditions during the day, whereas plant and fish respiration at night decreases pH to more neutral conditions. Daily maximum pH values at the Turwar and Blue Creek stations exceeded the upper threshold of 8.5 for both juvenile and adult salmon during most of August and September in 2004 (Yurok Tribe 2005), with values generally peaking in late afternoon when aquatic plant photosynthesis is at its highest. Daily maximum values were generally lower at the Tully Creek gauging site, where only several days during the summer exceeded a pH of 8.5. Ammonia toxicity can be a concern in aquatic environments, like the Klamath River, where high nutrient concentrations coincide with elevated pH and water temperature. However, ammonia toxicity is more of a concern within upstream reaches [*e.g.*, Iron Gate Dam to Seiad Valley (rm 128)] where temperatures and pH, as well as macrophyte and algae concentrations, are appreciably higher than those common to the lower river (PacifiCorp 2006). Furthermore, high temperature and pH within the lower river have largely attenuated by early October when adult coho salmon enter the river in large numbers. Estuary pH levels do not appear to fluctuate significantly compared to upstream areas; Yurok Tribe (2005) data showed a constant summer pH value of approximately 8.

b. Water Quantity and Other Stressors

Low flow levels may affect coho salmon as they utilize the mainstem Klamath River. For example, low spring flows can delay or slow coho salmon smolt passage toward the estuary, potentially decreasing survival rates (Giorgi *et al.* 2002). Low flows can also impede upstream passage of adult coho salmon at critically shallow riffles and abate flow-related cues that stimulate upstream migration (CDFG 2004). Yet, the cause behind low flow conditions within the mainstem can vary seasonally within the Klamath River. For instance, flows released from Iron Gate Dam typically comprise less than 20 percent of the flow volume at Orleans (rm 59) during May and June, with the other portion derived primarily from tributary accretion (NAS 2004). By September, over 60 percent of the river volume is derived from Iron Gate releases, as tributary accretion wanes considerably over the summer months. Nevertheless, current baseline flow releases are substantially greater than those that occurred during the adult salmon die-off in the fall of 2002. For instance, minimum Iron Gate Dam releases during September will be no less than 1000 cfs under the proposed action, whereas releases during September 2002 were approximately 750 cfs. Maintaining flow releases at or above 1000 cfs will likely maintain suitable water temperatures in the lower river during the late summer (Hardy and Addley 2001). Based upon analysis of flow data, passage impediments related to river depth likely did not occur during the 750 cfs release of 2002 (CDFG 2004), thus increasing releases by 250 cfs above the 2002 level should ensure adequate depths at critical riffle sections.

Coho salmon within the lower Klamath River are also directly affected by other mechanisms not linked to habitat degradation and disease. For instance, pinniped predation on returning adult salmon can significantly affect escapement numbers within the Klamath River basin. Hillemeier (1999) assessed pinniped predation rates within the Klamath River estuary during August, September, and October, 1997, and estimated that a total of 223 adult coho salmon were consumed by seals and sea-lions during the entire study period. Fall-run Chinook salmon were the main fish consumed (an estimated 8,809 during the entire study period), which may be primarily due to the fall-run Chinook salmon migration peaking during the study period (the peak of the coho salmon run is typically October through mid-November). Hillemeier (1999) cautioned that the predation results may represent unnaturally high predation rates, since ocean productivity was comparatively poor during the El Niño year of 1997. The Marine Mammal Protection Act of 1972 protected seals and sea lions from human harvest or take, and as a result, populations are now likely at historical highs (Low 1991).

A significant number of coho salmon are harvested along with the Yurok Tribe's fall in-river harvest of fall-run Chinook salmon (Good *et al.* 2005). Tribal harvest of coho salmon ranged from 42 and 135 fish between 1997 and 2000, then increased to 895 fish in 2001. Hatchery fish dominated the catch (ranging between 63 percent and 86 percent), and most hatchery fish were of Trinity River Hatchery origin (87-95 percent). Iron Gate Hatchery fish generally made up a small fraction (8 percent or less) of the total hatchery fish captured, except during 2001 when they constituted approximately 37 percent of the hatchery fish harvested.

2. Middle Klamath River (Above Trinity River Confluence to Portuguese Creek Confluence)

The Middle Klamath River section begins above the Trinity River confluence and extends upstream 85 miles to the mouth of Portuguese Creek (rm 128). Water quality and quantity are issues within the Middle Klamath River section, just as they are largely throughout the entire basin. Iron Gate Dam flow releases typically have a proportionally larger affect on the flow regime in this area as compared to the lower river, since two (Salmon and Trinity Rivers) of the four major Klamath River tributaries enter near the lower end of this section. As a result, flows can be low and critically warm during summer months, and water quality can be compromised to the detriment of instream fish populations.

A few tributaries within the Middle Klamath River Population Unit (*e.g.,* Boise, Red Cap and Indian Creeks) support significant populations of coho salmon (NMFS 2007), and offer critical cool water refugia within their lower reaches when mainstem temperatures and water quality approach critical levels. However, several anthropogenic factors limit the function and accessibility of refugial habitat in the area, and in turn limit the area's potential with regard to coho salmon productivity. Municipal and private water diversions limit summer base flows within many Klamath River tributaries, which can reduce refugial areas as well as increase water temperatures. High tributary sediment loads arising from poor riparian habitat management and the extensive forest road network have caused chronically high sediment concentrations within most tributaries. In the absence of adequate peak flows to transport excess sediment downstream, large sediment volumes accumulate at tributary confluences, which can either physically limit juvenile fish from entering refugial habitat, or alternatively force flows subsurface and eliminate refugial areas entirely.

a. Water Quality Conditions

As noted previously, much of the water quality data for the mainstem Klamath River is currently being validated and is largely unavailable for this analysis. FERC (2006) presents most of its water quality results as monthly averages, not as daily minimum or maximum values critical to detailing likely fish response. In the absence of validated water quality data for the mainstem Klamath River, NMFS again relies on Yurok Tribe (2005), although the only Yurok Tribe monitoring site within the Middle Klamath River Population Unit occurs just upstream of the Trinity River confluence near the town of Weitchpec, California. Staff at the NCRWQCB also provided insight and analysis on mainstem water quality conditions resulting from their ongoing development of the Klamath River Total Maximum Daily Load.

(1) Temperature. Ambient air temperatures tend to be higher within the Middle Klamath River section as compared to the Lower Klamath River section, which, when combined with limited tributary accretion throughout much of the section, can produce critically high water temperatures during summer months. Water temperatures at Weitchpec during 2004 were consistently above 22°C for much of July and August (Yurok Tribe 2005), whereas further upstream near Cade Creek (rm 110), the mean weekly maximum temperature (MWMT) exceeded 29°C when monitored in 1992 (Fadness 2007). Perhaps more importantly, minimum nighttime water temperatures at both locations were consistently above 20°C for the same time period, even approaching 24°C on several occasions. Mainstem rearing coho salmon are thought to opportunistically utilize lower night-time water temperatures for foraging (NAS 2004), and could be affected by higher water temperatures. Yet, the number of coho salmon affected is likely small, since most summer rearing within the mainstem river appears to occur within refugial sites between Iron Gate Dam and Seiad Valley (*i.e.,* within the Upper Klamath Population Unit).

By late September when adult coho salmon migration begins, water temperatures are usually close to 19°C throughout the Middle Klamath River section, although one gauging site [Klamath River at Oak Flat Creek (rm 100)] registered water temperatures in excess of 23°C during late September 1992 (Fadness 2007). As weather conditions cool during the fall, water temperatures correspondingly equilibrate below 17°C (MWMT) throughout the reach as coho salmon migration increases to its peak in early November. Thus, most migrating adult coho salmon are likely unaffected by elevated summer water temperatures characteristic of the Middle Klamath River section. Coho salmon smolts also encounter water conditions that generally support high migration and rearing survival. The peak of the coho salmon smolt outmigration during April and May of 2004 coincided with water temperatures below 16°C, although temperatures spiked to 18°C over a several day period at the beginning of June when the outmigration period is typically waning.

(2) Dissolved oxygen. 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 (Yurok Tribe 2005). The exception was several days in both late August and early September, when DO levels as low as 5.5 mg/L were measured. During August, diel DO readings varied by almost 2 mg/L. Further upstream, DO concentrations averaged approximately 8 mg/L within the reach between the Salmon and Scott Rivers during late May and early June, according to NCRWQCB analysis of several years of mainstem Klamath River water quality data (Fadness 2007). Average DO concentrations were similarly around 8 mg/L within the same river reach during early October, with minimum values above 6 mg/L.

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 enriched outflow from Iron Gate Dam. DO concentrations are usually above 7 mg/L during smolt and adult migration seasons.

(3) pH. pH values 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 when adult fish would likely be migrating through the area in early October. Similar to downstream reaches, observed pH values fluctuated widely between day and night from late spring through mid-October. High pH, in combination with high water temperatures, can precipitate high ammonia levels during summer months (FERC 2006). Limited sampling has only detected a few instances of ammonia toxicity within the Klamath River mainstem, and those cases were confined to areas between Copco Reservoir and the California/Oregon state border (Fadness 2007). Yet, pH and temperature conditions that are conducive to ammonia toxicity are present at times throughout the river, and a more robust ammonia sampling regime would likely document the presence of high ammonia levels on a more frequent basis (Fadness 2007).

However, coho salmon are rare within the Middle Klamath Population Unit during periods when ammonia toxicity is likely to occur (*i.e.,* summer and early fall).

b. *Water Quantity*

Baseline flows within the Middle Klamath River section are likely sufficient with regard to depth and water velocity for upstream and downstream movement of coho salmon. Based upon comparative analysis with historical Klamath flow records, CDFG (2004) could not conclusively demonstrate that water depth impeded upstream migration during the 2002 fish die-off, although anecdotal evidence (*i.e.,* field observations, gage height data, *etc.*) suggest some fish migration may have been impeded. Water velocity was sufficient to stimulate upstream movement of fish during 2002 (CDFG 2004), and should be even higher under the proposed flow regime. As mentioned previously, sediment deltas that impair juvenile migration have formed at many tributary/mainstem confluences, and both excessive tributary erosion rates and insufficient flushing flows are likely largely responsible.

3. Upper Klamath River (Portuguese Creek to Spencer Creek)

The Upper Klamath Population Unit extends from Portuguese Creek (rm 128) upstream to Spencer Creek (rm 228), which is thought to be the historical upstream limit of coho salmon migration (Hamilton *et al.* 2005). Under baseline condition, fish passage is currently blocked by Iron Gate Dam (rm 190), the lowermost facility within a Project area that includes four other impoundments further upstream (Copco 1, Copco 2, J.C. Boyle, and Keno). All Project facilities lack adequate passage facilities for anadromous fish.

To facilitate the baseline analysis, the Upper Klamath Population Unit will be further delineated as two separate reaches: the downstream reach from Portuguese Creek to Iron Gate Dam, to which fish currently have access; and the upstream Project reach, to which fish passage is currently precluded by Iron Gate Dam. Water quality within the downstream reach is influenced by Project releases, especially during summer months when agricultural diversions limit cold water accretions from the Shasta and Scott Rivers. However, water released from Iron Gate Dam during summer months is already at a temperature stressful to juvenile coho salmon, and intense solar warming can increase temperatures even higher (up to 26°C) as flows travel downstream (NAS 2004). Additionally, DO and pH levels can fluctuate rapidly within the reach, a direct result of diel swings in productivity from the large mass of aquatic macrophytes (especially the species *cladophora*) and the highly enriched Iron Gate Dam releases that support them. Therefore, the section of river from Iron Gate Dam to Seiad Valley would appear to be inhospitable to rearing salmonids during summer months. However, juvenile anadromous salmonids, including coho salmon, have been documented rearing within mainstem Klamath River habitat during summer months, 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). As mentioned earlier, 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 comprise a proportion of the coho salmon observed at these mainstem thermal refugial areas. Thus, a small population of juvenile coho salmon appears to annually rear within the Iron Gate

Dam to Seiad Valley reach, relying heavily on thermal refugia and cooler nighttime water temperatures to survive, despite generally inhospitable water temperatures throughout much of the river.

Upstream of Iron Gate Dam, Project reservoirs and their operational regimes have substantially altered the natural hydrologic regime and instream habitat that once supported large populations of anadromous salmonids. Above Keno Reservoir, nutrient rich return flow from agricultural and municipal sources supplement the naturally eutrophic conditions of Upper Klamath Lake and Lake Ewauna, which in turn fuels the explosion of aquatic plants and algae (particularly *Aphanizomenon sp.*) that degrade water quality throughout the entire mainstem Klamath River. The Project's larger reservoirs (specifically Iron Gate and Copco 1) influence water quality through complex nutrient cycling mechanisms, at times acting as nutrient sinks for the highly enriched source water entering from above, while at other times acting as a nutrient source for downstream reaches; however, the Project appears to be a net sink on an annual basis (Kann and Asarian 2007).

Finally, the high level of *C. shasta* infection within salmonids inhabiting the lower river appears to be influenced by the presence of the Project's dams (Stocking and Bartholomew 2007). The parasite's intermediate host *M. speciosa* appears to favor habitat at the lotic-lentic interface where river flows enter the Project's reservoirs. The creation of reservoirs within the upper basin has likely altered the natural abundance and distribution of *M. speciosa*, creating large source populations that can augment downstream host numbers (Stocking and Bartholomew 2007). Furthermore, a *C. shasta* infection nidus was documented downstream of Iron Gate Dam (*i.e.*, from the Interstate 5 bridge downstream approximately 20 miles), which may result from an overlap of high concentrations of *M. speciosa* and the large number of infected salmon spawning below impassable Iron Gate Dam (Stocking and Bartholomew 2007).

a. Water Quality Conditions

(1) Temperature. Like the lower river, water temperatures within the Upper Klamath River section vary considerably both spatially and temporally. Generally, water temperatures follow the typical cycle of spring/summer heating and fall/winter cooling, but the thermal lag caused by reservoir impoundments has effectively delayed both the spring warming trend and the fall cooling trend by several weeks. This effect is most pronounced immediately downstream of Iron Gate Dam where summer low flow conditions are more prolonged when compared to historical conditions (NAS 2004).

(a) Above Iron Gate Dam. Within the Project reach, the two largest reservoirs, Iron Gate and Copco 1, both stratify beginning in March and destratify in October (Copco 1) and November (Iron Gate). When not stratified, both reservoirs exhibit similar temperatures throughout the water column (*i.e.*, isothermal), usually between 6 and 8°C (FERC 2006). When stratified, both reservoir water columns separate into three distinct layers: the warm, uppermost layer referred to as the epilimnion; the middle metalimnion, characterized by a strong temperature gradient; and the cold, deep hypolimnion. The epilimnion begins to form in early spring, and can reach temperatures approaching 25°C during July in both reservoirs (FERC 2006). The temperature and size of the metalimnion can vary throughout the summer months based upon surface water temperatures, but is located at a depth or around 50 feet during mid-summer. Temperatures within the hypolimnion remain under 10°C throughout the summer.

Water temperatures between Project facilities (*i.e.*, within riverine sections) are greatly influenced by inflow from Project reservoirs, as well as meteorological patterns that control ambient air temperatures. The exception to this pattern occurs within areas directly downstream of spring accretions, specifically the J.C. Boyle reach where ~250 cfs of cold spring water (~11°C) enters the river between J.C. Boyle Dam and the peaking power plant approximately 4 miles downstream. Much of the flow released from J.C. Boyle reservoir is bypassed directly to the peaking power plant within a canal (J.C. Boyle Bypassed Reach) alongside the river, where it re-enters the river at the beginning of the J.C. Boyle Peaking Reach. Since the majority of warm reservoir water is bypassed around the spring reach, water temperatures within the 4-mile reach average approximately 15°C from June through August (FERC 2006). Downstream of the J.C. Boyle Powerhouse, the impact from spring flows ameliorates quickly once the powerhouse outflow rejoins the river (PacifiCorp 2006). Nevertheless, measured water temperatures entering Copco 1 Reservoir can be 1 - 4°C lower than J.C. Boyle outflow, demonstrating the latent impact of not only the spring accretion but also the effect of upstream peaking operations. Elsewhere, water temperatures within the Link River Dam to J.C. Boyle Reservoir reach (above the bypassed reach) exceed 20°C for much of the summer, and are largely inhospitable to anadromous fish (FERC 2006) except for channel areas offering thermal refuge. However, a productive fishery for red band trout (*O. mykiss*) exists within the Keno reach (4.7-mile section between Keno Dam and J.C. Boyle Reservoir) despite summer water temperatures that approach 25°C (FERC 2006). From November through March, water temperatures are typically below 10°C throughout the Project reach (FERC 2006) and are not thought to be limiting with regard to anadromous fish survival.

(b) Below Iron Gate Dam. In general, summer water temperatures below Iron Gate Dam increase gradually in the downstream direction, though the immediate temperature gain below Iron Gate Dam can be significant with regard to salmonid survival. For example, Iron Gate Dam (rm 190) outflow during August is typically around 22°C. However, water temperatures increase rapidly to a daily maximum in excess of 26°C within the first 15 miles of river (NAS 2004) as cooler Iron Gate Dam releases enter the shallow Klamath River and are heated by hot ambient air temperatures (PacifiCorp 2006). Poor riparian recruitment caused by rapid flow ramping below the dam (FERC 2006) likely exacerbates the issue by inhibiting stream channel shading. Daily maximum water temperatures can approach 30°C within the reach between Seiad Valley and Clear Creek (rm 99), largely due to the continued influence of warm air temperatures and constant exposure to solar heating, as well as diminished tributary accretion from the Scott River, Shasta River, and other large tributaries. To survive these conditions, juvenile coho salmon likely utilize thermal refugia during the day and opportunistically forage on abundant food within the mainstem at night (NAS 2004). As part of an ongoing thermal refugia study downstream of Iron Gate Dam, Karuk Tribal biologists documented summer use of cold-water refugia by juvenile coho salmon at the mouths of Beaver and Tom Martin Creeks. In fact, Karuk Tribal biologists have documented large numbers of juvenile coho salmon rearing throughout the summer within mainstem refugial sites between Iron Gate Dam and Seiad Valley where water temperatures and velocities are low and aquatic cover is plentiful (Soto 2007). Although the overall fate of mainstem rearing coho salmon is still unknown at this time, the results noted above would seem to contradict previous suggestions that juvenile coho salmon are largely absent from the mainstem Klamath River by late summer (NAS 2004).

(2) Dissolved Oxygen

(a) Above Iron Gate Dam. Similar to water temperature, DO levels within the Project reach vary considerably between reservoir and riverine reaches during summer months. Within the J.C. Boyle Reach of the mainstem Klamath River, DO levels are generally above 7 mg/L for most of the summer (PacifiCorp 2006) and would likely support re-introduced anadromous salmonids. Small diurnal fluctuations in DO concentration occur in both river reaches, likely due to minimal primary productivity of benthic macrophytes.

Within Project reservoirs, DO levels vary widely during the summer as a result of alternating diel cycles of photosynthesis and respiration, thermal stratification of the water column, and benthic decomposition of plant matter. As mentioned above, Iron Gate and Copco Reservoirs regularly stratify by March and destratify by October (Copco 1) and November (Iron Gate), events that can alter water chemistry throughout the water column. When the lakes are not stratified between October and March, DO concentrations are consistently above 10 mg/L throughout the water column. However, when stratification exists during summer, DO concentrations plummet with increasing reservoir depth, ranging from concentrations greater than 10 mg/L at the reservoir surface to less than 1 mg/L at depths greater than 10 meters (FERC 2006). The anoxic summer conditions within the hypolimnion of Iron Gate and Copco 1 Reservoirs are believed to result from the aerobic decomposition of dead algae and other organic matter that settle to the reservoir bottoms (FERC 2006). Except for a localized area near the J.C. Boyle log boom, DO concentrations throughout the J.C. Boyle Reservoir are consistently at natural saturation levels throughout the year, since the reservoir is too small to effectively stratify. Re-introduced coho salmon would likely migrate through the reservoir system during late fall and spring, times when Copco 1 and Iron Gate Reservoirs are either isothermal or weakly stratified and generally contain suitable DO concentrations. Coho salmon are not expected to reside within reservoir habitat during summer months.

(b) Below Iron Gate Dam. DO concentrations within the Iron Gate Dam outflow can be sub-optimal during late summer/early fall, when relatively deep releases are made from the stratified reservoir (PacifiCorp 2006). Minimum DO concentrations within outflow waters are commonly below 7 mg/L during the March through November period, with an instantaneous low value of 2.91 mg/L detected during early September 2000 (Fadness 2007). However, the water is quickly aerated as it turbulently travels downstream, and DO concentrations above the Shasta River confluence average greater than 10 mg/L during much of the summer (FERC 2006). Unfortunately, FERC (2006) presents much of the DO data as monthly average values, thus masking nighttime minimum DO concentrations that can be 3 to 4 mg/L lower than maximum daytime DO levels (PacifiCorp 2006). Nocturnal 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.

(3) pH

(a) Above Iron Gate Dam. pH values within the highly eutrophic Link River/Keno Reservoir reach can range from 8 to 10 during summer months when primary production is high, moderating slightly within the Keno reach and J.C. Boyle Reservoir. Additionally, pH values can exhibit wide diurnal swings in the Project's highly eutrophic reservoirs as aquatic plant communities alternate between high daytime photosynthesis rates and high nighttime respiration rates. Within the J.C. Boyle bypassed and peaking reaches, summer pH values can approach 8.7 during summer at locations directly upstream of Copco Reservoir, but are generally around 8.0 throughout both reaches (PacifiCorp 2006). Within Copco 1 and Iron Gate Reservoirs, pH values can differ dramatically with depth during summer months. Primary production can drive surface water pH above 9.0. On the other hand, pH can drop below 6 when anoxic conditions occur within the cold hypolimnion. During winter and spring when isothermal conditions exist throughout the Project reach, pH typically ranges from 7 to 8 (PacifiCorp 2006).

(b) Below Iron Gate Dam. 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 (PacifiCorp 2006). High pH values can increase fish susceptibility to ammonia toxicity, which when combined with already elevated water temperatures and fluctuating DO concentrations, can produce summer instream conditions highly stressful to coho salmon. As previously noted, juvenile salmon within the Klamath River mainstem likely avoid these conditions by rearing within and near cold water refugia within the mainstem Klamath River and lower tributary reaches where water quality conditions are acceptable (NAS 2004, Sutton *et al.* 2004).

b. Water Quantity and Other Stressors

(1) Above Iron Gate Dam. Flow levels within the Project's riverine sections are highly influenced by Project operations. Peaking operations and bypass channels have altered the natural flow regime within the Klamath River below J.C. Boyle and Copco 1 Reservoirs, causing unnatural flow fluctuations and degrading instream flow levels to the detriment of fish habitat. Current operations at J.C. Boyle Reservoir lead to rapid flow fluctuations within the J.C. Boyle peaking reach between 300 and 3,000 cfs on a daily basis, which likely impair riparian function and recruitment, reduce the abundance of macroinvertebrate communities, and increase juvenile fish stranding (FERC 2006). Moreover, the J.C. Boyle Powerhouse does not currently have the means to maintain downstream flow levels when one or both generating units unexpectedly trip offline. When this happens, the river below the powerhouse can drop 1.5 and 3 feet within a very short period of time (PacifiCorp 2006), creating a significant stranding risk. Also, water trapped within the bypass canal commonly spills back to the river when a trip occurs, causing significant hillside erosion that eventually impairs fish passage once the larger material settles within the river channel. The current flow regime within the J.C. Boyle Bypassed Reach is 100 cfs released from the dam, which is augmented by 220 to 250 cfs of spring inflow beginning approximately 0.5 miles downstream. While bypassing the majority of flow around the 4-mile reach ensures constant water temperatures between 10 and 15°C, the minimal flow levels impair riparian function and limit the amount of instream habitat. Moreover, sustained high flows necessary to flush sediment from spawning gravels likely occur less frequently under current operations, although some flushing probably happens during spring spill events (FERC 2006). Further downstream, Copco 2 Dam currently diverts all Klamath River flow, except for the approximately 5-10 cfs that leaks from the dam, into the Copco 2 bypass channel, leaving the 1.5-mile river reach between Copco 2 Dam and Iron Gate Dam unusable for most fish.

(2) Below Iron Gate Dam. Downstream of Iron Gate Dam, flow volumes under the baseline flow regime are consistent with Phase III flows as outlined within the Klamath Project biological opinion (NMFS 2002), and are acknowledged as sufficient to support coho salmon reproduction, abundance and distribution within the lower river (*i.e.,* avoid jeopardy; NMFS 2002). Current ramping rates at Iron Gate Dam are also considered to be protective of rearing and migrating coho salmon within the lower river (NMFS 2002). However, 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). Dams also impair gravel and fine sediment recruitment downstream of Project reservoirs, which result in poorly functioning floodplains that fail to support healthy riparian recruitment. The lack of gravel also diminishes the amount and quality of salmonid spawning habitat downstream of Project dams. This condition is especially critical below J.C. Boyle and Iron Gate Dams (FERC 2006).

(3) Lack of Fish Passage. Lack of adequate fish passage at each of the mainstem Klamath River dams has suppressed anadromous salmonid populations for several decades. Chinook salmon and steelhead were once common in tributaries to Upper Klamath Lake, and coho salmon are believed to have inhabited mainstem and tributary habitat up to, and including, Spencer Creek (rm 228, Hamilton *et al.* 2005). The Upper Klamath Population Unit of coho salmon is characterized as an independent, "long-run" population (versus the more common coastal populations) with evolutionarily adapted traits allowing the species to inhabit and thrive within the unique high-elevation habitat of the upper Klamath River basin. By blocking access to approximately 40 percent of the historical habitat once available to the Upper Klamath Population Unit, the dams have likely compromised the population's viability by directly degrading each individual viability parameter (*i.e.*, population size, population growth rate, spatial structure, and diversity; McElhany *et al.* 2000; McElhany 2006). Coho salmon abundance and productivity within the Upper Klamath River are depressed from historical levels, largely resulting from the reduced population size supported by the remaining habitat located below Iron Gate Dam. Furthermore, habitat within the remaining fraction is currently limiting with regard to salmon spawning and rearing (CDFG 2004a, Good *et al.* 2005). The population's spatial structure is limited by the fact that coho salmon cannot access a large proportion of their historical habitat. Since the inaccessible habitat above the dams differs characteristically (*e.g.,* higher elevation, different climatological patterns, *etc.*) from downstream areas, the population as a whole has likely lost important traits and adaptive mechanisms specific to that upper basin habitat that enable persistence through natural environmental variation, as well as future evolutionary change. NMFS believes coho salmon below Iron Gate Dam would colonize habitat within the Project area once upstream passage is provided (Simondet 2006).

4. Spring and Fall Creeks

PacifiCorp operates an instream diversion dam on Spring Creek (tributary of Jenny Creek) that diverts up to 16.5 cfs into Fall Creek, and another dam on Fall Creek which diverts up to 50 cfs of flow into a canal and penstock that leads into the Fall Creek Powerhouse. Both tributary dams are above suspected anadromous fish barriers (impassable waterfalls) that occur approximately 1.8 miles upstream of Iron Gate Dam on Jenny Creek, and approximately 1.0 miles upstream on Fall Creek (FERC 2006). Prior to the construction of Iron Gate Dam, the confluence of Jenny Creek and the Klamath River was considered a productive fishing location for adult coho salmon (Hamilton *et al.* 2005), suggesting adult coho salmon staged to enter Jenny Creek to spawn. Fall Creek also historically supported runs of coho salmon (Hamilton 2006). Both streams currently enter into Iron Gate Reservoir and thus are inaccessible to anadromous fish.

Jenny Creek currently contains suitable habitat for anadromous fish within its lower 2 miles (Li 2007). A habitat survey of Fall Creek in October, 2004, documented the stream channel as having large-sized substrate, relatively low substrate embeddedness, and adequate depth (flow at the time was 15 cfs). The distribution of spawning habitat was spotty, and spawning success was forecasted to be sporadic for this reason. Flows within Jenny Creek are greatly diminished by the water diversions that occur within the creek's headwaters. The largest diversion occurs through Reclamation's Rogue River Project, which diverts an average of over 100 cfs into Bear Creek (Rogue River drainage) during March and April (Reclamation 2003). During summer and fall, the Rogue River Project typically diverts less than 10 cfs from the Jenny Creek basin. The total volume of water annually diverted from Jenny Creek through the Rogue River Project is approximately 24,000 acre-feet. Smaller diversions also occur within the upper Jenny Creek basin, namely PacifiCorp's 16.5 cfs diversion from Spring Creek to Fall Creek and private water diversion in the lower reaches of Spring Creek (FERC 2006).

Fall Creek enters Iron Gate Reservoir approximately 2 miles above the confluence of Jenny Creek. Water diverted from Spring Creek enters Fall Creek approximately 1.7 miles upstream of the Fall Creek diversion (FERC 2006). The Fall Creek diversion dam bypasses all but 0.5 cfs of flow into the Fall Creek bypass channel, effectively de-watering the steep 1.2-mile bypassed section of Fall Creek between the diversion dam and where the Fall Creek Powerhouse outflow rejoins the creek. However, anadromous fish passage has historically been precluded by the falls that occur just 0.2 mile above the powerhouse (Wales and Coots 1954). The City of Yreka, California, operates a 15 cfs water diversion located below the powerhouse, and CDFG and PacifiCorp operate 10 cfs diversions below Yreka's. Despite these diversions, flows within Fall Creek below the powerhouse are usually between 30 and 50 cfs, and exhibit very high water quality and low temperatures as a result of the spring-fed nature of the watershed. Instream habitat is suitable for coho salmon spawning and rearing.

CDFG has operated a juvenile salmon rearing facility on Fall Creek downstream of the impassable falls during past years (FERC 2006). The hatchery was used to annually raise approximately 100,000 fall Chinook salmon yearlings to augment production at Iron Gate Hatchery. Due to funding restrictions, CDFG discontinued the operation in 2003.

D. Current Viability of Affected Klamath River Population Units

This section will detail the current viability of the three mainstem Klamath River population units and two tributary population units (*i.e.,* the Shasta and Scott) affected by the Project. Within the California portion of the SONCC ESU, estimating the viability of a given coho salmon population is difficult since longstanding monitoring and abundance trends are largely unavailable. Williams *et al.* (2007) proposed biological viability criteria in the form of population abundance thresholds as part of the ESA recovery planning process for the SONCC coho salmon ESU. The viability criteria developed by Williams *et al.* (2007) address and incorporate the underlying viability concepts (*i.e.,* abundance, productivity, diversity and spatial structure) outlined within McElhany *et al.* (2000), and are intended to provide a means by which population and ESU viability can be evaluated in the future when robust population data become available. For our purposes, comparing rough population estimates recently derived through Klamath coho salmon life-cycle modeling efforts (Ackerman *et al.* 2006) against population viability thresholds proposed by Williams *et al.* (2007) allow NMFS to make conservative assumptions concerning the current viability of Klamath River mainstem and tributary population units.

Generally speaking, none of the five population units of Klamath River coho salmon affected by the proposed action are considered viable at this point in time. As can be seen within table 5, even the most optimistic estimates from Ackerman *et al.* (2006) indicate each population falls well short of abundance thresholds for the proposed viability criteria that, if met, would suggest that the populations were at low risk for this specific criterion. A population is considered at low risk of extinction if all criteria are met, therefore failure to meet any one specific criterion would result in the population being at risk of extinction (*i.e.*, not viable). Furthermore, the Shasta River coho salmon population is critically low and likely experiencing depensation pressures. With regard to spatial structure and diversity, Williams *et al.* (2007) abundance thresholds were based upon estimated historical distribution and abundance of spawning coho salmon, and thus capture the essence of these two viability parameters. By not meeting the low risk annual abundance threshold, all five Klamath coho salmon populations are likewise failing to meet spatial structure and diversity conditions consistent with functionally viable populations.Another viability criterion proposed by Williams *et al.* (2007) entails the influence of hatchery fish within a population. Generally speaking, hatchery fish can affect natural salmon populations through increased competition, disease introgression and genetic dilution (NRC 1996). To limit these effects, Williams *et al.* (2007) propose that the fraction of naturally spawning fish within a given population that are of hatchery origin not exceed 5 percent. Both the Klamath River and Trinity River basins are heavily influenced by hatchery fish, with native coho salmon present only in small numbers (NMFS 2004a). The high proportion of hatchery-reared coho salmon within the Trinity and Klamath Rivers would suggest the Klamath River meta-population is at least at a moderate risk of extinction with regard to its genetic integrity (*i.e.,* diversity). However, the Trinity River and Iron Gate Hatcheries integrate naturally-produced coho salmon into their broodstock programs, effectively minimizing genetic drift arising from hatchery fish spawning within the natural population. Furthermore, NMFS has determined that hatchery fish from the two hatcheries are genetically similar to natural populations, meaning, in essence, that hatchery production of coho salmon contributes greatly to the abundance of the species throughout the

Table 5. Estimated abundance versus various abundance thresholds for the five coho salmon populations affected by Project operations (from Williams *et al.* 2007).

Population Unit	Approximation of run size estimates from 2001-2004 (from Ackerman *et al.* 2006)	High Risk Annual Abundance Level[a]	Low Risk Annual Abundance Level[b]
Lower Klamath	0 – 2,000	205	5,900
Middle Klamath	0 – 1,500	113	3,900
Upper Klamath	100 – 4,000	425	8,500
Scott River	10 – 4,000	441	8,800
Shasta River	100 - 400	531	10,600

[a] High risk annual abundance level 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).

[b] 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.

Klamath River basin (June 28, 2005, 70 FR 37160). Overall, the effect of these hatchery programs on the spatial structure, productivity and diversity within the SONCC coho salmon ESU is likely limited (June 28, 2005, 70 FR 37160).

To summarize, NMFS believes that the SONCC coho salmon ESU is currently not viable and is at moderate risk of extinction. 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). Due to data limitations, Williams *et al.* (2007) were not able to assess the viability of the SONCC coho salmon ESU with the quantitative approach they proposed, however, they agree with the previous assessments in CDFG (2002), Good *et al.* (2005), and Weitkamp *et al.* (1995) that SONCC coho salmon are likely to become endangered in the foreseeable future.

E. Critical Habitat

Designated critical habitat for SONCC coho salmon in the mainstem Klamath River downstream of Iron Gate Dam is vital to the species' continued survival. Within the action area, the essential habitat types of SONCC coho salmon designated critical habitat are: (1) juvenile and adult migration corridors in the Lower Klamath River section; (2) juvenile and adult migration corridors, juvenile summer and winter rearing areas, and spawning areas within the Middle Klamath River section; and (3) juvenile and adult migration corridors, juvenile summer and winter rearing areas, and spawning areas within the Upper Klamath River section. Because the mainstem Klamath River provides migratory connectivity between high value tributary spawning and rearing habitat and the ocean, NMFS finds that critical habitat within the mainstem Klamath River has high value for the conservation of SONCC coho salmon. NMFS also acknowledges that although a very small population of SONCC coho salmon spawn in the Upper Klamath River section, and the Upper and Middle Klamath River sections provide rearing opportunities largely at the cool water refugial areas at the mouths of tributaries, critical habitat within the mainstem Klamath River has conservation value for spawning and rearing.

As mentioned previously, the Klamath River basin (including the Trinity River) comprises one of the main meta populations in the SONCC coho salmon ESU. Thus, the conservation value of the designated critical habitat in the action area is extremely important for the species. However, water quality conditions upstream of Iron Gate Dam have resulted in the reduction of suitable juvenile rearing and migration habitat, and to a lesser extent adult migration, for miles downstream. In addition, spawning gravel recruitment has been limited as a result of Iron Gate Dam. The current condition of these essential habitat features of critical habitat likely limit the current value of critical habitat in the action area downstream of Iron Gate Dam. Phase III flows were implemented starting in 2006, improving the condition and providing for increased value of critical habitat within the mainstem Klamath River to provide spawning and rearing habitat, and migratory connectivity for juvenile and adult SONCC coho salmon.

IV. EFFECTS OF THE ACTION

The effects analysis will follow the general format introduced within the *Baseline* section – that is, the effects discussion will be organized spatially around the three mainstem areas (*i.e.*, Lower, Middle and Upper Klamath River). Since the Scott River and Shasta River lie outside the action area, the proposed action is not anticipated to affect habitat within the two watersheds. However, coho salmon smolts from the Shasta and Scott Rivers migrate through the mainstem Klamath River on their way to the ocean, and, as noted earlier, large numbers of YOY coho salmon are pushed into the mainstem Klamath River from the Shasta and Scott Rivers each spring. Once within the mainstem Klamath River, these fish are expected to experience Project-related effects discussed below.

NMFS expects FERC to issue a new license to PacifiCorp within 1 year of the issuance date of this Opinion. For the purposes of this analysis, NMFS assumes Phase III minimum flow levels, as outlined within the NMFS' (2002) biological opinion on the 10-year operations plan for Reclamation's Klamath Project, will be implemented as part of the proposed action.

NMFS also assumes both the proposed Sediment and Gravel Resource Management Plan and the proposed Water Quality Management Plan will be completed within the same 1-year time frame as the SMP and AMP mandated by BLM as part of its 4(e) conditions. As a result, improvements to water quality, water quantity and instream habitat resulting from the Sediment and Gravel Resource Management Plan and Water Quality Management Plan detailed below will begin to be realized within a few years time following license issuance (the lone exception will be turbine venting to improve DO concentrations below Iron Gate Dam, which will begin immediately).

NMFS acknowledges that the proposed action will continue to preclude passage upstream of Iron Gate Dam for an estimated 6 years during the design and implementation of the Project's fish ladders and associated structural modifications. For simplicity, the benefits of fish passage will be discussed as if they are attendant with the other portions of the Project. Delaying fish passage past Iron Gate Dam until year 6 of the license will prolong certain adverse impacts that will be alleviated by upstream fish passage (*e.g.*, disease nidus below Iron Gate Dam), while also delaying certain beneficial aspects associated with improving the abundance, productivity, diversity and spatial structure of the Upper Klamath Population Unit. However, the Klamath River coho salmon population has been generally stable, albeit at depressed abundance levels, since the mid-1990s (Good *et al.* 2005). NMFS believes that beneficial effects of the action that will be realized shortly after license issuance, such as DO improvements and to a lesser degree, gravel augmentation, will allow the population to persist until fish passage benefits are realized. Over-summer survival of juvenile coho salmon should increase with improving DO conditions brought about by turbine venting. Low DO conditions likely limit the nightly period during which juvenile fish leave refugial habitat to forage within the mainstem Klamath River. Higher nighttime DO concentrations should afford juvenile coho salmon greater foraging opportunities outside the confines of the existing thermal refugial areas, ultimately resulting in higher survival rates for the estimated several hundred fish that rear between Iron Gate Dam and Seiad Valley each summer. NMFS expects slight improvements to water quality conditions during the interim phase of the license leading up to the implementation of proposed fish passage facilities. These anticipated water quality improvements, combined with the implementation of Phase III minimum flow levels, and continued improvements to basin-wide tributary conditions through restorative actions, lead NMFS to conclude that coho salmon populations are likely to remain stable through the interim period.

Gravel augmentation is expected to provide additional mainstem spawning habitat. While gravel augmentation will primarily benefit Chinook salmon species, the predominant species spawing in the mainstem Klamath River, coho salmon will also experience benefits from gravel augmentation. Low numbers of coho salmon annually spawn in side channel and margins of the Klamath River in close proximity to Iron Gate Dam. Gravel augmentation will likely improve the quality of spawing in these areas and improve spawning success.

A. Lower and Middle Klamath River Population Units

The combined Lower and Middle Klamath Population Units encompass the mainstem reach between the Portuguese Creek confluence (near Seiad Valley) and the Pacific Ocean. Flow levels within this reach are not expected to change as a result of the Project, since the flow regime released from Iron Gate Dam is not expected to change from baseline conditions. For the most part, instream DO variations attributed to Project operations are generally restricted to the area immediately below Iron Gate Dam (PacifiCorp 2006), and thus, are not expected to affect the Lower and Middle Klamath Population Units. With regard to pH conditions, levels vary both seasonally and longitudinally within the mainstem Klamath River below Iron Gate Dam, at times reaching levels harmful to coho salmon. Yet, most of that change is attributed to the respiration/photosynthesis cycle of the immense aquatic algae populations within the river and is largely unaffected by Project operations. The reservoirs do exert a thermal lag on water temperatures within the mainstem, delaying both the warming of the river during spring and river cooling in the fall (PacifiCorp 2006). However, the lag is most pronounced just below Iron Gate Dam and diminishes quickly downstream, with water temperatures close to equilibrium with meteorological conditions downstream of Shasta River (PacifiCorp 2006). Therefore, adult coho salmon and coho salmon smolt migrating through the Lower and Middle Klamath reaches are not significantly affected by the spring and fall temperature lag. Mainstem rearing by juvenile coho salmon is likely rare within the Lower and Middle Klamath Population Units.

Current flow releases from Iron Gate Dam during late summer and early fall are substantially higher (*i.e.*, 33 percent greater; 1000 cfs versus 750 cfs) than those during the fall 2002 fish die-off within the lower Klamath River, when low flows were considered one of several possible factors inhibiting upstream fish movement (CDFG 2004, figure 4). Hardy and Addley (2001) recommended that fall flow releases from Iron Gate Dam not fall below 1000 cfs to ensure an adequate temperature regime for migrating salmonids within the lower river. Proposed flow releases from the Project are at or above 1000 cfs throughout the adult coho salmon migration period, and will likely be sufficient to preclude temperature and river depth impacts to upstream migrating adult fish.

The effect of spring flows on smolt migration and disease incidence is more difficult to discern. As noted within the *Environmental Baseline* section, higher flows would theoretically accelerate downstream smolt passage, although this effect has not been evaluated specific to the mainstem Klamath River (NAS 2004). While higher spring flows would theoretically dilute pathogen concentrations and disperse smolts over a greater area, any potential lowering of infection rates within the coho salmon smolt population would be difficult to quantify. Since most smolts are likely infected within upstream pathogen "hot zones" located between Iron Gate Dam and Seiad Valley (Stocking and Bartholomew 2007), conditions within the Lower and Middle Klamath River sections (*i.e.*, below the Portuguese Creek confluence) would appear to have little effect on disease infection rates within the coho salmon smolt population in general.

Iron Gate Dam blocks the natural routing of sediment and LWD[6] from the upper basin, which has degraded spawning and rearing habitat in areas downstream of the dam. Fine sediment routing has also been largely interrupted by the complex of reservoirs, which hinders floodplain development and riparian recruitment immediately below Iron Gate Dam (FERC 2006). However, this effect is largely confined to the area between Iron Gate Dam and the Shasta River, since large influxes of sediment from tributary sources minimize the effect further downstream (FERC 2006).

B. Upper Klamath River Population Unit

1. Effects Below Iron Gate Dam

a. Water Quality

The naturally high nutrient loads and warm water temperatures common to the basin will likely continue, and pH and DO concentrations will continue to fluctuate as primary production dominates water quality within the mainstem Klamath River. However, DO concentrations below Iron Gate Dam are expected to improve marginally through implementation of proposed minimization measures. PacifiCorp will implement turbine venting at Iron Gate Dam, which is expected to improve downstream DO concentrations by at least 2.2 to 2.7 mg/L on a short-term

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[6] For purposes of this analysis, LWD represents large logs, generally at least 12 inches in diameter with an attached root wad, that have fallen into streams, creating stable structures and a diversity of cover conditions and habitat for aquatic organisms.

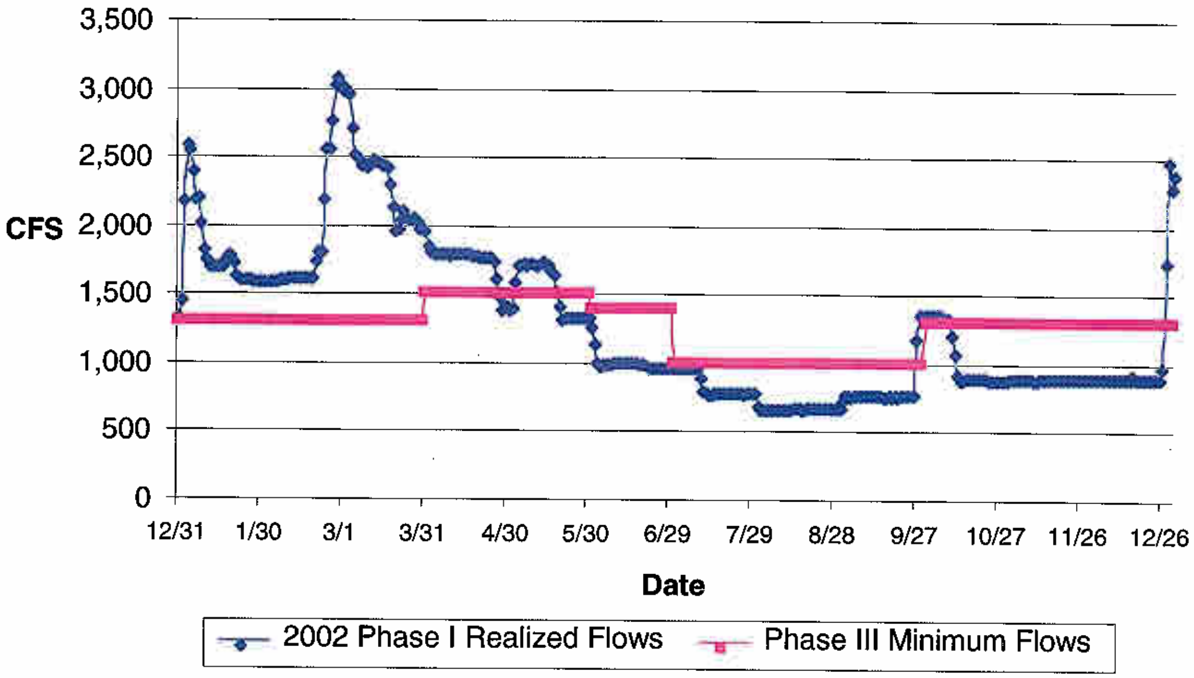

Figure 4: Iron Gate Dam flows realized during 2002 (Phase I) versus Phase III minimum flows. Note that discharge from the upper Klamath Basin during winter and spring is often higher than reservoir capacity, and uncontrolled spill regularly occurs. Thus, early season flows during Phase III will likely mimic a more natural hydrograph pattern, such as what occurred in early 2002. The fish die-off occurred the last half of September.

basis, depending on the configuration of the vents (Mobley Engineering 2005 *op cit.* FERC 2006). PacifiCorp will also investigate and install other technologies (*e.g.*, hypolimnetic oxygenation system) to improve DO conditions when feasible, making sure any proposed measures do not bring about unintended consequences with regard to other water quality parameters (*e.g.*, hypolimnetic oxygenation could affect reservoir stratification and destroy the cold-water pool; FERC 2006). As a result of turbine venting, adult and juvenile coho salmon occupying the river below Iron Gate Dam during summer and fall will likely experience relief during periods of low DO (FERC 2006). Yet, even with the venting mitigation, DO concentrations during late summer and early fall will continue to fall below 7 mg/L at night, largely due to high respiration by the aquatic plant community. Thus, as a result of the Project's effect on DO concentrations below Iron Gate Dam, coupled with the naturally high density of the aquatic plant community, mainstem rearing coho salmon will be forced to rely upon cold-water refugia to a greater degree during summer months, since nighttime excursions away from refugial habitat will likely be limited due to low DO conditions in surrounding areas.

The Project alters the timing and magnitude of the river's seasonal spring warming and fall cooling (Bartholow *et al.* 2005, Dunsmoor and Huntington 2006), but the overall effect on coho salmon survival is difficult to discern. The delay likely presents a thermal detriment to rearing and adult salmon by extending high summer water temperatures further into the fall, but this effect is likely less critical with regard to adult coho salmon due to their later run timing as compared to Chinook salmon and steelhead. On the other hand, the Project may benefit coho salmon smolts by delaying the onset of warm water temperatures during their critical outmigration period. Overall, the spring and fall temperature lag does not appear to appreciably affect coho salmon within the Upper Klamath Population Unit.

While the observed temperature lag would appear to minimally affect coho salmon adults and smolts during the fall and spring, respectively, the Project likely affects rearing juvenile coho salmon below Iron Gate Dam during summer months, including fish displaced during the spring from the Scott and Shasta Rivers. The constant release of warm outflow from Iron Gate Dam moderates the natural diurnal temperature variation of the river (*i.e.,* warming during the day and cooling at night). For example, modeling of water quality conditions between 2000 and 2004 by Dunsmoor and Huntington (2006) appears to show that average daily minimum and maximum water temperatures directly below Iron Gate Dam during the warmest time of the year (late July) varied significantly under a "without Project" scenario (18°C to 23°C) as compared to the constant 22°C temperature modeled under "existing conditions." While slightly cooling critically high water temperatures a few degrees may benefit juvenile coho salmon to a small degree, warmer nighttime conditions may be especially unfavorable since fish are likely at their limit of thermal tolerance (NAS 2004). This effect would cause individual fish to rely more heavily on cold-water refugial habitat for survival during periods of critically warm water temperatures. Several other factors, such as season, climatic and meteorological conditions, and water year type, also affect water temperature dynamics during this time of the year (FERC 2006). To minimize these effects, FERC proposes to investigate modifying the intake and release structures at Iron Gate Dam so that cold water releases can be made from Iron Gate Reservoir during summer/fall periods when water temperatures in the lower river are critically high. The cold water "pool" within Iron Gate Reservoir is limited with regard to its small size, and Iron Gate Hatchery taps into the same water supply (NAS 2004). Nevertheless, the pool could be used to effect short-term relief from warm river temperatures, improving the survival of early returning adult coho salmon that approach the reach below Iron Gate Dam in September. Preliminary analysis by USGS regarding the feasibility of cold water releases from Iron Gate Dam suggests that mixing flows from the existing upper outlet with a new lower outlet could result in significant cooling downstream of the dam (NMFS 2006). As mentioned above, fish exposed to warm water and low DO concentrations likely congregate within available cold-water refugia near tributary mouths, springs and deep pools until conditions improve.

b. Instream Habitat

Spawning gravel is limited within the reach between Iron Gate Dam and the Shasta River, as sediment routing from upstream sources is blocked by the Project's dams. FERC proposes to improve spawning habitat within the reach through the development and implementation of a sediment and gravel resource management plan. The plan includes mapping and evaluating existing gravel distribution within the Iron Gate Dam to Shasta River reach, determining amounts and locations for gravel augmentation, and monitoring introduction sites so that future gravel augmentation can be adaptively managed. Small numbers of coho salmon have recently been observed spawning within the mainstem Klamath River on an annual basis, with the majority of sightings between Iron Gate Dam and the Shasta River (Magneson and Gough 2006). Gravel augmentation between Iron Gate Dam and the Shasta River is expected to improve spawning habitat availability and spawning success, leading to greater production from the small population of coho salmon that utilize the mainstem for spawning.

Riparian habitat directly below Iron Gate Dam is currently limited by the Project operations. This condition is expected to continue, since FERC proposes to use identical ramp rates for the Project. Poorly functioning riparian habitat affects individual fish in several ways. Juvenile and adult coho salmon inhabiting the reach immediately below Iron Gate Dam will likely encounter less allochthonous input (insects and organic matter) and slightly higher water temperatures from the lack of shade-producing riparian trees. Properly functioning riparian habitat cools water temperatures through shading, and contributes organic matter and insects upon which juvenile fish prey (Meehan and Bjornn 1991).

c. Hatchery Effects

Fish released from Iron Gate Hatchery can adversely impact wild coho salmon in several ways (NRC 1996). Stray hatchery adults can interbreed with wild fish, lowering the fitness level and genetic diversity of wild stocks. Competition between hatchery and wild adult coho salmon for limited spawning habitat is also a concern. Adult straying from the hatchery is currently greatest within areas directly below Iron Gate Hatchery (CDFG and NMFS 2001), since the dam forms a complete barrier to upstream migration and stray fish tend to spawn within mainstem and tributary habitat just downstream of the dam. Once passage is provided at Iron Gate Dam, a significant portion of the "stray" population will likely move above the dam and help seed unoccupied habitat within the upper basin (Simondet 2006). Several million juvenile salmonids are released annually from the hatchery during late spring and compete with wild fish for limited food and habitat within the mainstem Klamath River, although competition likely decreases as juvenile fish disperse downstream into the lower river and estuary. Individual coho salmon parr and smolts within the Upper Klamath Population Unit likely compete for food and habitat with hatchery-reared fish (NAS 2004). In river systems where mainstem rearing habitat is lacking, such as the Klamath River mainstem, individual fish may experience lower growth rates and reduced survival as a result of these interactions. Smolts that are comparatively smaller at ocean entry likely experience lower ocean survival (Holtby *et al.* 1990, Ward and Slaney 1988). To minimize the competition between natural and hatchery juvenile fish, FERC has proposed to rehabilitate the Fall Creek rearing ponds so that a substantial portion of fall-run Chinook salmon production from Iron Gate Hatchery will be yearling-age fish. Releasing yearling Chinook salmon from the hatchery (usually between October 15 and November 15) will not overlap with the natural outmigration season of coho salmon, thus reducing interspecific competition between juvenile fish. Furthermore, yearling fish have been shown to migrate downstream faster and residualize less than fish released at the fingerling stage (*i.e.*, younger, smaller fish released in the spring; CDFG and NMFS 2001). Although these indirect hatchery effects likely impact Klamath River coho salmon, the overall impact of the effects on species viability is likely small. A recent assessment of the effects of Rogue River Hatchery, Trinity River Hatchery, and Iron Gate Hatchery on the viability of the ESU in-total concluded that they decrease risk of extinction by contributing to increased ESU abundance, but have a neutral or uncertain effect on the productivity, spatial structure and diversity of the ESU (June 28, 2005, 70 FR 37160). More specifically, NMFS noted the hatcheries have a limited effect on SONCC ESU productivity and spatial structure, and a likely limited effect on diversity (June 28, 2005, 70 FR 37160).

While the indirect hatchery impacts arising from Iron Gate Hatchery operations are likely limited in nature, implementing the hatchery's broodstock program will directly take a large number of adult coho salmon each year. Iron Gate Hatchery requires a minimum of 200 adults (100 of each sex) to meet its current production goals. Furthermore, CDFG's current procedures include annually using approximately 10 unmarked/wild adult coho salmon each year as part of its broodstock program (Rushton 2007) to meet production goals. Integrating wild fish into the hatchery's spawning plan is necessary in order to maintain genetic diversity within the stock and retain any natural characteristics intrinsic within the wild population. Concerning surplus fish that return to the hatchery (*i.e.,* those coho salmon that are above and beyond the broodstock need), CDFG handles, tags and releases unmarked/wild coho salmon in excess of its production goals back to the mainstem Klamath River through a pipe at Iron Gate Hatchery, and sacrifices marked/hatchery origin fish. In recent years, the number of excess adult coho salmon returning to the hatchery has ranged from approximately 100 to 1500 individuals (table 6). This type of direct take (*i.e.,*harassment and death resulting from handling, tagging, spawning or sacrificing fish) is not appropriately addressed through section 7 consultation and issuance of an incidental take statement, since these actions are part of the integral operation of a hatchery and the resulting take is therefore not incidental in nature. Instead, NMFS considers a Hatchery and Genetics Management Plan (HGMP)[7] as the proper vehicle for addressing direct take resulting

Table 6. Number of adult coho salmon entering Iron Gate Hatchery by week, 2003-2006 (CDFG 2007 unpublished data).

Week Beginning	2003	2004	2005	2006
26-Sep	0	0	0	0
3-Oct	0	0	0	0
10-Oct	6	0	0	0
17-Oct	54	30	3	0
24-Oct	125	203	29	0
31-Oct	313	385	144	5
7-Nov	329	336	275	25
14-Nov	343	265	478	80
21-Nov	146	118	174	78
28-Nov	192	143	210	82
5-Dec	20	124	98	44
12-Dec	26	122	3	18
19-Dec	1	4	10	0
26-Dec	3	1	1	0
2-Jan	0	3	0	0
Total	1,558	1,734	1,425	332

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[7] On June 28, 2005 (70 FR 37160), NMFS adopted a rule under section 4(d) of the ESA prohibiting the take of 20 groups of threatened salmon and steelhead. In addition to prohibiting take of threatened salmon and steelhead, the rule also included a set of 13 limits on the application of the ESA take prohibitions for specific categories of activities that contribute to the conservation of the listed salmon and steelhead or adequately limit their adverse impacts. With regard to fish hatchery impacts, the section 4(d) rule does not prohibit take of listed fish for a variety of hatchery purposes if a state or federal management agency develops, and NMFS approves, an HGMP that minimizes the hatchery's impact and works toward the conservation of the species.

from hatchery operations, or alternatively, Pacificorp could apply for a section 10(a)(1)(A) permit which authorizes this take.

d. Disease

Project reservoirs have likely increased the prevalence of disease pathogens *C. shasta* and *P .minibicornis* within Chinook and coho salmon populations inhabiting the lower river. A large population of *M. speciosa*, the intermediate host for the pathogens, occurs below Iron Gate Dam (Stocking and Bartholomew 2007). Since the dam lacks passage, salmon congregate in the area below the dam every fall, and disease transmission between host (adult salmon) and intermediate host is facilitated. Allowing fish to pass above into the Project should diminish pathogen transmission between infected adult salmon and *M. speciosa* in the area below Iron Gate Dam, which would theoretically lower infection rates of juvenile salmon the following spring (*i.e.,* less infected *M. speciosa* would translate into lower disease transmission to coho salmon).

Once infected with *C. shasta*, fish survival rates vary by location within the mainstem Klamath River, but are generally low. Sentinel studies during September and November, 2003, documented high infection rates of rainbow trout (*O. mykiss*) exposed to the pathogen both upstream and downstream of Iron Gate Dam, but survival rates were lower below the dam than above (Oregon State University 2004). Specific to coho salmon, Bartholomew and Stocking (2007) found that mortality rate and mean time to death of fish exposed to *C. shasta* near Beaver Creek (rm 161) varied according to water temperature. Eighty-five percent of coho salmon exposed to the pathogen at 18°C died, whereas mortality rates were only 5 percent for fish exposed at 13°C. Mean time to death was also shorter at the higher temperature, 25 versus 35 days. How the Project's effect on seasonal water temperature (*i.e.,* the thermal lag) impacts *C. shasta* and *P. minibicornis* infection rates is unknown at this time.

2. Effects Above Iron Gate Dam

In the following sections, we describe the anticipated effects of the Project on SONCC coho salmon that will utilize habitat upstream of Iron Gate Dam. Effects of the Project upstream of Iron Gate Dam are organized by section; however, NMFS acknowledges the interconnection of effects. The following categories of effects are described below:

a. Habitat increase resulting from fish passage;
b. Effects of flow management (water quantity);
c. Effects to water quality;
d. Effects from fish passage facilities;
e. Effects of the Project on predation; and
f. Effects of the Project on fish disease.

a. Habitat Increase Resulting From Fish Passage

The Project includes the Services' section 18 fishway prescriptions, requiring construction, maintenance and operation of fishway facilities at PacifiCorp facilities, including: Iron Gate Dam, Copco 1 Dam, Copco 2 Dam, J.C. Boyle Dam, and tributary diversion sites on Spring Creek and Fall Creek. The Services' section 18 fishway prescriptions also identify passage improvements to J.C. Boyle and Copco 2 bypass reaches, as well as a timetable for completing fish ladder and passage impediment modifications. For the purpose of this analysis, NMFS assumes this timetable will be met. Six years following the issuance of PacifiCorp's license), coho salmon will be afforded approximately 58.5 miles of habitat that is currently unavailable (table 7). Approximately 40 percent of the historic habitat of the Upper Klamath River Population Unit of coho salmon will become available through fish passage (Williams *et al.* 2006).

In the following two sections, we describe in general terms, the anticipated quantity and quality of habitat conditions that will be available through fish passage. Subsequent sections will describe the effects of the Project on water operations, water quality, predation, disease and effects of fish passage structures and Fall Creek Hatchery.

(1) Tributary habitat. Six years following the issuance of the license, approximately 58.5 miles of historical habitat will become available to coho salmon to meet their life history needs, including 21.6 miles of tributary habitat (table 7). At least 10 miles of perennial stream reaches within the Project area have gradients at or below 4 percent (Williams *et al.* 2006). These include: Jenny, Fall, Shovel, and Spencer Creeks, which presently support spawning populations of resident salmonids, thereby suggesting that those habitats would also be suitable for use by anadromous fish.

The expected habitat conditions for coho salmon in tributaries will vary in quality; however, Judge McKenna concluded that there is significant suitable habitat, including tributary habitat, upstream of Iron Gate Dam for the needs of the life history of coho salmon (Ultimate Findings of Fact and Conclusions of Law, ALJ 2006). Within the range of tributary habitat of the Upper Klamath Population Unit (Portuguese Creek to Spencer Creek), high quality, cold water tributary habitat for coho salmon exists upstream of Iron Gate Dam, and we generally describe these key tributaries below.

Jenny Creek is a spring-fed stream and the lowest tributary upstream of Iron Gate Dam (rm 194). Historically, Jenny Creek was used by anadromous salmonids (Coots 1962, Fortune *et al.* 1966). Prior to the construction of Iron Gate Dam, the confluence of Jenny Creek and the Klamath River was considered a productive fishing location for adult coho salmon (Hamilton *et al.* 2005), suggesting adult coho salmon staged to enter Jenny Creek to spawn. Spawning habitat is available, but limited. Coots and Wales (1952) and Huntington (2006) estimated the length of habitat available for adult anadromous salmonids to be approximately 4,220 feet, while Li's (2007) habitat survey estimated approximately 9,000 linear feet of habitat available. NMFS also observed a potential upstream barrier to juvenile salmonids 3,000 feet from the confluence of the Klamath River (Li 2007). The Jenny Creek watershed is hydrologically impaired as result of approximately 24,000 acre feet being exported though the inter-basin transfer of water to the Rogue River (Reclamation 2003). As described above, PacifiCorp currently diverts approximately 16.5 cfs from the Spring Creek, tributary to Jenny Creek, and releases it into Fall Creek. PacifiCorp proposes to shut down the water transfer from May through September prior to 2015 (FERC 2006). This modification to the Spring Creek diversion will provide additional base flow during the critical over-summering period for rearing coho salmon in the future.

Table 7. Project reach habitat for coho salmon.

River Reach	Habitat Miles Available for Coho Salmon[1]	Source for Miles of Historical Anadromous Salmonid Habitat or Potential Anadromous Fish Use
Iron Gate to Copco 2:		
Iron Gate Reservoir	6.8	FERC (2006)
Scotch Creek	3.9	Hamilton *et al.* (2005)
Slide Creek	1.1	Hamilton *et al.* (2005)
Camp Creek	2.9	Hamilton *et al.* (2005)
Jenny Creek	0.8	Coots and Wales (1952), Huntington (2006)
Copco 2 Bypass	1.4	PacifiCorp (2004)
Fall Creek	0.8	Wales and Coots (1954), Huntington (2006)
Salt Creek	0.2	Hamilton *et al.* (2005)
Copco 2 Reservoir	0.3	FERC (2006)
Copco 1 Dam to J.C. Boyle:		
Copco 1 Reservoir	4.5	FERC (2006)
J. C. Boyle Peaking	17	PacifiCorp (2004)
Shovel Creek	2.1	CDFG (2005), Huntington (2006)
J. C. Boyle Bypass	4	PacifiCorp (2004)
Long Prairie Creek	0.3	Coots (1965)
Deer Creek	0.3	Hamilton *et al.* (2005)
Edge Creek	0.2	Hamilton *et al.* (2005)
Frain Creek	0.1	Hamilton *et al.* (2005)
Negro Creek	0.5	Hamilton *et al.* (2005)
Tom Hayden Creek	0.9	Hamilton *et al.* (2005)
Topsy Creek	0.2	Hamilton *et al.* (2005)
Beaver Creek	0.2	Coots (1965)
J.C. Boyle to Spencer Creek:		
J.C. Boyle Reservoir to Spencer Creek	2.9	PacifiCorp (2004)
Spencer Creek	7.1	Fortune *et al.* (1966), Huntington (2006)
Total Coho Salmon Habitat (miles) inside Project:	**58.5**	**N/A**

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[1] Habitat Miles for coho salmon = steelhead ("anadromous") fish miles x (0.774) in tributaries (as described in Huntington 2004). Note that these figures are estimates or approximations. In addition, as described farther below, miles of available habitat may be for one or more life history phases (but not necessarily all life stages) of coho salmon.

Some reduction in habitat capacity may occur during the Spring Creek diversion operation season (October-April). Fish screens on Spring Creek, as proposed, will ensure no coho salmon are entrained at the diversion.

Fall Creek, entering Iron Gate Reservoir, at rm 196.3, is a spring-fed tributary that provides near optimal stream temperatures for rearing coho salmon (10-16°C, average 12.5°C; PacifiCorp 2007). Prior to the construction of Iron Gate Dam, Fall Creek supported runs of anadromous salmonids, including coho salmon (Hamilton 2006). Approximately 4,800 linear feet of habitat is available for anadromous salmonids (PacifiCorp 2007). Spawning gravel is available, but limited. As described in the *Proposed Action* section above, Fall Creek Hatchery is expected to be used to full potential for production of yearling hatchery Chinook salmon in the future. The current infrastructure at Fall Creek Hatchery allows for 6-8 cfs of water diverted from Fall Creek to 6 ponds. Approximately one-third of the water is returned to Fall Creek at a location approximately 100 feet downstream of the diversion, while the remainder of the water is returned to Fall Creek approximately 450 feet downstream of the diversion. Water quality effects of this water use are unknown, although no discernable effect to water temperature has been observed (Rushton 2007). Fall Creek maintains spring-fed base flow through the summer and PacifiCorp's combined water operations on Fall Creek (*i.e.*, flow augmentation from Jenny Creek, hatchery diversion and return) will have minimal effect on habitat availability. Fish screens on Fall Creek as proposed will ensure no coho salmon are entrained at the diversion.

Shovel Creek enters the Klamath River in the J.C. Boyle peaking reach at rm 206.5. Shovel Creek contains habitat conducive to spawning and rearing coho salmon (Li 2007). A number of cold water springs exist, providing cold water refugia. At least 3 miles of available habitat for anadromous salmonids exist in Shovel Creek. Currently, Shovel Creek supports spawning habitat for resident rainbow trout, and while quality spawning habitat is available for coho salmon, the quantity of spawning gravel is limited, which may limit future production. PacifiCorp proposes to eliminate the gravity-fed water diversions from Shovel Creek and its tributary, Negro Creek, to prevent trout fry from being entrained, and this effort will also ensure coho salmon will not become entrained in the future.

Spencer Creek enters the Klamath River at rm 227.6, and is considered the historical extent of coho salmon distribution in the Klamath River (Williams *et al.* 2006). Spencer Creek was characterized by Duffy (2006) as the most important potential habitat for coho salmon in the Project reach. Fortune *et al.* (1966) and Huntington (2006) estimated approximately 7.1 miles of habitat available for anadromous salmonids. Spencer Creek flows through a relatively low gradient area, resulting in the lower velocity habitats juvenile coho salmon prefer. Furthermore, it supports beavers, whose activities create the side-channel or off-channel habitats preferred by juvenile coho salmon (CDFG 2002). Spencer Creek contains areas of healthy riparian corridor, which provide shade and could provide extended stretches of thermal refugia for over-summer rearing juvenile coho salmon.

Other tributaries between Iron Gate Dam and Spencer Creek, including Camp Creek, Scotch Creek, Long Prairie Creek, Tom Hayden Creek, and Negro Creek, may provide suitable conditions for spawning, rearing or holding coho salmon.. Many of these streams flow intermittently, and intermittent streams may often go dry near their confluences to the mainstem

Klamath River. Many of these tributaries would provide important habitat for coho salmon populations. Coho salmon have adapted life history strategies (spatial and temporal) to utilize intermittent streams. For example, adult coho salmon will often stage within mainstem rivers at the mouth of natal streams until hydrologic conditions allow them to migrate into tributaries. Also, juvenile outmigration of 1 year-old coho salmon in the upper Klamath River will likely occur from February through May, when base flows of these small streams are relatively high and full connectivity to the mainstem Klamath River exists. Intermittent channels are also an important winter refuge for juvenile coho salmon (CDFG 2002), and may provide refuge from high mainstem flows.

(2) Mainstem habitat. In this section, we describe the anticipated effects of 36.9 additional miles of mainstem habitat to coho salmon. Effects of the Project on mainstem Klamath River habitat between Iron Gate Dam and Spencer Creek vary spatially and temporally. The Project creates lacustrine, hyperutrophic conditions observed in reservoirs during summer months, yet also contains riverine cold-water refugia suitable for rearing salmonids (*e.g.*, J.C. Boyle bypass reach).

Generally, reservoir portions of the Klamath River (*i.e.*, Iron Gate, Copco 1 and 2, J.C. Boyle) will function primarily as a migratory corridor as adults move upstream to spawn, and smolts move downstream to the ocean. Juvenile coho salmon primarily rear in tributaries and prefer habitat conditions most likely to occur in small, low gradient streams. However, as part of their life history strategy, juvenile coho salmon disperse and move from their natal tributaries to other habitats and are found in a broader diversity of habitats than are any of the other anadromous salmonids, from small tributaries of coastal streams, to lakes, to inland tributaries of larger rivers (Meehan and Bjornn 1991). Some young-of-year and parr coho salmon are likely to experience reservoir habitats while they rear. During summer months, suitable habitat for rearing coho salmon will likely be confined to small pockets of thermal refugia at the mouths of perennial streams (*e.g.*, Fall Creek confluence), while from late fall through spring, water quality conditions are likely to allow coho salmon to utilize additional habitat within reservoirs, although lacustrine habitats are not preferred. Currently, the reservoirs are inhabited by a number of fish species, including trout, indicating food sources preferred by juvenile coho salmon are likely to be available within the reservoir environment. Factors, including predation and adverse water quality, are more likely to limit the quality of reservoir habitat for rearing juvenile coho salmon. While historically, coho salmon may have spawned in portions of the mainstem Klamath River currently inundated by reservoirs, the reservoir environment does not provide conditions conducive for adult coho salmon to spawn (*e.g.*, flows, substrate).

In general, the continued operation and maintenance of reservoirs by PacifiCorp perpetuate the alteration of riverine habitat to reservoir habitat, limiting the potential habitat for future coho salmon to utilize and reducing the production potential of habitat upstream of Iron Gate Dam. Juvenile coho salmon that may utilize mainstem habitat for rearing will most likely be affected by this continued action.

Approximately 22.4 miles of mainstem riverine habitat will become available to coho salmon with fish passage. These reaches include the Copco 2 Bypass reach, the J.C. Boyle peaking reach, and the J.C. Boyle Bypass reach. Habitat conditions with these reaches will vary, and

Project operations, specifically flow management actions, will have pronounced effects on both the quality and quantity of habitat for coho salmon, which will be described in subsequent sections. Generally, these reaches provide potential habitat for all freshwater life history phases of coho salmon, including migration, spawning, incubation, and rearing.

Portions of the mainstem that are likely to provide conditions for a variety of life history stages of coho salmon include the J.C. Boyle Bypass and Peaking reaches, which are afforded a volume of approximately 250 cfs of cold water spring contributions. These reaches currently support resident rainbow trout, providing evidence to support the likelihood that these reaches contain habitat conditions to support rearing coho salmon. The J.C. Boyle Bypass and Peaking reaches are downstream and proximate to Spencer Creek, increasing the likelihood that these reaches will be utilized by coho salmon. Habitat surveys indicate that these reaches afford a diversity of meso-habitat types and cover elements preferred by juvenile and adult coho salmon, however, their conditions are impaired as a result of PacifiCorp operations (NMFS 2007). Spawning habitat appears to be limited due to the lack of preferred substrate (NMFS 2007), but may improve prior to the colonization of coho salmon with the implementation of the proposed Sediment and Gravel Resource Management Plan.

Habitat for coho salmon within the Copco 2 Bypass reach is limited due to the limited volume of instream flow. Current habitat conditions are degraded as a result of the loss of long-term hydrologic processes. An extended bedrock sill exists in this reach and may impede fish under the proposed flow regime. As a requirement of NMFS' section 18 Fishway Prescriptions, PacifiCorp will construct, operate, maintain, and evaluate a volitional fishway at Copco 2 Dam to provide for the safe, timely, and effective upstream passage of Chinook and coho salmon. The effects of flow management and other elements of the Project influencing this reach are described below.

Generally, riverine portions of the mainstem Klamath River provide potential habitat for coho salmon needs, including migration to and from tributaries, rearing and spawning. However, the potential for these riverine habitats to provide suitable conditions for the life history needs of coho salmon will be limited by effects of the Project further described in subsequent sections.

b. Effects of Flow Management

In this section, we describe the effects of flow management (*i.e.*, water quantity) on juvenile and adult life history stages of coho salmon. While flow is inherently connected to a number of other stressors that may affect coho salmon, such as disease, predation, water quality, and effects related to fish passage facilities, we have chosen to separate out these stressors and describe them in separate subsections.

(1) Mainstem flows. As described in the *Environmental Baseline*, the Project has substantially altered the hydrologic regime, both upstream and downstream of Iron Gate Dam. Flows through the Project reach are primarily set to reduce risks of flood, meet requirements as described in NMFS (2002), and to generate power through PacifiCorp's hydroelectric facilities. PacifiCorp's discretionary actions of modifying flow through the Project reach, combined with the effects of dam impoundments, have generally reduced the suitability of aquatic conditions for future populations of coho salmon.

As described above, NMFS' (2002) Long Term Flows at and below Iron Gate Dam (table 8) are currently instituted. PacifiCorp has discretion to modify instream flows through the Project above the Iron Gate Dam reach consistent with the FERC staff alternative and the mandatory prescriptions described in the *Proposed Action.* Here, we describe the expected effects of flow management on migration, holding, and rearing within reaches of the mainstem Klamath River. We also consider the effects of instream flows in subsequent sections (*e.g.*, predation, disease, water quality, fish passage).

(a) Iron Gate Reservoir Reach: Iron Gate Reservoir serves as a regulator of water released upstream at Copco Dam. Through high flow periods, Iron Gate Reservoir functions as run-of-river, and coho salmon will likely experience conditions similar to a large riverine system. Large areas of slack water form in reservoir coves during these high water events. As flows recede and the Project comes out of spill conditions into a controlled hydrologic environment, velocities decrease and the reservoir begins to exhibit more lacustrine hydrologic features. Generally, this shift from riverine to lacustrine environment occurs in late spring, although in dry water years, flows might not exceed 2,000 cfs throughout the entire year.

Based on Iron Gate Hatchery returns, adult coho salmon are expected to enter the Klamath River upstream of Iron Gate Dam as early as mid-October. However, the peak of the adult coho salmon run is anticipated to occur in late October and continue through mid-November (table 6). Based on data from downstream tributaries, adult coho salmon are likely to migrate through the Iron Gate Reservoir as late as January (CDFG 2007). Adult coho salmon entering Iron Gate Reservoir through the fishway will experience a minimum flow of 1,300 cfs at Iron Gate Dam from October through January (table 8). In general, the fall period of adult migration coincides with the beginning of increased precipitation, and flow variability above the prescribed minimum flow will likely occur. No passage impediments are expected through Iron Gate Reservoir (rm 190-197). Radio tracking studies of adult salmonids moving through reservoir systems indicate adult salmonids move rapidly, averaging 36.8-61.3 km/day (Naughton *et al.* 2005). While coho salmon smolt outmigration is likely to extend through late winter/early spring, the majority of smolt outmigration through Iron Gate Reservoir is anticipated to occur from January through early April (ALJ 2006). Minimum flows at Iron Gate Dam for the March through June period were developed by NMFS utilizing flow/habitat relationships for the Shasta River to Scott River reach of the Klamath River (NMFS 2002). Coho salmon smolt outmigration occurs coincident to high flow periods of the year. Higher flows are likely to improve the survival of coho salmon smolt outmigrants by reducing transit rates through the reservoir reach, and providing turbid conditions that reduce risks of predation. Young-of-year and parr coho salmon may reside in Iron Gate Reservoir as individuals move from natal tributary streams (*e.g.*, Jenny Creek, Fall Creek). Iron Gate Reservoir is unlikely to provide suitable rearing habitat through summer months, other than in limited locations where cold water tributaries are likely to provide zones of thermal refugia (*e.g.*, Fall Creek/Klamath River confluence). The amount and extent of refugial zones during summer months is most influenced by environmental conditions such as storms that raise flows in tributaries, or the influence of ambient temperature on water temperature.

Table 8. Long term Iron Gate Dam flows (cfs) by water year type (NMFS 2002).

Month	Dry	Below Average	Average	Above Average	Wet
October	1,300	1,300	1,300	1,300	1,300
November	1,300	1,300	1,300	1,300	1,300
December	1,300	1,300	1,300	1,300	1,300
January	1,300	1,300	1,300	1,300	1,300
February	1,300	1,300	1,300	1,300	1,300
March	1,450	1,725	2,750	2,525	2,300
April	1,500	1,575	2,850	2,700	2,050
May	1,500	1,400	3,025	3,025	2,600
June	1,400	1,525	1,500	3,000	2,900
July	1,000	1,000	1,000	1,000	1,000
August	1,000	1,000	1,000	1,000	1,000
September	1,000	1,000	1,000	1,000	1,000

Extremes in summer mainstem flows likely affect the quantity and quality of refugial zones by disconnecting refugial zones from mainstem habitat under extreme low flow conditions, or diminishing the beneficial effects of thermal refugia in extreme high flow conditions. NMFS is not aware of information specific to the effects that mainstem flow management through Iron Gate Reservoir may influence refugial zones. Tributary outlets entering Iron Gate Reservoir are generally located in coves that are not likely to experience discernible changes in flow within the range of summer mainstem flow conditions. Therefore, NMFS expects the proposed minimum flow schedule of 1,000 cfs at and below Iron Gate Dam, will provide sufficient flows for connectivity to refugial zones and ensure the integrity of the refugial zones is maintained.

(b) Copco Bypass Reach: A majority of mainstem flows are expected to be diverted from the historic Klamath River channel at Copco 2 dam and diverted through the bypass tunnel. Instream flows within the Copco Bypass reach are proposed to increase from current flows (5-10 cfs) to a minimum of 70 cfs and ramp-down rates will not exceed 125 cfs per hour in the Copco 2 Bypass reach, except for flow conditions beyond PacifiCorp's control. In our section 18 prescriptions, we directed PacifiCorp to ensure that the bedrock sill located approximately 0.5 miles upstream of the Copco 2 powerhouse be modified to allow unimpeded fish passage. The barrier will be modified in accordance with specified guidelines and criteria for fish passage (NMFS 2004), including providing at least 1.0 foot of swimming depth across the sill and with adequate attraction, velocity, capacity and vertical jump characteristics.

The Copco 2 Bypass reach has been strongly affected by Project operations over time. The Copco 2 powerhouse discharges directly into Iron Gate Reservoir, diverting flows around the bypass reach channel. The channel is in a deep, narrow canyon with a steep gradient, and consists of bedrock, boulders, large rocks, and occasional pool habitat. The Project's ability to divert up to 3,200 cfs, combined with decades of minimum flows in the bypassed reach of 5-10 cfs, have resulted in the almost complete de-watering of this reach. Approximately 99 percent of the flow into this reach has been diverted, except during spill events. As a result, riparian vegetation has encroached on the channel and adversely altered channel characteristics. PacifiCorp's instream flow habitat curves show this riparian encroachment and narrowing of the channel. Fisheries surveys conducted by PacifiCorp indicate that the fisheries in the Copco 2 Bypass reach are in poor condition in comparison to the other Project reaches (FERC 2006). Redband/rainbow trout fish density was observed to be much less in the Copco 2 Bypass reach [7.5 catch per unit effort (CPUE)] in comparison to the Keno (46.2 CPUE), and J.C. Boyle Bypass reach (19.1 CPUE).

FERC (2006) considered a number of minimum flow recommendations for the Copco Bypass Reach, including instream flow recommendations described in the Services' 10(j) recommendations. The Services' 10(j) recommendations recommended a minimum base flow in the Copco 2 Bypass reach that equals 40 percent of the mean annual inflow for that reach. The recommended reservation of at least 40 percent of the mean annual flow is supported by the hydrologic methods proposed by Tennant (1976), Tessmann (1980), Estes and Orsborn (1986), and the Instream Flow Council (Annear *et al.* 2004).

The proposed 70 cfs minimum flow in the Copco 2 Bypass channel, while increasing the availability of habitat relative to current conditions, will perpetuate the poor channel maintenance condition that currently limits habitat quality. Base flows of 70 cfs are approximately 4 percent of the mean annual flow. While spill conditions will continue to occur into the future through this reach, providing occasional channel maintenance conditions, artificially low base flow conditions, as proposed, will continue to allow for excessive encroachment of riparian vegetation and limit future opportunities for coho salmon to utilize the channel for their life history needs (*e.g.*, rearing, spawning, holding). In addition, since Copco 1 Reservoir stratifies much like Iron Gate Dam, summer and fall water releases from the epilimnion of the reservoir will likely be at temperatures stressful to coho salmon.

The 125 cfs per hour ramp rate requirements are expected to provide ample opportunities for young-of-year coho salmon to move from dewatering portions of the channel as flows recede. While stranding of juvenile fish occurs throughout natural riverine environments, these proposed ramp rates are expected to reduce Project effects to the point of making them negligible to risks associated with stranding.

(c) Copco 2 Reservoir: Reservoir water levels rarely fluctuate more than several inches in this short (0.3 mile) reach of reservoir habitat. Copco 1 Dam can discharge up to 3,560 cfs into Copco 2 Reservoir (FERC 2006). Poor habitat conditions, resulting from the impoundment of water, will reduce this reach of lacustrine habitat to simply a migratory reach for coho salmon moving up and downstream.

(d) Copco 1 Reservoir: Flow management in Copco 1 Reservoir will continue to include daily fluctuations in reservoir levels of approximately 0.5 feet due to peaking operations occurring at Copco 1 powerhouse. Fluctuations in the reservoir have been up to 6 feet (2601-2607 foot of elevation). Flows through Copco 1 Reservoir vary seasonally. Median average monthly flows between the years of 1990 and 2004 ranged from a low of 671 cfs in July to a high of 1972 cfs in March (table 3-19 in FERC 2006).

As described in other sections, NMFS expects poor habitat and water quality conditions will primarily limit opportunities for coho salmon to utilize Copco 1 Reservoir, and while instream flows are inherently connected to instream habitat and water quality, we describe those anticipated effects in other sections.

Coho salmon will primarily use Copco 1 Reservoir for migration, and the proposed range of flows are expected to be sufficient to ensure no migration barriers exist for upstream and downstream passage. NMFS expects coho salmon smolts will move quickly through the reservoir due to the lack of suitable rearing habitat. Young-of-year and parr coho salmon dispersing from upstream locations will experience limited areas for rearing, and as conditions deteriorate into summer months, juvenile coho salmon will be forced to either concentrate in refugial habitat at creek mouths and springs, or move in search of suitable habitat. Those juvenile salmon that do remain in unsuitable conditions will experience increased health risks, likely resulting in mortality (see *Water Quality*, *Disease* and *Predation* sections). As described above in our analysis of the effects of flow management in Iron Gate Reservoir, NMFS expects summer flows through Copco 1 Reservoir will provide sufficient connectivity with refugial zones to maintain integrity for fish, ensuring the integrity of the refugial zones is maintained.

(e) J.C. Boyle Peaking Reach: PacifiCorp's flow management has had a pronounced effect on the habitat of this 17-mile reach of river. PacifiCorp's peaking operations of the J.C Boyle development typically include storing and ponding water through the peaking reach at night. With the release of stored water, flows through the peaking reach typically are ramped up in the day time to either one unit operation (1,500 cfs), or two unit operation (2,750 cfs to 3,000 cfs). Wide fluctuations in flow and stage height occur. For example, the current FERC license allows for ramp up and down rates of 9 inches per hour. This pattern of flow alteration has simplified instream habitat over time. Instream habitat in the peaking reach is described as lacking active alluvial features and habitat complexity (FERC 2006).

Peaking operations can adversely affect the fitness of salmonids. ALJ (2006) provided the following conclusions regarding PacifiCorp's practice of daily peaking, based on evidence that peaking operations harm resident trout populations:

(1) Peaking operations negatively affect the redband trout fishery, evidenced through a relative reduced size rate in individuals residing in the J.C. Boyle Peaking reach. Average trout size has decreased since Project operations began. For trout residing below J.C. Boyle Dam, the average length has decreased from about 12 inches in 1961, shortly after the J.C. Boyle facility was completed, to about 7 inches in 1990.
(2) BLM's proposed upramp rate will improve conditions for fish resources and other aquatic organisms by reducing adverse effects caused by the existing 9 inch/hour ramp up rate.
(3) Peaking is the most widely documented source of fish stranding. Peaking fluctuations can result in severe cumulative impacts to fish populations.
(4) Project peaking operations kill, through stranding, large numbers of young fish and aquatic invertebrates that are the primary prey food for trout.
(5) Flow fluctuations from peaking operations increase energetic demands on salmonids, decreasing energy available for overall health, growth, and reproduction.

ALJ (2006) also included the following findings of fact regarding impacts of PacifiCorp's current peaking operations on macroinvertebrates, the primary food source for salmonids in the Klamath River:

1. Peaking operations reduce the production of sessile organisms, like macroinvertebrates, by 10 percent to 25 percent.
2. Macroinvertebrate drift rates, a measure of food availability for trout, in the non-peaking Keno reach were five to six times greater than in the peaking reach. Fluctuations in the peaking reach are undoubtedly a contributing factor to the lower macroinvertebrate drift rates.

The Project includes modifications to J.C. Boyle development operations that will improve current conditions for coho salmon. Peaking operations will be modified from daily to weekly peaking operation as follows: (1) a streamflow of 1,500 cfs to 3,000 cfs between 0900 and 1400 hours from Friday through Sunday, in the priority of Saturday, Sunday, and then Friday; (2) a minimum flow of 470 cfs, or 40 percent of the combined flow from Keno reach and Spencer Creek, whichever is greater of these two flows; and (3) ramp-up and ramp-down rates will be modified from the current 9 inches per hour rate to a rate not to exceed 2 inches per hour. Additionally, PacifiCorp will eliminate the gravity-fed water diversions from Shovel Creek and its tributary, Negro Creek (located adjacent to the Klamath River in the California segment of the J.C. Boyle Peaking reach), to prevent trout fry from being entrained and lost in the various ditches on PacifiCorp's Copco Ranch (a non-hydro related property).

Weekly peaking operations will limit the potential of the J.C. Boyle Peaking reach to provide rearing opportunities for the Upper Klamath population of juvenile coho salmon. Macroinvertebrate forage species of salmonids such as collector-gatherers, collector-filterers and scrapers, will be adversely affected by the continuous fluctuation in flows from peaking operations (Troelstrup Jr. and Hergenrader 1990), and drift densities will likely continue to be lower in this reach relative to other reaches that do not experience peaking operations (*e.g.*, Keno Reach). Substantial flow fluctuations (*e.g.*, 3,000 cfs to 470 cfs) may also pose risks to redds formed in the J.C. Boyle peaking reach. While adult coho salmon are anticipated to primarily use tributaries for spawning in the peaking reach (*e.g.*, Shovel Creek), some adult coho salmon are likely to spawn in the mainstem Klamath River, especially in side channel habitats that may experience weekly inundation and de-watering.

(f) J.C. Boyle Bypass Reach: Instream flows in the bypass reach will be modified under the Project. Minimum flows into the bypass reach are not likely to go below 470 cfs. In the unlikely event that calculated inflow is less than 470 cfs, flow will be provided to the J.C. Boyle Bypassed reach in an amount equal to the calculated inflow. In its 4(e) prescriptions, BLM also requires "when calculated inflow to J.C. Boyle Reservoir exceeds 3,300 cfs during the period between February 1st and April 15th, diversion to the J.C. Boyle Power Canal shall be suspended at least once and continued for a minimum of 7 days," allowing all flow to go through the bypass reach, creating a flushing flow. The proposed seasonal high flows for the bypass reach will create frequent, large magnitude high flow events through the peaking reach. Relatively coarse bed sediment (*i.e.*, gravel and cobble) can be mobilized in the bypass reach with flows of 1,700 cfs and greater. The high flows will mobilize and transport sediment within the Project.

Seasonal high flows, in combination with the gravel augmentation program, will likely create a more dynamic channel with a wider range of sediment deposits, improving conditions for spawning and rearing coho salmon over the life of the Project.

Approximately 250 cfs of cold water accretions contribute to this reach, increasing minimum flows to approximately 720 cfs. Similar to the J.C. Boyle Peaking reach, ramp-up and -down rates will be modified to not exceed 2 inches per hour. Down-ramping in the J.C. Boyle Bypass reach does not occur for power production purposes, but occurs primarily when coming off of spill mode or during infrequent maintenance events. Therefore, large flow fluctuations in this reach are most likely to occur from natural flow variation and not from effects of the Project.

Similar to the J.C. Boyle Peaking reach, coho salmon are expected to utilize the bypass reach for passage, rearing, and potentially, spawning. FERC (2006) analyzed varying flow alternatives for J.C. Boyle Dam release and its effects on resident rainbow trout habitat availability and on water temperature. FERC (2006) found that while instream habitat conditions improve within the high range of minimum flows released at J.C. Boyle Dam (range: 100-640 cfs), water temperatures in the lower end of the bypassed reach increase. Instream flows are likely to affect thermal refugia resulting from cold water springs. However, the effects are likely to be complex, as found in the mainstem Klamath River downstream of Iron Gate Dam (Karuk Tribe 2006, Sutton *et al.* 2004). The spatial distribution of thermal refugia area does not remain constant under varying flows, and under a higher flow regime, thermal refugia is likely to disperse over a greater area. Additionally, instream flows towards the higher end of the studied range (100-640 cfs) provide increased habitat availability to the 0.5-0.8 mile portion of the bypass reach upstream of the cold water springs.

Generally, we anticipate minimum J.C. Boyle Bypass flows, augmented intermittently by higher flows, will provide conditions suitable for rearing coho salmon by delivering an abundance of macroinvertebrate prey to an important cold water reach of river. Minimum flows are also expected to provide sufficient opportunities for migration through the reach of river.

(g) J.C. Boyle Reservoir: Adult and juvenile coho salmon will encounter J.C. Boyle Reservoir as they migrate to and from Spencer Creek. J.C. Boyle Reservoir will provided limited opportunities for coho salmon to utilize to meet their life history strategies, functioning primarily as a migratory corridor. Instream habitat conditions are not anticipated to be suitable for spawning or rearing coho salmon as the reservoir lacks combinations of depth, velocity, substrate and cover preferred by adult and juvenile coho salmon to meet their respective life history needs. Flows through J.C. Boyle Reservoir are comprised of accretions from Spencer Creek and from releases at Keno Dam and are anticipated to be sufficient to meet passage requirements for all life history stages of coho salmon.

c. *Effects on Water Quality*

In this section, we describe the effects of the Project on water quality conditions, including water temperature, DO, and nutrients, and assess how coho salmon are likely to respond to Project effects. The Project, including the continued operation of dams, has pronounced effects on water quality conditions downstream of Iron Gate Dam, as described above and within the Project reach. However, difficulty arises when trying to dissect water quality effects of the Project and those water quality conditions "inherited" from anthropogenic factors that influence water quality (*e.g.*, upper Klamath basin agriculture practices).

The Project includes future efforts to improve water quality conditions within the Project reach. While the goals of these actions will be to improve water quality, there exists a high degree of uncertainty in regard to the expected outcomes of these actions. The efficacy of these actions will be determined over time. For the purpose of this analysis, NMFS assumes current conditions, combined with our knowledge of other actions affecting the baseline, and climatological conditions projected into the future, to build the foundation for analyzing effects in a precautionary manner.

(1) Water temperature and dissolved oxygen: Cold water springs that could afford valuable refugia to anadromous salmonids will continue to be lost as a result of reservoir inundation. Increased surface area and increased retention time elevate water temperatures from historical riverine conditions. The reservoirs stratify, creating hypoxic conditions in the deepest portions of the reservoir during the warmest portions of the year. As described in the *Environmental Baseline* section, the two largest reservoirs, Iron Gate and Copco 1, both stratify beginning in March and destratify in October (Copco 1) and November (Iron Gate). Stratification affects water temperature and water quality and may have a pronounced effect on the behavior and health of coho salmon.

Adult coho salmon will begin entering Iron Gate Reservoir at a time when the reservoir is likely to be stratified. Adult salmonids migrating through reservoirs to upstream locations usually navigate along the slopes of the reservoir at depths of approximately 10-20 feet (Johnson *et. al.* 2004). Adult coho salmon migrating through Iron Gate Reservoir in October will experience water temperatures of approximately 16°C at depths of 10-20 feet (FERC 2006). By November, water temperatures will drop to approximately 11°C at depths of 10-20 feet. Copco Reservoir water temperatures in October and November are approximately 14°C and 9°C, respectively. Elevated water temperature exceeding 21°C can delay upstream migration of adult salmonids, as observed by Strange (2007). However, water temperatures at or below 16°C have been observed to have no effects on upstream migration in the Klamath River, and are within the range of preferred temperatures for adult coho salmon migration (Bjornn and Reiser 1991). Dissolved oxygen levels at depths of 10-20 feet in Iron Gate and Copco Reservoirs will vary from 7-10 mg/L (FERC 2006), and in the event that adult coho salmon experience the lower range of DO (*i.e.*, 7-8 mg/L), they are likely to experience increased stress. As referenced above, adult salmonids move through reservoir systems rapidly, averaging 36.8-61.3 km/day (Naughton *et al.* 2005), and most coho salmon experiencing low DO will likely migrate through individual reservoirs (less than 1 day per reservoir) or station near creek mouths where DO levels are likely to be suitable.

Similar to the mainstem Klamath River downstream of Iron Gate Dam (USFWS 1998), juvenile coho salmon may inhabit the mainstem Klamath River during all months of the year. Dunsmoor and Huntington (2006) modeled thermal stress levels for juvenile Chinook salmon and steelhead, for the relatively poor water quality years of 2000 to 2004, providing insight on "worst case" conditions likely to be experienced by juvenile coho salmon. Dunsmoor and Huntington's (2006) criteria for classifying stress thresholds for juvenile Chinook salmon rearing (FERC 2006) are relatively consistent with the threshold levels identified for coho salmon (table 3).

Dunsmoor and Huntington's (2006) model shows severe thermal stressors are likely to be experienced in Iron Gate and Copco Reservoirs through the months of July and August, while stressful conditions are also likely to be experienced from June through September. Poor water quality conditions will reduce the amounts of suitable habitat to small pockets of thermal refugia, at confluences of perennial tributaries (*e.g.*, Jenny and Fall Creeks), and at groundwater springs. As we describe above, juvenile coho salmon are not expected to use lacustrine habitats in large numbers during summer months, primarily because of their preference to use tributary habitat for rearing and because of the habitat limitations of the reservoir environment. However, juvenile coho salmon do exhibit strategies of dispersion and some small portion of juvenile coho salmon upstream of Iron Gate Dam are likely to encounter reservoir habitat during periods of poor water quality. The welfare of these individual juvenile coho salmon will likely be compromised, resulting in increased risks associated with predation and disease, as described in sections below. Future improvements to water quality are expected to result from the successful implementation of the proposed water quality management plan. However, discrete actions of the water quality management plan upstream of Iron Gate Dam are not clearly described, nor is there a timeline for implementation. Therefore, uncertainties preclude us from considering these potential water quality improvements in our analysis.

Water quality conditions in Copco 2 Reservoir are expected to be similar to Copco 1 Reservoir and coho salmon are expected to respond similarly (*i.e*, suitable conditions for adult migration, unsuitable conditions for juvenile coho salmon in summer months).

Due to its relatively short, narrow formation, and short flow retention rates, J.C. Boyle Reservoir stratifies weakly. Hypoxic conditions do occur in the deepest portions of the reservoir during summer months, but are not expected to overlap with the migration of adult coho salmon. Average monthly temperatures in October and November are 12.8°C and 6.2°C, respectively, while average DO levels for October and November are 8.2 mg/L and 10.3 mg/L (FERC 2006). Therefore, water quality conditions in J.C. Boyle Reservoir are expected to be suitable for migrating adult coho salmon.

Dunsmoor and Huntington's (2006) analysis of water quality conditions for juvenile Chinook salmon concluded severe thermal stressful conditions occurred from June 18 through August 26, while stressful conditions occurred from June 4 through September 23. Spencer Creek flows into J.C. Boyle Reservoir and juvenile coho salmon (both young-of-year and parr) are likely to disperse into J.C. Boyle Reservoir throughout the year. These individuals will experience a wide range of water quality conditions based on season. Springtime conditions, from March through May, when juvenile coho abundance is likely to be greatest, are expected to be suitable for rearing coho salmon. Average monthly temperatures ranged from a low of 7.7°C in March to 13.5°C in May, for the years 2000-2004 (FERC 2006). Summer months are less conducive for rearing coho salmon, with average monthly water temperatures exceeding 20°C from June through August. Hypoxic conditions exist in the deepest portions of the reservoir, however, juvenile coho salmon are unlikely to utilize these deepest sections, but are expected to range within shallow depths along the shoreline. Juvenile coho salmon exiting Spencer Creek and inhabiting J.C. Boyle Reservoir are most likely to stay confined to the confluence of Spencer Creek and J.C. Boyle Reservoir, where thermal refugia is likely to persist through summer months. However, individuals are likely to disperse downstream in search of suitable habitat as space becomes limited in the refugial zone. These displaced individuals will experience increased risks from predation and disease (described below) as they navigate through portions of stressful water quality conditions.

Within the Project's riverine sections (*i.e.,* Copco Bypass, J.C. Boyle Peaking, J.C. Boyle Bypass reaches), monthly water temperature presented in FERC (2006) indicates suitable thermal conditions will exist for coho salmon from September through June. Water temperatures for these reaches of river will vary, depending upon the influence of cold water accretions. Summer water temperatures are most likely to be stressful in the Copco Bypass reach. Peaking operations in riverine stretches of the Project reach will result in greater diurnal temperature fluctuations than they would without peaking. PacifiCorp provided water quality modeling results showing that, in the peaking reach, a steady flow alternative would provide slightly lower daily maximums and higher minimums, and a without Project alternative would provide even lower daily maximums and similar minimums, in comparison to the existing condition (FERC 2006). The effect of peaking operations on diurnal fluctuations will vary depending on season. Thomas *et al.* (1985) found under extreme diurnal fluctuations (*e.g.*, 6-20ºC) juvenile coho salmon may experience physiological stress. Peaking operations may exacerbate diurnal fluctuations to the degree that some juvenile coho salmon experience physiological stress during summer months. However, from fall through spring, peaking operations will have minimal effect on diurnal fluctuations and will not likely result in an increased risk of physiological stress to adult and juvenile coho salmon. Spillways and riffles dispersed throughout the riverine portions of the Project reach oxygenate outflows from reservoirs, and DO levels within the Project reach.

(2) Nutrients. PacifiCorp has contended that the Project reservoirs decrease nutrient loads and algal growth in the Klamath River below Iron Gate Dam by allowing organic matter from Upper Klamath Lake to settle in the reservoirs (FERC 2006), while other studies have shown that the reservoirs neither trap nutrients nor generate nutrients (Campbell 1999). Kann and Asarian (2007) conducted a nutrient budget analysis of Copco 1 and Iron Gate Reservoirs and demonstrated that Project reservoirs appear to be a net sink on an annual basis, but can act as both a source and sink for these nutrients, based largely upon the time of year and the cycling mechanisms occurring at that time. In the months of June through September 2002 when there were periods of negative nitrogen retention (release) in the reservoirs, total nitrogen retention was higher in the Iron Gate to Seiad River reach than in Iron Gate and Copco Reservoirs (Asarian and Kann 2006). Increased nitrogen levels may adversely affect DO levels to a level that reduces the fitness of coho salmon.

The large flow fluctuations associated with peaking hydropower operations limit the assimilative capacity of the river to remove hyper-eutrophic components of the water entering the system from upstream. Indeed, highly variable flow regimes limit the success of benthic algal species due to repeated desiccation and rewetting of benthic environments in the river (FERC 2006). Benthic algae are responsible for the removal of nutrients from the water column through assimilation. Without peaking operations, the Project reaches would provide stronger assimilation and removal of nutrients (FERC 2006). The Klamath River below Iron Gate Dam assimilates and removes nutrients due to uptake by algae and dilution from tributary streams (FERC 2006). Without peaking, the Project reaches of the Klamath River would likely remove nutrients more quickly, reducing the harmful effects associated with eutrophication of the Klamath River downstream.

Within the Project reach coho salmon will experience hyper-eutrophic conditions during summer months, in part, due to the Project. The effect this hyper-eutrophic condition will have on coho salmon is difficult to predict, but NMFS expects that natural hyper-eutrophic conditions, compounded with high temperatures, will increase stress on the physiology of juvenile coho salmon and ultimately lead to higher risks from disease and predation, described below.

d. Effects due to Fish Passage Facilities

The Project includes designs for fishways included in the new license, provisions for developing fishway operation and maintenance plans, provisions for evaluating and monitoring fish passage at the fishways, and provisions for modifying the fishways in response to evaluation and monitoring. These fish passage facilities may affect the migratory behavior, timing, and ultimately the health and reproductive success of adult and juvenile coho salmon. Negative effects of fish passage on adult and juvenile coho salmon will be reduced through the successful implementation of the Services' fishway prescriptions. Potential fish passage facility effects include:

1. Adult Delays at Fish Ladders
2. Adult Spillway Mortalities
3. Adult Delays or Injuries at Powerhouses
4. Adult Delays at Bypass Reaches
5. Juvenile Spillway Mortalities
6. Juvenile Fish Screen Losses
7. Adult and Juvenile Predation in Reservoirs

(1) Adult delays at fish ladders. Adult coho salmon can experience delays in upstream migration as they navigate through fish ladders, potentially blocking migration (Naughton *et al.* 2005). Delays at fish ladders generally occur due to (1) inappropriately designed or located ladder entrances; (2) inadequate flow rates, velocities, and temperatures at the ladder entrance and in the ladder; and (3) inappropriate hydraulic conditions within the ladder. Adult salmonids have also been observed to "fallback" during upstream spawning migration due to poor ladder exit location or design (Boggs *et al.* 2004, Naughton *et al.* 2005), delaying migration and reducing escapement to spawning grounds. Adults may be forced to use less than suitable conditions to spawn if delays are extensive, reducing the likelihood of successful reproduction.

NMFS' fish passage guidelines are expected to minimize delay at fish ladders. Based on considerations of flow, size, and configuration, we expect migration delays will be comparable at Iron Gate, Copco 1 and J.C. Boyle Dams. We expect delays will be lower at Copco 2 Dam due to its diminutive size and configuration. As an estimate of the delay adult coho salmon may experience at Iron Gate Dam, we expect delays to be less than those experienced at Bonneville Dam. Passage patterns at Bonneville Dam are the most complex on the Columbia River because there are three separate structures, two powerhouses, and an unattached spillway. There are also two passage routes at each powerhouse: the turbines and ice/trash sluiceway. Additionally, attraction flows into the Klamath ladders will be significantly greater (proportionately) than at Bonneville Dam, as specialized, lower attraction flow criteria exist for main-stem Columbia River facilities.

Limited information exists specific to adult coho salmon and delays at fish passage facilities. NMFS made a good faith effort to find published literature on this topic specific to coho salmon. The majority of relevant literature on this topic comes from research performed at Columbia River fish passage facilities. Because the only mainstem hydropower facility within the geographic scope of the Lower Columbia coho salmon ESU is Bonneville Dam, and because research efforts are often performed on species that are not Federally listed, the vast majority of this research focused primarily on Chinook salmon and steelhead. While there are physiological differences between coho and Chinook salmon, we consider this body of information on Chinook salmon and steelhead to function as a useful surrogate for our analysis. Median times for Chinook salmon to first enter fishways at Bonneville Dam were 2.0 and 2.2 hours in 1996 and 1997; steelhead median first entry times were 1.9 and 0.3 hours in 1996 and 1997, respectively (Bjorn *et al.* 1998). Data on median first entry time at Bonneville Dam are comparable to those at the three lower Snake River dams. Median times to first entries on lower Snake River dams were 1.9 to 2.6 hours at Ice Harbor and Lower Granite Dams in 1993 and 1994 (98.7 and 98.9 percent respectively, entered in less than 5 days). At Lower Monumental and Little Goose Dams, 98.5 and 98.2 percent entered in less than 5 days, and median times to first entries were 4.6 and 3.9 hours, respectively.

Spillway fallback is another form of delay at fish ladders. Fallback after exiting the ladder is positively correlated with river discharge, spill volumes, as well as the location of the spillway relative to the exit of the ladder (NMFS 2000a). Ladder exits should be located away from the vicinity of spillways to minimize fallback (Reischel and Bjornn 2003). Boggs *et al.* (2004) documented fallback of spring-summer and fall Chinook salmon and steelhead at eight Columbia River dams evaluated from 1996 to 2001. For all years combined, about 22 percent of spring–summer Chinook salmon, 15 percent of fall Chinook salmon, and 21 percent of steelhead fell back at least once at a dam. Fallback percentages for spring–summer Chinook salmon were generally highest at Bonneville and The Dalles Dams and decreased at progressively upstream dams.

Naughton *et al.* (2006) documented spillway fallback rates (the total number of fallback events at a dam divided by the number of fish known to have passed the dam) for eight Columbia River dams in 1997. The fallback rate of adult sockeye salmon ranged from 1.9 percent to 13.7 percent at the eight dams. The rate was highest at Bonneville Dam, the dam with the most complex fishway. Keefer and Bjornn (1999) estimated similar fallback rates for spring-summer Chinook salmon and steelhead at Columbia River dams at between 3 and 15 percent. As fallback is positively correlated to high spill events, rare high spill events may produce fallback in excess of these percentages. Naughton *et al.* (2005) reported that for Columbia River salmon, cumulative fall back events and slow migration across several dams or reservoirs could result in pre-spawning mortality.

Because river discharge and spill volume are less at Klamath dams, fallback of coho salmon is anticipated to be less than the 15 percent fallback of fall Chinook salmon over the eight

Columbia River dams. The details of how delay measurements will be performed will be established in coordination with the development of monitoring facilities and tagging and monitoring protocols. It would be impractical to establish the details of how delay will be measured in advance of the completion of these facilities and establishment of monitoring protocols.

(2) Adult spillway mortalities. Spillway survival studies have not been conducted at J.C. Boyle, Copco 1, Copco , and Iron Gate Dams. In accordance with a stipulation with PacifiCorp, the Services have revised the prescriptions for spillway modifications in the Modified Prescriptions to allow PacifiCorp to conduct site-specific studies on the need for and design of spillway modifications (DOI 2007). Spillway modifications will be constructed to minimize spillway effects on adult coho salmon unless the Services determine, based on any site-specific studies conducted by PacifiCorp in consultation with the Services, that spillway modifications are unnecessary.

Fish passing over spillways can be injured by strikes or impacts with solid objects (*e.g.*, baffles, rocks, or walls in the plunge zone), rapid pressure changes, abrasion with the rough side of the spillway, effects of gas supersaturation, and the shearing effects of turbulent water. Fallback over spillways during upstream migration of Pacific salmon may reduce spawning success or lead to increased prespawning mortality due to increased energy expenditure (Geist *et al.* 2000). A mortality rate of 8 percent was observed for adult sockeye salmon falling back through spillways at Bonneville Dam (Bjornn *et al.* 1998).

Keefer and Bjornn (1999) used radio-tagged fish known to have passed Bonneville Dam in 1996 to estimate survival to tributaries or the top of Priest Rapids Dam. Steelhead and spring/summer Chinook salmon that did not fall back over Bonneville Dam had survival rates were 3.8 to 5.2 percent higher than fish that did fall back. Keefer *et al.* (2005) reported that Chinook salmon and steelhead that fell back over one or more dams were significantly less likely to survive through the hydrosystem than fish that did not fall back.

Naughton *et al.* (2006) documented that the rate of survival was the same for sockeye salmon that fell back (68.0 percent) and fish that did not fallback (67.5 percent). Reservoir passage was also rapid, averaging 36.8–61.3 km/day, and appeared to compensate for slowed migration at dams. Rates observed in the unimpounded reaches suggest that total pre-dam migration rates may have been similar to current rates.

Whitney *et al.* (1997) concluded that 0 to 2 percent is the most likely juvenile mortality range for standard spillways on the Columbia River. Because of their size, adult salmon mortality is likely at the high end of this range, all other factors being equal. Supersaturation below spillways occurs in deep plunge pools. Because the Klamath River is shallow, NMFS does not expect significant supersaturation problems at Klamath spillways. However, spillway configurations at the Klamath dams, especially Copco 1 Dam, would likely cause mechanical injuries. NMFS' mandatory prescriptions require PacifiCorp to conduct studies prior to fish passage to determine if spillway modifications are necessary to reduce mortality. NMFS anticipates spillway mortality levels at Iron Gate, Copco 1 and J.C. Boyle will be 2 percent or below, and if studies determine mortality levels will be greater than 2 percent, spillway modifications will be conducted to reduce spillway mortality below 2 percent. There should be no mortality over the diminutive spillway at the Copco 2 Dam after spillway modifications are completed, or studies demonstrate they are not necessary.

(3) ***Adult delays or injuries at powerhouses.*** Adult anadromous fish are attracted into oncoming flows (NMFS 2004). Upstream migration may be delayed when tailrace flows from the powerhouse exceed river bypass reach flows. A migration delay, or combined delays at several facilities, may prevent fish from reaching suitable spawning habitat when they are ready to spawn or conditions are optimal for survival. Migration delays caused by tailrace effects may occur to a greater percentage and have a greater impact on fish populations than injury and mortality from turbine impacts (FERC 1994).

Migration delays from hours to several days are well documented for anadromous salmonids in the Pacific Northwest (Haynes and Gray 1980, Rondorf *et al.* 1983, Schadt *et al.* 1985, Vogel *et al.* 1990). For migratory fish, false attraction occurs when upstream migrants are attracted to turbine discharge or spillway flows rather than fishway flows. False attraction also occurs when upstream migrants detect scent of their natal stream downstream of its natural outlet (Fretwell 1989). This happens when water from a natal stream is diverted through a canal or pipe to a hydroelectric project.

The natural tendency for fish attracted to such an area is to hold and wait for passage conditions to improve, or to attempt to move past the obstacle either by swimming or leaping. Depending on powerhouse operations, draft tube discharge velocities at Project facilities are between 3.4 and 10.4 feet per second (CH2MHill 2006); these velocities easily fall within the swimming abilities of salmonids (Bell 1991, Weaver 1963).

The types of injury sustained by some fish entering draft tubes or contacting turbines vary from site to site, as do immediate and delayed mortality rates. Several studies, however, attribute injuries in migrating salmonids to powerhouse structures associated with tailrace structures (Department of Fisheries Canada 1958, International Pacific Salmon Fisheries Commission 1976, Schadt *et al.* 1985, Williams 1985).

The Project has powerhouses and associated turbine discharge structures at Eastside and Westside, J.C. Boyle, Copco 1, Copco 2, and Iron Gate developments. None of these facilities currently have tailrace barriers to exclude coho salmon from being falsely attracted to their discharges and injured or killed by contacting powerhouse structures. Water discharging from the Project powerhouses can represent a major portion of the total river flow of the Klamath River. Disparity in flow levels between the powerhouse and the bypassed reach can contribute to false attraction of upstream migrating fish to an area which provides no upstream passage, and delay these fish in their migration.

From February to September 2003, PacifiCorp documented the movements of rainbow trout near J.C. Boyle Dam facilities partly in order to (1) assess adult trout passage through the J.C. Boyle fish ladder and powerhouse tailrace; and (2) evaluate potential delays in adult trout movement related to flows, Project facilities, and operations (FERC 2006). While rainbow trout and coho salmon do not have the same migratory behavior, the study provides useful information on potential delay at powerhouse discharges. Of 28 fish released in the J.C. Boyle Peaking reach, five proceeded upstream and reached the confluence of the J.C. Boyle Powerhouse discharge and the bypass reach. Most, if not all, of the upstream migrants encountered the confluence area when the powerhouse was operating, and successfully passed the area on their first attempt as they moved into the bypass reach. A passage time for one of the five fish could not be provided because it passed after the fixed station was removed. Of the remaining four fish, upstream movement through the tailrace confluence area was achieved in 0.47 hours, 3.08 hours, and two fish at about 24 hours. While PacifiCorp reports that results do not provide evidence of delay of fish at the powerhouse, this information shows two of five fish took longer than 24 hours to move past the powerhouse tailrace and into the bypass reach.

In accordance with a stipulation with PacifiCorp, the Services have revised the prescriptions for tailrace barriers in the Modified Prescriptions (DOI 2007) to allow PacifiCorp to conduct site-specific studies on the need for and design of tailrace barriers (NMFS 2007). Tailrace barriers and guidance systems will be constructed to ensure no mechanical injury/mortality or migratory delay associated with powerhouse structures occurs, unless the Services determine, based on any site-specific studies conducted by PacifiCorp in consultation with the Services, that tailrace barriers are unnecessary. Coho salmon migration rates past Project powerhouses should not be significantly slower than migration rates in free-flowing reaches above and below the powerhouses.

(4) Adult delays at bypass reaches. When adult anadromous fish approach the confluence of an extended fish passage bypass reach and a powerhouse discharge, they will frequently explore the powerhouse outflow which often has a higher flow volume. However, fish will choose to swim up the bypass reach if they can sense a jet of higher velocity flow originating from the adjacent stream. The hydraulic conditions of this high velocity jet are critical cues to migrating fish looking for a path upstream (Ferguson *et al.* 2005).

Once coho salmon have entered the Copco 2 Bypass channel, fish passage may be affected by the transverse bedrock sill approximately 0.5 miles above the Copco 2 Powerhouse. According to the terms of the prescriptions, the Licensee "shall construct physical structures, facilities, or devices or modify the sill, unless the Licensee demonstrates that the sill in is not a barrier to fish passage under the normal operating flows specified for the Copco 2 bypassed reach in the new license."

The Services' Modified Prescriptions (DOI 2007) include flow rates into the fish ladders sufficient to produce attraction flows equal to at least 10 percent of High Fish Passage Design Flow, as determined in accordance with NMFS (2004) guidelines and criteria, as measured at a point upstream of the hydropower diversion, unless site specific analysis conducted in consultation with the Services, and the results approved by the Services, demonstrates a more suitable flow that meets the objectives of safe, timely, and effective fish passage. These flows will pass into the bypass reaches, and to ensure safe, timely and effective fish passage, the licensee must create sufficient attraction into the bypass reaches at the confluence of the bypass reach and the downstream powerhouse discharges.

(5) Juvenile spillway mortalities. In accordance with a stipulation with PacifiCorp, the Services revised the prescriptions for spillways in the Modified Prescriptions (DOI 2007) to allow PacifiCorp to conduct site-specific studies on the need for and design of spillway modifications. However, unless and until such site-specific studies are done, the Services must rely on the available information in concluding that spillway modifications are necessary for the safe, timely and effective passage of fish at J.C. Boyle, Copco 1 and 2, Iron Gate Dams.

To achieve fish passage with minimal entrainment of adult and juvenile coho salmon in Project turbines, the Services' Modified Prescriptions include positive exclusion barrier screens, with fish bypasses, if necessary, and spillway modifications (depending on study results). Juvenile coho salmon passage at Project dams will be achieved by either of two routes: (1) Collection at fish screens and passage downstream via a bypass conduit, or (2) over a spillway. Juvenile salmonids have experienced high rates of mortality at fish passage facilities (Williams *et al.* 2001), and as a result, design improvements have substantially reduced the levels of mortality (Williams and Matthews 1995). NMFS expects the design of fishway facilities to effectively reduce the level of injury and death caused by fishway structures.

At J.C. Boyle, PacifiCorp estimated that 20 percent of outmigrating anadromous salmonids exit downstream through spillways (PacifiCorp 2006a). No spill survival studies have been performed for Project dams. Spill survival estimates for juvenile salmonids at other dams are numerous and range from 76 percent to 100 percent, depending on species, life stage, amount or proportion of water spilled, spillway configuration, tailwater hydraulics, the methodology of estimating survival, and predator conditions (NMFS 2000a). Fish passing down a spillway may experience physical, chemical, and biological effects. Fish passing over spillways can be injured by strikes or impacts with solid objects (*e.g.*, baffles, rocks, or walls in the plunge zone), rapid pressure changes, abrasion with the rough side of the spillway, and the shearing effects of turbulent water. Losses of salmon and steelhead trout in the Columbia River due to supersaturation have been severe in years of high spillage (Ebel and Raymond 1976).

Whitney *et al.* (1997) reviewed 13 estimates of spill mortality for salmonids (3 on steelhead and 10 on salmon) published through 1995 and concluded that 0 to 2 percent is the most likely mortality range for standard spillways. They also pointed out that back eddies or other situations that may favor the presence of predators, may lead to higher spill mortality. Some point estimates for mortality in spillways with spill deflectors are higher than estimates for spillways without deflectors (NMFS 2000a). For example, the highest estimates of survival for yearling Chinook salmon and steelhead at Snake River dams were obtained from spillways without flow deflectors, ranging from 98.4 to 100 percent (Muir *et al.* 1995a, 1996, 1998). Although lower survival estimates were obtained from spillways with flow deflectors (ranging from 92.7 to 100 percent; Iwamoto *et al.* 1994, Muir *et al.* 1995a, 1998), differences in survival between the two types of spillways compared pairwise were not significant at Little Goose (steelhead), or Lower Monumental Dams (yearling Chinook salmon). A number of methodologies have been used to estimate spillway survival at lower Columbia River dams, including identification of test fish by fin clips (Holmes 1952), freeze brands (Johnson and Dawley 1974, Raymond and Sims 1980), coded wire tags (CWT) and freeze brands (Ledgerwood *et al.* 1990), balloon tags (Normandeau Associates Inc. *et al.* 1996, 1996a), and Passive Integrated Transponder (PIT) tags (Dawley *et al.* 1998, 1999).

Based on this information we conclude higher mortality is likely for spillways that have deflectors or conditions of gas supersaturation below the dam, all other parameters being equal. Gas supersaturation occurs below dams when water passes over a spillway and plunges to increased depths and pressures, forcing high amounts of air into solution. While this is often the case on rivers with deep plunge pools such as the Columbia River, it should not be as prevalent at Project dams. Mortality issues related to flow deflectors (such as may occur at Copco 1 Dam) will be minimized by any necessary spillway modifications, as specified in NMFS' Modified Prescriptions (NMFS 2007). Therefore, NMFS expects 1 percent or less juvenile coho salmon mortality at Project spillways with fishway modifications, if necessary.

(6) Juvenile Fish Screen Losses. The Services' prescriptions specify that the Licensee shall construct, operate, maintain, and evaluate fish screens and bypass facilities for volitional fish passage at all Project dams that divert water for hydro generation (DOI 2007). The screens and bypass shall be operated year-round and shall be designed in accordance with NMFS' (1997a) juvenile fish screen criteria or alternative criteria as determined by the Services. Properly designed and constructed positive barrier exclusion screens prevent salmon from entering into turbines by collecting and bypassing them into a bypass conduit. NMFS' criteria specify different approach velocities and screen openings for fry (< 60 mm) and fingerling (60 mm and longer) salmonids and are expected to be equally protective for both, ensuring near 100 percent passage success. NMFS will normally assume that fry-sized salmonids are present at all sites unless adequate biological investigation proves otherwise. The burden of proof is the responsibility of the owner of the screen facility. As such, coho salmon losses due to turbine mortality are expected to be zero, and bypass conduit mortality should be very low. The details of how fish screen losses will be measured will be developed in coordination with the design of fish passage monitoring facilities and protocols. It would be impractical to develop these details in advance of monitoring facilities and protocols.

Salmon injury or mortality may occur at the screens and bypass systems due to impingement, abrasion, or predation, however. Muir *et al.* (1995, 1996, 1998) estimated survival through bypass systems at Snake River dams based on PIT-tagged fish ranged from 95.4 to 99.4 percent for yearling Chinook salmon and from 92.9 to 98.3 percent for steelhead groups of released into the collection channel. Estimated survival was 95.3 percent for steelhead that passed through the entire bypass system at Little Goose Dam in 1997 (Muir *et al.* 1998). The Services' Modified Fishway Prescriptions include positive exclusion barrier screens according to NMFS' guidelines. Operating correctly, we anticipate each screen and bypass facility will result in zero turbine mortality and 98 percent or more survival through the bypass system.

(7) Adult and Juvenile Predation in Reservoirs. The modification from riverine environment to lacustrine environment within the reservoirs of the Project reach has increased the community of piscivorous predators and created improved conditions for predatory success. Warm water species suited to lacustrine habitat have established, including introduced piscivorous fishes (*e.g.*, largemouth bass).

Adult coho salmon that experience fallback or substantial delays as a result of fish passage, may experience a reduction of predatory avoidance skills, increasing their risks to predators (*e.g.*, bald eagles), however, we anticipate this effect to be relatively minor due to the lack of predators concentrated in and around Project reservoirs.

Risks to juvenile salmonids from predation in reservoirs has been expressed as supporting evidence to truck and haul fish around the Project (FERC 2006). PacifiCorp brought evidence to the trial-type hearing supporting the claim that survival of juvenile salmonids would be substantially decreased due to predation. However, Judge McKenna, in his findings of fact, found the Miller Radio-Telemetry Study (Miller *et al.* 2004) to be scientifically unreliable. Judge McKenna found the study was based on a small sample of hatchery juvenile salmonids, which lack the predator avoidance skills of wild fish, and the authors themselves admitted that fish passage success and travel time may be underestimated (ALJ 2006). Further, Judge McKenna found the study: (1) lacked a control group; (2) was conducted during one water year type and so it does not represent the normal range of flow conditions; (3) was conducted with highly variable peaking flows; and (4) produced widely varying results between 18 and 100 percent survival for different groups of salmonids in one reservoir. (*Id.*).

While the Radio-Telemetry Study (Miller *et al.* 2004) was intended as a pilot-study rather than an experimentally or statistically robust study, further telemetry studies were never performed in Project reservoirs. NMFS regards the results as scientifically unreliable and a worst-case scenario for juvenile coho survival rates through Copco 1 and Iron Gate Reservoirs for the following reasons: (1) The test was run in a "Below Average" water year type (Reclamation 2004) and, therefore, with below average downstream flows, reduced migratory cues, and reduced transportation flows for juvenile salmon; (2) The test for coho salmon was performed from April to mid-May, well after optimal conditions and timing of coho salmon outmigrations (see below); (3) There was no control group to assess mortality from disease or the radio implantation process; (4) The study used hatchery fish rather than wild fish; (5) The small sample size of test groups (groups of 20 fish) increased likelihood of predation over predicted sizes of actual outmigrations (tens and hundreds of thousands); and (6) The 7.3-inch implanted external antenna would likely compromise the swimming speed and behavior of 5.4-inch mean fork length fish (Miller *et al* 2004). Under these conditions and not accounting for losses due to disease or the surgical implantation process, 35 to 50 percent and 25 to 50 percent of test fish successfully passed through Copco 1 and Iron Gate Reservoirs, respectively.

Downstream migrating juvenile coho salmon (young-of-year and smolts), are most likely to occur during the period of February through April at times when instream flows are likely to be high, turbidity high, and water temperatures low. These combined environmental conditions reduce the risk of predation. Predation risks are likely to be highest in the vicinity of dams where predators concentrate and fish are most likely to concentrate. Further, juvenile salmonids can become disoriented as they navigate through passage facilities, reducing their predator avoidance skills.

Survival through reservoirs depends on fish condition, fish size, predator populations, water temperature and quality, water year type and outflow amount, reservoir flow patterns, and peaking conditions. Using Reclamation's five water year type classification system for river flow operations planning (Reclamation 2004), for average water-year types and water release conditions, the passage success of juvenile coho salmon is expected to be much higher than the

25 to 50 percent success rates achieved under PacifiCorp's adverse experimental conditions due to higher flows and improved water quality conditions relative to conditions experienced during the Miller *et al.* (2004) study. Passage through Copco 1 and Iron Gate Reservoirs is expected to be equal to or greater than 90 percent for average water year types. Juvenile coho salmon inhabiting reservoirs during low flow, warm water conditions will experience higher risks from predation, and a worst case, may experience levels as high as Miller *et al.* (2004) reported (*i.e.*, approximately 50 percent). Stressful thermal conditions will further increase the risks of predation.

f. Fish Disease Effects

Fish disease has adversely affected Klamath River anadromous salmonids, as documented in prior sections, and we have described the effects of the Project on fish disease downstream of Iron Gate Dam. Currently, low rates of disease are observed within endemic species of the Project reach. Resident trout populations in the Project reach appear to have developed genetic resistance to the *C. shasta* parasite (Bartholomew *et al.* 2001). With the re-introduction of coho salmon and other anadromous salmonids to the Project reach, the Project will alter the distribution and concentration of disease prevalence of the two primary pathogens impacting salmonid populations (*P. minibicornis* and *C. shasta*). As described above, a *C. shasta* infection nidus currently exists downstream and proximal to Iron Gate Dam, where high concentrations of adult Chinook salmon spawners and high concentrations of *M. speciosa* overlap. With the advent of fish passage, reduction in Iron Gate Hatchery production will likely take place as habitat upstream of Iron Gage Dam becomes productive. Thus, density of mainstem spawning proximate and downstream of Iron Gate Hatchery will be reduced in this area of high infection.

With the advent of fish passage, coho salmon will continue to experience risks of disease infection throughout their distribution within the mainstem Klamath River, including the Project reach. However, we anticipate the risks of fish disease while in their freshwater life history stages will be lower with increased distribution of anadromous salmonids. The intermediate host (*M. speciosa*) of both *P. minibicornis* and *C. shasta* ranges throughout the mainstem Klamath River (Stocking and Bartholomew 2007). However, *C. shasta* infection rates of *M. speciosa* within the Project reach are low (Stocking and Bartholomew 2007). Stocking and Bartholomew (2007) found consistent large populations of *M. speciosa* at the inflow to the mainstem reservoirs, where densities were correlated with distance from the inflow into the reservoir. Adult salmonids are not likely to spawn and die in concentrations at reservoir inflows. Within the Project reach, *M. speciosa* was found most often at these reservoir inflow areas at velocities between 0.02 and 0.05 m/sec where the polychaete was associated with sand-silt embedded with fine benthic organic matter. Reservoir inflow areas do not provide suitable conditions for spawning salmon. Velocities and substrate are not conducive for successful spawning.

NMFS expects PacifiCorp's development and implementation of a cooperative fish disease risk monitoring and management plan to minimize disease risk in the Klamath River and, along with proposed improvements to water quality, reduce future effects of fish disease on anadromous salmonids, including coho salmon, throughout the Klamath River basin. NMFS anticipates coho salmon smolt outmigration will occur through the Project reach primarily from February through April when water temperatures are below 12°C, a threshold temperature for the progression of disease transmission. Juvenile coho salmon inhabiting the mainstem Klamath River from June through September will be at the greatest risk from disease. However, lacustrine environments do not provide conditions suitable for *M. speciosa*, and we do not anticipate a significant overlap of concentrations of spawning salmonids and *M. speciosa*, and in turn, we do not anticipate disease outbreaks in the Project reach of the magnitude observed in downstream portions of the Klamath River. We conclude that given the current baseline conditions with the Project in place, juvenile coho salmon would likely experience low levels of infection of *C. shasta and P. minibicornis* in the Project reach, even if the Project was removed from the system, and NMFS is not aware of any information that suggests coho salmon will experience higher disease rates upstream of Iron Gate Dam as a result of the Proposed Action.

g. Effects from Construction Activities

Most coho salmon rearing within the mainstem during summer (when construction activities are expected to occur) will likely associate with tributary refugial areas, and not expected near dam construction sites. Construction of the proposed fish passage facilities has the potential to cause short-term adverse effects on water quality, such as increased turbidity. However, these effects will be effectively minimized and avoided by implementing best management practices (*e.g.*, installing silt fencing and other sediment trapping devices on land, silt curtains in water, and covering exposed soil until permanently stabilized) and effective isolation of the work area from the aquatic environment. However, since fishway designs and construction plans are to be finalized following license issuance and, thus, are currently unknown, NMFS cannot be certain of the effect level resulting from construction acitivities. At this time, NMFS is assuming minimization measures, such as those mentioned above, will effectively isolate work areas from aquatic habitat. If, during the course of fishway design and construction planning, new information arises that reveals construction effects are likely, it will be necessary for FERC to reinitiate formal consultation on the Project.

PacifiCorp will be required by Federal, state, and county regulations to develop sediment and erosion control plans as part of the construction process. Chemical spills could also occur during construction, but development of a pollution prevention plan in accordance with appropriate Federal, state, and county requirements will minimize the effects of such an occurrence. Typically, a pollution prevention plan specifies areas for equipment maintenance and refueling, spill prevention and emergency response strategies, requirements for keeping emergency response spill containment kits onsite, and for having trained personnel present onsite during construction. No long-term negative effects on aquatic resources are anticipated from construction of new fish passage facilities.

h. Effects from Aquatic Monitoring and Evaluation

Under the Project, numerous measures will be implemented to protect and enhance salmon and steelhead populations and their habitat in the Klamath River basin. These measures include the reintroduction of coho salmon throughout the Project reach; the construction of upstream and downstream fish passage facilities; hatchery supplementation programs; and several habitat enhancement measures. The currently altered state of the Klamath River basin will affect the distribution and abundance of coho salmon, Chinook salmon, steelhead, Pacific lamprey, and other native and non-native species. Future monitoring and analysis of coho salmon passage into and through the Project reach is of utmost importance because, without sufficient data, it will be impossible to determine whether Project activities are benefiting fish as expected. Fish habitat and population monitoring is often conducted to determine if environmental measures, like those included in the Project, provide the desired level of protection and enhancement for target fish species and aid in the development of responsive adaptive management strategies. Monitoring also ensures the allotted level of incidental take is not exceeded.

PacifiCorp will monitor and evaluate the effectiveness of various aquatic measures, including fish passage compared to performance standards; adult anadromous salmonid migration, spawning, distribution, and abundance; water quality; and hatchery supplementation programs. PacifiCorp will prepare annual monitoring reports. Work will be conducted by PacifiCorp or their contractors. Monitoring is a necessary tool for providing data critical to adaptive management. Its implementation will allow for the improvement of salmonid spawning and rearing habitat and for the long-term protection of habitat for aquatic species in the Klamath River basin by ensuring that managers have information to determine the effectiveness of the proposed aquatic measures.

This monitoring information will also allow adaptive management decisions to be made to ensure the long-term persistence of coho salmon within the Klamath River basin, as well as the ability to respond to significant changes in environmental conditions. Some adverse effects are expected during monitoring activities. These include potential injury or mortality due to handling and/or marking. Fish that enter a collection facility are subject to handling by one or more people depending upon the scope of each monitoring activity. There is an immediate risk of injury or mortality and a potential for delayed mortality due to mishandling. The number of fish subjected to this impact is expected to be small because the handlers will be trained and will follow protocols established to protect fish. Those same fish that survive initial handling may also be subject to tag insertion and/or fin clipping for identification purposes during monitoring activities. There is an expected 1 percent loss of juveniles associated with tagging (PacifiCorp and Cowlitz Public Utilities District 2004). Adult losses due to tagging and marking are expected to be considerably less based on years of reporting under ESA section 10 research permits.

A major portion of effects the proposed monitoring activities would have will be in the form of harassment. Harassment generally leads to stress and other sub-lethal effects and is caused by observing, capturing, and handling fish. The various monitoring and evaluation activities for anadromous fish measures would cause many types of effects, and while there is some uncertainty between what constitutes an activity (*e.g.*, electrofishing) and what constitutes an effect, it is important to keep the two concepts separate. The reason for this is that the effects being measured here are those which the activity itself has on the listed species. They may be expressed in terms of the take categories (*e.g.*, how many salmonids are harmed, or harassed, or even killed), but the actual mechanisms of the effects themselves (*i.e.*, the activities) are the causes of whatever take arises and, as such, bear examination. Therefore, the first part of this section is devoted to a discussion of the general effects known to be caused by the potential proposed activities - regardless of where they occur or what species are involved.

The following subsections describe the types of activities that are proposed. Each is described in terms broad enough to apply to every relevant plan. The activities would be carried out by trained professionals using established protocols and have widely recognized specific impacts. PacifiCorp will incorporate any NMFS pre-established minimization measures within any monitoring or study plan.

(1) Observation. For some monitoring, coho salmon will be observed in-water (*i.e.*, snorkel surveys). Direct observation is the least disruptive and simplest method for determining presence/absence of the species and estimating their relative abundance. Its effects are also generally the shortest-lived among any of the monitoring activities discussed in this section. Typically, a cautious observer can obtain data without disrupting the normal behavior of a fish. Fry and juveniles frightened by the turbulence and sound created by observers are likely to seek temporary refuge behind rocks, vegetation, and deep water areas. In extreme cases, some individuals may temporarily leave a particular pool or habitat type when observers are in their area. Observers minimize the amount of disturbance by moving through streams slowly, thus, allowing ample time for fish to escape to cover. Monitoring may at times involve observing adult fish, which are more sensitive to disturbance. During some of the activities discussed below, redds may be visually inspected, but no redds will be walked upon. Harassment is the primary form of take associated with these observation activities, and few if any injuries or deaths are expected to occur—particularly in cases where the observation is to be conducted solely by observers on the streambanks rather than in the water. There is little an observer can do to minimize the effects associated with observation activities because those effects are so minimal. In general, all they can do is move with care and attempt to avoid disturbing sediments, gravels, and, to the extent possible, the fish themselves.

(2) Capture/Handling. Capturing and handling fish cause them stress. The primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the river and wherever the fish are held), DO conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18°C or DO is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps that are not emptied on a regular basis. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis. Based on prior experience with the techniques and protocols that would be used to conduct the proposed monitoring, no more than 5 percent of the juvenile salmonids encountered are likely to die as an unintentional result of being captured and handled. In most cases, minimization measures will be employed, thereby keeping adverse effects to a minimum. Any unintentional mortalities caused by the monitoring activities may be retained as reference specimens.

(3) Electrofishing. Electrofishing is a process by which an electrical current is passed through water in order to stun fish, thus making them easy to capture. It can cause a suite of effects ranging from simple harassment to actually killing fish. The amount of unintentional mortality attributable to electrofishing may vary widely depending on the equipment used, the settings on the equipment, and the expertise of the technician. Electrofishing can have severe effects on adult salmonids. Spinal injuries in adult salmonids from forced muscle contraction have been documented. Sharber and Carothers (1988) reported that electrofishing killed 50 percent of the adult rainbow trout in their study. The long-term effects electrofishing has on both juveniles and adult salmonids are not well understood, but experience with electrofishing indicates that most impacts occur at the time of sampling and are of relatively short duration. The effects electrofishing may have on the threatened species would be limited to the direct and indirect effects of exposure to an electric field, capture by netting, holding captured fish in aerated tanks, and the effects of handling associated with transferring the fish back to the river (see the previous subsection for more detail on capturing and handling effects). Most of the studies on the effects of electrofishing on fish have been conducted on adult fish greater than 300 mm in length (*e.g.*, Dalbey *et al.* 1996). The relatively few studies that have been conducted on juvenile salmonids indicate that spinal injury rates are substantially lower than they are for larger fish. Smaller fish intercept a smaller head-to-tail potential than larger fish (Sharber and Carothers 1988) and may therefore be subject to lower injury rates (*e.g.*, Dalbey *et al.* 1996, Hollender and Carline 1994, Thompson *et al.* 1997). McMichael *et al.* (1998) found a 5.1 percent injury rate for juvenile Middle Columbia River steelhead captured by electrofishing in the Yakima River subbasin. The incidence and severity of electrofishing injury is partly related to the type of equipment used and the waveform produced (Dalbey *et al.* 1996, Dwyer and White 1997, McMichael 1993, Sharber and Carothers 1988). Continuous direct current (DC) or low-frequency (30 Hz) pulsed DC have been recommended for electrofishing (Dalbey *et al.* 1996; Fredenberg 1992; Snyder 1992, 1995) because lower spinal injury rates, particularly in salmonids, occur with these waveforms (Dalbey *et al.* 1996, Fredenberg 1992, McMichael 1993, Sharber *et al.* 1994). Ainslie *et al.* (1998) and Dalbey *et al.* (1996) have examined the long-term effects of electrofishing on salmonid survival and growth. These studies indicate that although some of the fish suffer spinal injury, few die as a result. However, severely injured fish grow at slower rates and sometimes they show no growth at all (Dalbey *et al.* 1996). NMFS' (2000) electrofishing guidelines will be followed in all surveys using this procedure.

In larger rivers and reservoirs, electrofishing units are sometimes mounted on boats. These units often use more current than backpack electrofishing equipment because they need to cover larger (and deeper) areas and, as a result, can have a greater impact on fish. In addition, the environmental conditions in larger, more turbid, streams can limit the operators' ability to minimize impacts on fish. For example, in areas of lower visibility, it is difficult for operators to detect the presence of adults and, thereby, take steps to avoid them. All evaluators intending to use boat electrofishing will use all means at their disposal to ensure that a minimum number of fish are harmed.

(4) Tagging/Marking. Techniques such as PIT tagging, coded wire tagging, the use of radio transmitters, and fin clipping are common to many scientific research efforts. All sampling, handling, and tagging procedures have an inherent potential to stress, injure, or even kill the marked fish. A PIT tag is an electronic device that relays signals to a radio receiver. It allows salmonids to be identified whenever they pass a location containing such a receiver (*e.g.*, any of several dams) without evaluators having to handle the fish again. The tag is inserted into the body cavity of the fish just in front of the pelvic girdle. The tagging procedure requires that the fish be captured and extensively handled. In general, the tagging operations will take place where there is cold water of high quality, a carefully controlled environment for administering anesthesia, sanitary conditions, quality control checking, and a carefully regulated holding environment where the fish can be allowed to recover from the operation. PIT tags have very little effect on growth, mortality, or behavior (Hockersmith *et al.* 2000, Jenkins and Smith 1990, Prentice and Park 1984, Prentice *et al.* 1987).

CWTs are made of magnetized, stainless-steel wire, limited to use within hatcheries, and can be coded for such data as species, brood year, and hatchery of origin (Nielsen 1992). The conditions under which CWTs may be inserted are similar to those required for applying PIT tags. The tag is injected into the nasal cartilage of juvenile salmon, causing little direct tissue damage (Bergman *et al.* 1968, Bordner *et al.* 1990) and having a negligible effect on the biological condition or response of tagged salmon. However, if the tag is placed too deeply in the snout of a fish, it may kill the fish, reduce its growth, or damage olfactory tissue (Fletcher *et al.* 1987, Peltz and Miller 1990). In order for the CWT and data to be recovered, the fish must be killed. However, this is usually not a problem because evaluators generally recover CWTs from salmon that have been taken during the course of commercial and recreational harvest (and are therefore already dead) or from carcasses collected after the fish has died.

The other primary method for tagging fish is to implant them with radio tags. There are two main ways to accomplish this, and they differ in both their characteristics and consequences. First, a tag can be inserted into a fish's stomach by pushing it past the esophagus with a plunger. Stomach insertion does not cause a wound and does not interfere with swimming. This technique is benign when salmon are in the portion of their spawning migrations during which they do not feed (Nielsen 1992). In addition, for short-term studies, stomach tags allow faster post-tagging recovery and interfere less with normal behavior than do tags attached in other ways. The second method for implanting radio tags is to place them within the body cavities of (usually juvenile) salmonids. These tags do not interfere with feeding or movement. However, the tagging procedure is difficult, requiring considerable experience and care (Nielsen 1992). Because the tag is placed within the body cavity, it is possible to injure a fish's internal organs. Infections of the sutured incision and the body cavity itself are also possible, especially if the tag and incision are not treated with antibiotics (Chisholm and Hubert 1985, Mellas and Haynes 1985). Fish with internal radio tags often die at higher rates than fish tagged by other means because radio tagging is a complicated and stressful process. Mortality is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). Acute mortality is caused by trauma induced during capture, tagging, and release. It can be reduced by handling fish as gently as possible. Delayed mortality occurs if the tag or the tagging procedure harms the animal in direct or subtle ways. Tags may cause wounds that do not heal properly, may make swimming more difficult, or may make tagged animals more vulnerable to predation (Howe and Hoyt 1982, Matthews and Reavis 1990, Moring 1990). Tagging may also reduce fish growth by increasing the energetic costs of swimming and maintaining balance.

Fin clipping is the process of removing part or all of one or more fins to make it identifiable. When entire fins are removed, it is expected that they will never grow back. Alternatively, a permanent mark can be made by punching holes or cutting notches in fins, by removing only a part of the fin, or the end of a fin or a few fin rays are clipped (Kohlhorst 1979, Welch and Mills 1981). Although researchers have used all fins for marking at one time or another, the current preference is to clip the adipose, pelvic, or pectoral fins. Many studies have examined the effects of fin clips on fish growth, survival, and behavior. The results of these studies are somewhat varied. However, fin clips do not generally alter fish growth (Brynildson and Brynildson 1967). Moreover, wounds caused by fin clipping usually heal quickly - especially those caused by partial clips. Mortality among fin-clipped fish is also variable. Some immediate mortality may occur during the marking process, especially if fish have been handled extensively for other purposes (*e.g.*, stomach sampling). Delayed mortality depends, at least in part, on fish size. Coble (1967) suggested that fish shorter than 90 mm are at particular risk. The degree of mortality among individual fishes also depends on which fin is clipped. Studies show that adipose- and pelvic-fin-clipped coho salmon fingerlings have a 100 percent recovery rate (Stolte 1973), and less for those that are clipped on the pectoral, dorsal, and anal fins (Nicola and Cordone 1973). Clipping the adipose and pelvic fins probably kills fewer fish because these fins are not as important as other fins for movement or balance (McNeil and Crossman 1979). Regardless, any time evaluators clip or remove fins, it is necessary that the fish be handled. Therefore, the same safe and sanitary conditions required for tagging operations also apply to clipping activities.

(5) Sacrifice. In some instances, it is necessary to kill a captured fish in order to gather data for a study. In such cases, determining effect is a very straightforward process: the sacrificed fish, if juveniles, are forever removed from the listed species' gene pool; if the fish are adults, the effect depends upon whether they are killed before or after they have a chance to spawn. If they are killed after they spawn, there is very little overall effect. Essentially, it amounts to removing the nutrients their bodies would have provided to the spawning grounds. If they are killed before they spawn, not only are they removed, but so are all their potential progeny. Thus, killing pre-spawning adults has the greatest potential to affect the listed species. Because of this, NMFS rarely allows it to happen. And, in almost every instance where it is allowed, the adults are stripped of sperm and eggs so their progeny can be raised in a controlled environment such as a hatchery - thereby greatly decreasing the potential harm posed by sacrificing the adults. Clearly, there is no way to minimize the effects of outright sacrifice to an individual fish.

C. Effects on Designated Critical Habitat

As discussed in the *Description of the Action Area* section and the final rule designating SONCC coho salmon critical habitat (May 5, 1999, 64 FR 24049), designated critical habitat includes the historical range of the ESU that can still be occupied by any life stage of coho salmon, and excludes inaccessible reaches above longstanding, naturally impassable barriers, including Iron Gate Dam. Therefore, the following analysis of the effects on critical habitat within the action area will be limited to the mainstem Klamath River below Iron Gate Dam. Essential features of critical habitat, as discussed below, include adequate (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6), cover/shelter, (7) food, (8) riparian vegetation, (9) space, and (10) safe passage conditions.

1. Lower and Middle Klamath River Sections

The essential habitat types of SONCC coho salmon designated critical habitat are juvenile and adult migration corridors in the Lower and Middle Klamath River sections. These areas provide connectivity for juveniles and adults between freshwater spawning and rearing habitat and the ocean. As described in the *Environmental Baseline* and *Effects of the Action* sections, above, the Project is not likely to negatively affect habitat conditions within the Lower and Middle Klamath River sections. The Project's reservoirs cause a "thermal lag" in downstream water temperatures, and fall river temperatures can remain slightly warmer as a result of Iron Gate Dam releases, but this effect is largely attenuated by the time flows reach the Shasta River (PacifiCorp 2006). Coho salmon smolts typically migrate downstream and into the Klamath River estuary during April and May, and have largely outmigrated by July when water quality degrades and water temperatures rise. Water temperatures are typically below 17°C when adult coho salmon migration peaks between late October and mid-November. NMFS expects that any effects of the Project on designated critical habitat within the Lower and Middle Klamath River sections are insignificant and discountable. Therefore, NMFS concludes that the conservation value of the juvenile and adult migration corridor in the Lower and Middle Klamath River sections will not diminish as a result of the Project.

2. Upper Klamath River Section

The essential habitat types of SONCC coho salmon designated critical habitat are juvenile and adult migration corridors, juvenile summer and winter rearing areas, and spawning areas within the Upper Klamath River section. The five mainstem impoundments, upstream of and including Iron Gate Dam, likely influence water quality within the mainstem Klamath River in the Upper Klamath River section, although a large portion of the poor water quality typical of the Klamath River can be attributed to the highly eutrophic condition of Upper Klamath Lake. Nevertheless, some water quality (*e.g.,* water temperature, DO, pH and nutrient levels) degradation within downstream riverine reaches likely result from the Project. In the critical habitat portion of the Upper Klamath River section, the naturally high nutrient loads and warm water temperatures common to the basin will likely continue, and pH and DO levels will continue to fluctuate. Temporally, the Project's effect on downstream habitat is greatest during summer and fall, when tributary inflows are low and Project releases dominate the hydrologic regime. Conversely, Project effects are generally small during winter and spring as high tributary accretions dominate the mainstem hydrograph.

The thermal lag caused by the Project likely overlaps with the beginning of the adult coho salmon migration, and therefore, reduces the quality of migratory habitat in this section of the river. At the onset of the irrigation season (around April 1 of each year) in the Shasta and Scott River watersheds, juvenile coho salmon originating from those rivers are likely forced into the mainstem Klamath River to rear. The thermal lag in the fall would likely reduce rearing habitat quality. FERC proposes to release cold water from Iron Gate Reservoir during summer/fall periods to ameliorate the warm water within the mainstem Klamath River. This will provide short-term relief from warm river temperatures.

Dissolved oxygen levels are low immediately below Iron Gate Dam, but increase relatively quickly downstream. Adult and juvenile coho salmon occupying the river below Iron Gate Dam during summer and fall experience stress from low DO concentrations. In addition, diel fluctuations in DO are expected to continue. The proposed turbine venting is expected to increase DO levels immediately downstream of Iron Gate Dam.

The Project physically blocks the flow of gravel and wood from upstream sources, which has limited salmonid spawning and rearing habitat and generally simplified available instream habitat below Iron Gate Dam within the Upper Klamath River section. In addition, the proposed ramp-down rates from Iron Gate Dam preclude the establishment of functional riparian vegetation. These effects are largely confined to the area between Iron Gate Dam and the Shasta River, since large influxes of sediment and wood flow from tributary sources minimize the effect further downstream. The proposed sediment and resource management plan will result in improved spawning habitat immediately downstream of Iron Gate Dam, with proposed measures including spawning gravel augmentation. Juvenile and adult coho salmon inhabiting the reach immediately below Iron Gate Dam will encounter few pools and deep water areas as a result of the poor LWD recruitment, and spawning gravel may transport out of the area at an accelerated rate, necessitating more frequent gravel injections.

Overall, juvenile and adult coho salmon inhabiting the mainstem Upper Klamath River section, especially during late summer/early fall, will continue to experience poor habitat conditions for migration, rearing, spawning. Much of the poor habitat conditions are attributed to the naturally poor water quality conditions within the Klamath River basin, but part of the poor habitat conditions are attributed to the ongoing operations of the Project. Therefore, NMFS concludes that the Project will slightly diminish the value of rearing and spawning habitat in the Upper Klamath River section. Thus, the Project will adversely affect SONCC coho salmon designated critical habitat.

NMFS expects that much of the minimization measures proposed will improve essential features of coho salmon habitat. Coho salmon are typically tributary spawners, but the proposed gravel augmentation will improve spawning habitat quality downstream of Iron Gate Dam. The proposed turbine venting and cold water releases are expected to improve water quality conditions for rearing and migration, although conditions will still be poor within the Upper Klamath River section relative to optimal spawning, rearing, and migratory habitat for SONCC coho salmon, except where cold water refugia exist.

VII. CUMULATIVE EFFECTS

Bartholow (2005) simulated the effects of climate change on the spatial and temporal water temperature patterns within the mainstem Klamath River from 1962 to 2001 using existing data and statistical software. Although there were large degrees of uncertainty in the simulation, including the short thermograph records, large data gaps in thermograph records, and ordinary intra-annual variability that resulted in few statistically significant trend estimates, Bartholow (2005) determined that the average trend in mainstem water temperatures has been an increase of 0.5°C/decade. Bartholow (2005) suggests trends of (1) cumulative exposure to stressful temperatures that have been increasing in both number and duration; (2) the length of the annual period of potentially stressful temperatures that has been increasing (*i.e.*, summer effectively starts earlier in the spring and extends longer into the fall); and (3) the average length of river with suitable temperatures has been decreasing. As discussed, above, water temperatures in the lower mainstem Klamath River are currently marginal for anadromous salmonids. If water temperature trends of the magnitude found for the mainstem Klamath River continue into future decades, some populations may decline to levels insufficient to ensure population survival (Bartholow 2005).

VIII. INTEGRATION AND SYNTHESIS OF THE PROPOSED ACTION

Our assessment is structured around the physical (*e.g.*, riparian function, substrate composition, and flow volume) and chemical (*e.g.*, water quality) processes that dictate habitat conditions in the action area, and how changes to those processes resulting from the Project, in aggregate with already existing baseline conditions, ultimately affect coho salmon and their habitat within the action area.

Within the *Environmental Baseline* section, we described in detail the current and ongoing impacts of Project operations on SONCC coho salmon and their habitat (*e.g.,* water quality, water quantity, and other factors), and the likely factors that caused the current state of the habitat within the action area. In short, the Klamath River suffers from many of the same stressors common to large river systems on the west coast. Water withdrawals for irrigation and municipal use have caused critically low river volumes, facilitating poor water quality and aquatic disease outbreaks. The destruction of streamside riparian and upslope forested habitat through timber harvest, road building and agricultural/rural development has accelerated erosion rates within the watershed. A substantial portion of the historical coho salmon habitat within the basin is currently inaccessible due to impassable dams, road crossings and diversion structures. In light of the many stressors acting throughout the watershed that have effectively suppressed coho salmon numbers and distribution, none of the five population units of Klamath River coho salmon affected by the proposed action are considered viable at this point in time.

The *Effects of the Action* section acknowledges and analyzes the continued effect of operating the Project based on the proposed action. Certain effects of the Project, such as the thermal lag in surface water warming and cooling caused by the reservoir complex, are difficult to minimize and thus are expected to continue into the future. However, proposed improvements to DO levels downstream of Iron Gate Dam and gravel augmentation measures are expected to sufficiently minimize existing effects attributed to the Project's operation. Furthermore, the advent of upstream fish passage within 6 years of license issuance will greatly benefit the suppressed Upper Klamath River Historical Population of coho salmon by allowing fish to re-populate areas of high quality habitat within the Project boundary that have been inaccessible for close to a century. Given the current environmental baseline and its affect on coho salmon habitat as a backdrop, we then determine if the change in water quantity/quality and instream habitat that result from implementing the Project will provide conditions that meet the life history needs of coho salmon.

Recently, Williams *et al.* (2006) described the structure of historical populations of SONCC coho salmon using information and assumptions related to habitat quality, carrying capacity and historical distributions. Williams *et al.* (2006) characterized the SONCC coho salmon ESU as containing 45 historical populations, of which 9 historical populations are within the Klamath

River basin (figure 2).[8] The term "historical population" pertains to the current population associated with the population units identified in Williams *et al.* (2006). The term "population unit" will be used to identify the geographic area of those historical populations. The term "Klamath River meta-population" refers to the Klamath River and Trinity River basin populations of coho salmon, which is comprised of nine historical populations, as described above.

The *Integration and Synthesis* section will extrapolate the individual response, as described within the *Effects of the Action* section, to further analyze the effect of the Project and any cumulative effects on the population size, growth rate, spatial structure, and diversity (*i.e.,* population viability parameters) of each historical population in the action area and, thus, qualitatively assess how the viability of the Lower, Middle, and Upper Klamath River historical populations would likely change after implementing the Project. The analysis will also include an investigation of the Project's effect on the viability parameters of SONCC coho salmon within the Scott River and Shasta River historical populations. Any change in viability noted at the historical population scale will then be evaluated as to its impact on the larger Klamath River meta-population (comprised of nine population units spanning both the Klamath and Trinity River watersheds), with a similar determination of how its viability will likely change as a result of the Project. We will conclude with an analysis to determine whether the Project will reduce SONCC coho salmon's reproduction, numbers, or distribution at the larger Klamath River meta-population and ESU scales. If the viability, as represented by the four viability parameters, weakens as a result of the Project, NMFS will evaluate whether this state of lower viability will reduce appreciably the likelihood that the SONCC coho salmon ESU will survive and recover (*i.e.,* jeopardize the continued existence). If, on the other hand, viability is expected to improve, the likely conclusion would be that the Project would not jeopardize the continued existence of the SONCC coho salmon ESU.

A. Historical Populations

Five coho salmon historical populations will be affected by the Project -- the three mainstem Klamath populations, as well as the Shasta River and Scott River populations (see Williams *et al.* 2006 for a more detailed explanation of historical populations of coho salmon within the Klamath River basin). Although the Shasta River and Scott River populations inhabit watersheds that lie outside the action area of the Project, poor habitat conditions each spring force large numbers of coho salmon parr out of the Shasta and Scott basins and into the mainstem Klamath River (Chesney and Yokel 2003). While not restricted to the Scott and Shasta Rivers, this phenomenon nevertheless appears to impact these two populations to a much greater degree than other tributary-based populations within the Klamath River basin.

1. Lower and Middle Klamath River Populations

As explained within the effects section, both the Lower and Middle Klamath populations are largely unaffected by water quality impacts brought about by the Project. Likewise, physical

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[8] The Klamath River contains six population units, including the Lower Klamath River, Middle Klamath River, Upper Klamath River, Salmon River, Scott River and Shasta River. The three Trinity River population units are the Lower Trinity River, Upper Trinity River, and South Fork Trinity River. The nine population units together comprise the Klamath meta-population.

habitat conditions within the Lower and Middle Klamath River sections are also minimally affected by the Project. The wood and sediment deficit caused by the Project is largely restricted to the area between Iron Gate Dam and Shasta River. Sediment and wood input from tributaries replenish the Klamath River channel below Shasta River (FERC 2006).

Releases from Iron Gate Hatchery may affect coho salmon within the Lower and Middle Klamath River sections through increased inter and intra-specific competition between juvenile fish and straying of hatchery adults into the wild population. However, NMFS considers these effects to be greatest within mainstem and tributary habitat directly below the hatchery. Downstream disbursement of juvenile fish from the hatchery would theoretically lessen competition the closer fish get to the ocean, since fish densities likewise would decrease in the downstream direction. Similarly, the number of straying adult fish entering non-natal tributary habitat likely diminishes with greater distance from the hatchery. Tributary carcass and weir counts of adult Klamath River Chinook salmon have shown the largest number of strays are encountered within Bogus Creek just downstream of the hatchery, with few strays recovered elsewhere (CDFG and NMFS 2001). Transitioning a portion of the Iron Gate Hatchery Chinook salmon production from fingerling to yearlings will reduce the temporal overlap between coho salmon and hatchery-reared Chinook salmon migration periods, lessening competition during the spring outmigration. Overall, NMFS concluded the effect of these hatchery programs on SONCC ESU spatial structure, productivity and diversity is likely limited, whereas higher abundance levels resulting from hatchery augmentation minimized future extinction risk (June 28, 2005, 70 FR 37160).

Continuing the current Phase III flow regime as part of the proposed action will ensure that flow levels during the critical late spring and early fall migration windows will provide water quality and fluvial conditions that protect migrating coho salmon.

a. Viability

The viability of coho salmon of populations inhabiting the Lower and Middle Klamath River sections is not expected to change appreciably as a result of the Project. Abundance will still fall well short of levels that approximate natural carrying capacities, and in turn, represent viable populations. In short, the populations remain at a low to moderate risk of extinction over a 100-year time frame.

2. Upper Klamath Population

Project effects will have the greatest influence on the Upper Klamath River historical population. With the advent of fish passage, coho salmon will be afforded a substantial increase in habitat for the freshwater phases of their life history (*i.e.*, migration, rearing, and spawning). Prior to fish passage, Iron Gate Dam will continue to restrict coho salmon to existing habitat below Iron Gate Dam. Mainstem river water quality and temperature in the mainstem Klamath River will remain stressful during summer to the small population of coho salmon that rear in cold-water refugia between Iron Gate Dam and Seiad Valley. Nevertheless, the small but stable Klamath River meta-population of coho salmon is expected to persist during the interim period before fish passage is afforded, benefiting from Phase III flow releases at Iron Gate Dam, spawning gravel augmentation below Iron Gate Dam, and improved DO conditions that result from turbine venting. During spring and fall, when adult coho salmon migrate through the mainstem Klamath River, instream conditions are largely conducive to coho salmon survival.

Juvenile coho salmon will continue to experience increased competition for habitat and food as a result of ongoing hatchery releases, although the effect will be lessened to a degree once a portion of the Chinook salmon production is shifted to the Fall River Hatchery site. Adult coho salmon of hatchery origin will continue to stray and spawn within tributary and mainstem habitat close to the hatchery. However, since hatchery stocks are genetically similar to wild coho salmon within the Klamath River basin (*i.e.,* no more divergent than closely related natural populations; June 28, 2005, 70 FR 37160), the introgression of hatchery genetics into the wild population is likely of little consequence. All told, the hatchery likely benefits coho salmon abundance, while having little to no effect on their diversity, spatial structure, or productivity (June 28, 2005, 70 FR 37160).

Habitat conditions within the Project reach will vary from optimal coldwater tributary conditions to severe lacustrine conditions unsuitable for coho salmon. Generally, coho salmon will experience benefits from this additional habitat due to their propensity to use tributaries for spawning, and rearing from swim-up stage to smoltification. Additionally, coldwater habitat in the mainstem Klamath River downstream and proximal to Spencer Creek will provide quality rearing habitat for coho juvenile salmon that disperse from Spencer Creek.

Peak emigration and immigration of coho salmon (both wild and hatchery) through the Project reach is expected to occur when mainstem water quality conditions are suitable for their physiological needs. Juvenile coho salmon that use the mainstem during the late spring through early fall period are most likely to be adversely affected by Project water quality effects. A small proportion of adult and juvenile coho salmon would likely experience harm from fish passage facilities. NMFS anticipates a small proportion of the returning adult coho salmon annually would likely experience a delay in migration as they navigate through fish ladders, potentially reducing spawning success of those individuals. However, the reproductive success of coho salmon within the Upper Klamath historical population would likely be enhanced, as some of these individuals, without the opportunity of fish passage, would have otherwise used less than suitable mainstem Klamath River habitat to spawn.

Fish passage facilities pose risks to juvenile coho salmon. Impingement and entrainment will be greatly reduced with the construction of facilities consistent with NMFS' screening guidelines. The Services' fish passage prescriptions are expected to result in greater than 98 percent survival at each fish passage facility.

a. Viability

While the Upper Klamath historical population is currently unviable, it is nevertheless a stable population that is likely to persist until fish passage is afforded. The population will benefit from improved water quality and spawning gravel recruitment below Iron Gate Dam, as well as higher Phase III baseline flow levels, during the interim 7 years prior to upstream passage. Once fish passage structures are completed, the Project will allow Upper Klamath River coho salmon to re-populate 58 miles of historical habitat that has been inaccessible for close to a century, likely improving each of the four individual viability parameters discussed in McElhany *et al.* (2000). However, quantifying the extent of improvement is difficult (Williams 2006). The Upper Klamath historical population will likely become more abundant as adult coho salmon colonize tributary habitat within the action area upstream of Iron Gate Dam. As population abundance grows, productivity will likely increase as well, meaning the growing population will be more likely to "bounce back" if perturbed. Perhaps most important to the long-term viability of the Upper Klamath historical population is the Project's anticipated benefit to the population's spatial structure and diversity. The opportunity to move across the landscape during portions of its lifecycle is important for the persistence of local anadromous salmonid populations (Williams 2006). Providing passage at each mainstem Klamath River dam will allow adult coho salmon to move volitionally throughout the upper basin, inhabiting suitable mainstem and tributary habitat up to and including Spencer Creek (rm 228). Coho salmon inhabiting areas upstream of Iron Gate Dam are exposed to different habitat conditions than those below the dam (Williams 2006, Williams *et al.* 2006). Establishing populations within the upper basin will help restore the Upper Klamath historical population's historical diversity, thus enabling it to better withstand environmental perturbation.

3. Shasta and Scott Populations

A substantial number of coho salmon parr are pushed out of the Shasta River and Scott River watersheds during the month of April as irrigation diversions degrade instream water quality and flow levels (Chesney and Yokel 2003). Thus, coho salmon from the Shasta River and Scott River populations likely utilize the Klamath River mainstem and associated non-natal tributaries for summer rearing to a greater extent than other Klamath River tributary populations not confronted with such degraded instream habitat conditions. These displaced coho salmon parr should experience higher summer survival rates due to the water quality improvements anticipated under the Project. As a result, the abundance of Shasta River and Scott Rivers coho salmon should improve modestly as more fish survive to spawning age and a concomitant increase in recruitment develops.

4. Summary

Although some Project activities are likely to improve baseline habitat conditions above and below Iron Gate Dam (*e.g.,* gravel augmentation, water quality enhancements, reduced river peaking), many effects inherent to dams and water impoundments will remain. Migration through the Project's reservoirs will expose coho salmon to predation and, at times, marginal water quality, while weekly peaking operations at the J.C. Boyle powerhouse will likely reduce aquatic invertebrate production and dewater spawning redds. Below Iron Gate Dam, Klamath River water temperatures will continue to warm slower in the spring and cool slower in the fall under the Project. Low DO conditions, although improved as part of the Project, will still limit rearing success, as will higher nighttime water temperatures. Yet, despite these impacts, the Project will likely improve each of the viability parameters within the Upper Klamath River coho salmon population[9]. In the interim period, spawning gravel augmentation will improve coho

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[9] It should be noted that NMFS does not expect any of the individual Historical Populations, nor the greater Klamath metapopulation and SONCC coho salmon ESU, to become viable as a result of the Proposed Action. Rather, the expectation is that individual viability parameters

salmon spawning success within the Klamath River below Iron Gate Dam, resulting in greater population abundance and productivity. Similarly, improved DO conditions resulting from turbine venting should afford rearing coho salmon greater access into foraging habitat adjacent to cold-water refugial areas. Finally, the proposed flow regime below Iron Gate Dam (*i.e.,* Phase III flows) provides the depth and velocity of riverflow necessary to protect coho salmon migration through the mainstem Klamath River.

Williams *et al.* (2007) were not able to assess the current viability of the SONCC coho salmon ESU with the quantitative approach they proposed, yet they agree with the previous assessments in CDFG (2002), Good *et al.* (2005), and Weitkamp *et al.* (1995) that SONCC coho salmon are likely to become endangered in the foreseeable future. Based on the above descriptions of the population viability parameters, and qualitative viability criteria presented in Williams *et al.* (2007), NMFS believes that the SONCC coho salmon ESU is currently not viable and is at moderate risk of extinction. However, while the affected historical populations (*i.e.,* Upper Klamath, Scott and Shasta), as well as the SONCC coho salmon ESU as a whole, are currently considered unviable, they have nevertheless survived at this depressed level for several generations and are currently stable with regard to their abundance and distribution (Good *et al.* 2005). Habitat improvements realized during the interim period, as well as further implementation of Phase III flows, will allow these depressed populations to persist until fish passage at Iron Gate Dam allows coho salmon to re-populate 58 miles of high quality river and stream habitat within the Project boundary.

The viability of the Upper Klamath Historical Population should benefit from the renewed passage into the Project reach; the population's abundance, spatial structure, diversity and productivity are all expected to improve. The Project should also improve viability of the Scott River and Shasta River coho salmon populations, albeit to a much smaller degree. In short, allowing passage into and out of the Project reach will "benefit coho salmon by: a) extending the range and distribution of the species thereby increasing the coho salmon's reproductive potential; b) increasing genetic diversity in the coho populations; c) reducing the species vulnerability to the impacts of degradation; and d) increasing the abundance of the Coho population" (ALJ 2006).

B. Klamath River Meta-Population

The Klamath River meta-population of coho salmon, made up of nine distinct coho salmon historical populations, will experience an overall benefit from the Project. As discussed above, three of the five historical populations directly affected by the Project (Upper Klamath, Scott and Shasta) are all expected to experience an improvement in some or all of their viability parameters. None of the nine populations will experience degradation with regard to any of the viability parameters. As a result, NMFS expects the individual improvements experienced at the historical population scale to translate into improved abundance, productivity, diversity and spatial structure at the larger scale of the Klamath River meta-population. Since the Klamath River basin is one of three large river systems that dominate the SONCC coho salmon ESU, any

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(*i.e.*, abundance, productivity, spatial structure and diversity) will improve at the individual Historical Populations, metapopulation, and ESU scale as a result of the Project. As individual viability parameters improve, the viability of the population will trend upward toward a future viable state (*i.e.*, meeting all four viability parameter criteria).

change in abundance, productivity, diversity or spatial structure experienced by the meta-population would likely impact the viability of the ESU as a whole. By extension, as the Klamath River meta-population trends toward a viable state, NMFS expects the SONCC coho salmon ESU to trend in the same direction. Therefore, we expect that implementation of the Project will not appreciably reduce the likelihood of the survival and recovery of SONCC coho salmon in the wild.

C. SONCC Coho Salmon Critical Habitat

Reduced habitat complexity, poor water quality, and reduced habitat availability continue to persist in many areas of the Klamath Basin, and are likely limiting the conservation value (*i.e.*, limiting the numbers of salmonids that can be supported) of designated critical habitat within these freshwater habitats at the ESU scale. As a result of the Project, habitat conditions (*e.g.*, increase DO and spawning gravel, and decrease temperatures) within the mainstem Klamath River downstream of Iron Gate Dam will likely improve. While Project implementation is likely to affect coho salmon critical habitat through continued reduction of LWD recruitment and simplified riparian vegetation, the habitat response as a result of Project implementation will allow critical habitat to remain functional or retain its current ability for juvenile and adult migration corridors, juvenile summer and winter rearing areas, and spawning areas to be functionally established and serve its intended conservation role for the species. Therefore, NMFS determines that the Project will not destroy or adversely modify the value of constituent elements essential to the conservation of SONCC coho salmon in the mainstem Klamath River below Iron Gate Dam, and thus will not destroy or adversely modify SONCC coho salmon critical habitat.

IX. CONCLUSION

After reviewing the current status of SONCC coho salmon and its critical habitat, the environmental baseline for the action area, the effects of the Project and the cumulative effects, it is NMFS' biological opinion that the action, as proposed, is not likely to jeopardize the continued existence of SONCC coho salmon, and is not likely to destroy or adversely modify SONCC coho salmon designated critical habitat.

X. INCIDENTAL TAKE STATEMENT

Section 9(a)(1) of the ESA prohibits the take of endangered species without a specific permit or exemption. Protective regulations adopted pursuant to section 4(d) extend this prohibition to threatened species. Take is defined as to harass, harm, pursue, hunt, wound, kill, capture or collect, or to attempt to engage in any such conduct [ESA section 3(19)]. Harm is further defined by NMFS as an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering (50 CFR 222.102). Incidental take refers to takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the

Federal agency or applicant (50 CFR 402.02). Section 7(o)(2) exempts any taking from the take prohibition that meets the terms and conditions of a written incidental take statement (ITS).

The measures described below are non-discretionary, and must be implemented by FERC so that they become binding conditions of any grant or permit issued to the permittee, as appropriate, in order for the exemption in section 7(o)(2) to apply. FERC has a continuing duty to regulate the activity covered by this ITS. If FERC (1) fails to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, FERC must report the progress of the action and its impact on the species to NMFS as specified in the ITS [50 CFR 402.14(i)(3)]. Please note that while NMFS expects take to result from broodstock collection at Iron Gate Hatchery, we do not consider this take to be incidental and thus, it will not be exempted as part of this ITS.

A. Amount or Extent of Take

Habitat Downstream of Iron Gate Dam

Quantifying Project take below Iron Gate Dam is difficult since effects are largely restricted to water quality and habitat effects. Translating these water quality effects into definitive numbers of fish taken cannot be done at this time, due to the current uncertainty regarding coho salmon population numbers and distribution patterns within the Klamath River below Iron Gate Dam.

The Project has a significant impact on DO concentrations directly below Iron Gate Dam, since outflow concentrations can decrease to 3 mg/L at times during late summer and early fall as a result of reservoir stratification. When subjected to low DO conditions, rearing coho salmon between Iron Gate Dam and Seiad Valley will experience less opportunity to forage outside of cold-water refugial habitat, and therefore experience lower fitness and survival. Proposed turbine venting at Iron Gate Dam is expected to improve DO concentrations within Iron Gate Dam outflow by at least 2.2 mg/L (Mobley Engineering 2005 *op cit.* FERC 2006), and venting is expected to be implemented during the summer and early fall period when DO levels below Iron Gate Dam are stressful to coho salmon. Thus, incidental take will be exceeded if turbine venting contributes less than 2.2 mg/L to outflow water from Iron Gate Dam when operated.

The constant temperature of Iron Gate Dam outflow has the effect of lowering daytime water temperatures and increasing nighttime temperatures within the river section between Iron Gate Dam and Seiad Valley, compromising the amount of nighttime relief fish experience from warm daytime water temperatures. During late July, when the effect is likely greatest, modeling by Dunsmoor and Huntington (2006) suggest that mean daily minimum temperatures below Iron Gate Dam can be up to 4°C higher as a result of the Project. Therefore, if the Project elevates mean weekly minimum temperatures below Iron Gate Dam by a margin greater than 4°C, then incidental take will be exceeded. To monitor compliance with this allowable take level, PacifiCorp will measure mean weekly minimum temperatures within the Klamath River at a representative location both directly below the dam outflow and downstream of the Shasta River confluence (outside of the Project's influence on temperature).

Habitat Upstream of Iron Gate Dam

Once fish passage is provided into the Project reach, a small number of coho salmon redds may be dewatered by weekly peaking operations at the J.C. Boyle powerhouse. According to Magneson and Gough (2006), the highest annual number of coho salmon spawning within the 136.5-mile mainstem reach between Iron Gate Dam and Seiad Valley was 13 fish (2001 season), or approximately 0.1 coho salmon redds per mile of habitat. Extrapolating this density to the 17-mile J.C. Boyle Peaking reach, NMFS assumes that no more than two coho salmon redds per year will be dewatered by weekly peaking operations at J.C. Boyle powerhouse. If more than two coho redds are dewatered as a result of Project operations during each spawning season, then take will have been exceeded.

The macroinvertebrate community within the J.C. Boyle Peaking reach will likely be reduced by weekly peaking operations. As downriver flows drop and water is pooled within J.C. Boyle Reservoir, large areas of streambed are dewatered for at least 10 hours, exposing macroinvertebrate colonies to desiccation and predators. The weekly cropping of the benthic community is important to juvenile salmonids since macroinvertebrates are their major food source (Groot and Margolis 1991). The loss of macroinvertebrate production will lower forage success of rearing coho salmon, potentially lowering survival rates. Peaking operations reduce the production of sessile organisms, like macroinvertebrates, by 10 percent to 25 percent (ALJ 2006). Macroinvertebrate losses of greater than 25 percent within the 17-mile J.C. Boyle peaking reach caused by peaking operations would exceed the allotted incidental take.

As described in the *Effects of the Action*, the Project's dams have modified the natural riverine habitat, creating lacustrine habitat that is seasonally unsuitable for young-of-year and parr coho salmon. In instances when young-of-year and parr coho salmon will encounter poor water quality and habitat conditions in these lacustrine habitats, individuals may experience a reduction in fitness that could lead to mortality levels greater than would be expected in an unaltered river system. While NMFS is unable to quantify this potential level of take at this time, we anticipate the take will primarily be realized through the predation effects described below.

Fish Passage Facilities

Quantifying a numerical estimate of SONCC coho take at fish passage facilities is impractical for several reasons. Since Copco 1 Dam was constructed in 1918, salmon have not had access to the more than 350 miles of salmon and steelhead habitat in the mainstem of the upper Klamath River and its tributaries. Over this nearly 90-year period, habitat changes have occurred above Copco 1 Dam that will affect how many adults the habitat will support, how many juveniles it will produce, and how these salmon will distribute throughout the habitat. In addition, coho salmon production targets for the habitat above Iron Gate Dam have not been set. Thus, numerical estimates of take based on future habitat production capacity and recovery goals is not practical. Because coho salmon were not discriminated from other species of salmon in early historical records for the Klamath River (Hamilton *et al.* 2005), a numerical estimate of take based on the historical record is also not practical. Therefore, NMFS provides a nonnumeric surrogate measure of take that can be practically applied to coho salmon runs when the population has been reestablished above Iron Gate Dam and recovery goals have been set.

The Services' prescriptions and reservations of authority for fishways for the Project include design specifications, implementation schedules, operating requirements, and specifications for post-installation evaluation and modifications that are designed to minimize the incidental take of SONCC coho salmon. Conservation measures include the creation of a Fisheries Technical Subcommittee comprised of fish passage specialists to ensure quality and performance of complex hydraulic and biological systems, and Fishway Evaluation and Modification Plan to adaptively manage the fish facilities for maximum efficiency. The prescriptions are in accordance with NMFS (2004) fish passage guidelines and are based upon the best biological and engineering information available. Nonetheless, NMFS anticipates that some individual juvenile and adult coho salmon will be injured or killed during operation of the fish passage facilities.

NMFS expects the percentage of individuals that are injured or killed in the construction of fish passage facilities to be low because facilities will be built according to NMFS (2004) fish passage guidelines, construction activities will be minimized during periods of coho salmon presence, and appropriate exclusion devices will be used to keep coho salmon out of the affected areas. As post-installation evaluations and modifications improve facility performance, the percentage of fish injured or killed will decrease.

In the *Effects of the Action* section, NMFS described the mechanisms by which coho salmon would likely be affected (taken) by fish passage measures implemented under the proposed action. These mechanisms include, without limitation:

1. Adult Delays at Fish Ladders
2. Adult Spillway Mortalities
3. Adult Delays or Injuries at Powerhouses
4. Juvenile Spillway Mortalities
5. Juvenile Fish Screen Losses
6. Juvenile Predation in Reservoirs

1. Adult Delays at Fish Ladders

Fish ladder design, construction, and operation according to NMFS fish passage guidelines (NMFS 2004) will minimize delay of coho salmon at Project dams. Because of water quality, water temperature, facility design, and operational issues, it is difficult to quantify delays at fish ladders before they have been constructed. Therefore, data that have been collected from the operation of Bonneville Dam will be utilized for this analysis. However, as described in section IV, fish ladder configurations at Project dams will be smaller and less complicated than at Bonneville Dam. For two reasons, median times for fish to enter Klamath River Dam ladders should be significantly less than at ladders at Bonneville Dam, where delays have not been shown to be a problem. Attraction flows into the Klamath ladders will be significantly greater than at Bonneville Dam (proportionately), and because the Klamath River is much narrower than the Columbia River, the ladder entrance will be easier to find.

Incidental take in the form of delay is when median first-entry times at Iron Gate, Copco 2, Copco 1, and J.C. Boyle dams are less than 2.0 hours and more than 98.5 percent of coho salmon enter in less than 5 days. Incidental take is exceeded when median first-entry times at Iron Gate, Copco 2, Copco 1, and J.C. Boyle dams are equal to or more than 2.0 hours or less than 98.5 percent of coho salmon enter in less than 5 days.

Fallback of coho salmon at Project dams should be less than at the average rates of fallback of spring-summer Chinook and steelhead at eight Columbia River dams, which averaged 22 percent and 21 percent, respectively, over 5 years (Boggs *et al.* 2004). Therefore, incidental take is exceeded when average fallback rates of coho salmon exceed 22 percent for Project dams.

2. Adult Spillway Mortalities

As described in the Effects of the Action section, in accordance with a stipulation with PacifiCorp, the Services have revised the prescriptions for spillway modifications in the Modified Prescriptions to allow PacifiCorp to conduct site-specific studies on the need for and design of spillway modifications (DOI 2007). Because of depth and flow considerations, Klamath River spillways are not expected to have significant supersaturation problems. However, spillway configurations at the Project dams, especially Copco 1 Dam, would likely cause mechanical injuries. Spillway modifications, if necessary, will minimize mortality of any adult coho salmon falling back over the spillways. Therefore, take levels at Iron Gate, Copco 1 and J.C. Boyle Dams will be exceeded if more than 2 percent of coho salmon falling back are killed at any of these dams. There should be no mortality over the diminutive Copco 2 Dam. Thus, take will be exceeded at Copco 2 Dam if there is any mortality of adult coho salmon that fall back over the dam.

3. Adult Delays or Injuries at Powerhouses

With the installation of tailrace barriers, if necessary as described in the Effects of the Action section, and sufficient attraction flows into the bypass reaches, there should be no mechanical injury/mortality or delay associated with powerhouse structures. Coho salmon migration rates past Project powerhouses should not be significantly slower than migration rates in free-flowing reaches above and below the powerhouses. Take will be exceeded if any significant mechanical injury or mortality occurs at the powerhouses, or if adult migration rates are significantly different at any of the powerhouses than they are across adjacent reaches.

4. Juvenile Spillway Mortalities

As described in the *Effects of the Action* section, spillway mortality is likely higher for adults than for juveniles. Higher mortality is likely for spillways that have deflectors or conditions of gas supersaturation below the dam, all other parameters being equal. Gas supersaturation occurs below dams when water passes over a spillway and plunges to increased depths and pressures, forcing high amounts of air into solution. While this is often the case on rivers with deep plunge pools such as the Columbia River, it should not be as prevalent at the four Klamath River dam sites. Spillway modifications, if necessary, will minimize mortality of any juvenile coho salmon passing over the spillways. Therefore, take levels at Iron Gate, Copco 1 and J.C. Boyle will be exceeded if more than 1 percent of juvenile coho salmon passing over the spillway are killed at any of these dams. There should be no juvenile coho salmon mortality over the diminutive Copco 2 Dam. Thus, take will be exceeded at Copco 2 Dam if there is any mortality of juvenile coho salmon passing over the dam.

5. Juvenile Fish Screen Losses

The Services' Modified Fishway Prescriptions include positive exclusion barrier screens designed according to NMFS' Fish Screening Criteria for Anadromous Salmonids. These criteria include different approach velocity and screen opening criteria for fry and fingerling life stages, and are expected to be equally protective for both, ensuring near 100 percent passage success. Operating correctly, each screen and bypass facility will result in zero turbine mortality and 98 percent or more survival through the bypass system of both fry and fingerlings. Take will be exceeded if turbine mortality occurs at any of the dams or if there is more than 2 percent mortality of fry or fingerling coho passing a dam through the fish screen and bypass system. The criteria will be applied year round as fish screen facilities will be operated year round.

6. Juvenile Predation in Reservoirs

As described in *Effects of the Action* section, we anticipate passage success of juvenile coho salmon through J.C. Boyle, Copco 1 and Iron Gate Reservoirs is expected to be equal or greater than 90 percent for average, above average, and wet water year types, and equal to or exceeding 50 percent in below average and dry water year types according to Reclamation's five water year type classification system for river flow operations planning (Reclamation 2004). Therefore, incidental take will be exceeded when more than 10 percent of juvenile coho salmon are lost to predation or mortality in any Project reservoir in average, above average, and wet water year types, and incidental take is exceeded when more than 50 percent of juvenile coho salmon are lost to predation or mortality in any Project reservoir in below average and dry water year types.

B. Effect of the Take

In the Opinion, NMFS determined that this level of anticipated take is not likely to jeopardize the continued existence of SONCC coho salmon.

C. Reasonable and Prudent Measures

NMFS believes that the following reasonable and prudent measures and terms and conditions are necessary and appropriate to minimize or to monitor the incidental take of SONCC coho salmon resulting from the Project, which includes its operation and modification. In order to be exempt from the prohibitions of section 9 of the ESA, FERC must ensure that PacifiCorp complies with all of the reasonable and prudent measures and terms and conditions set forth below.

1. PacifiCorp shall monitor and document the extent of SONCC coho salmon take resulting from hydropower operations and proposed Project modifications, as further detailed below.

2. PacifiCorp shall investigate and minimize to the greatest possible extent Project-related impacts arising from Project operations and modifications. Specifically, PacifiCorp shall investigate the Project's effect on fish disease and riparian function below Iron Gate Dam, aquatic habitat and channel function within the Copco 2 Bypass reach, and implement feasible measures to minimize take associated with these aspects of the Project. PacifiCorp shall also implement fish seeding operations to facilitate rapid reintroduction of coho salmon within the Project area.

Where noted, future studies and monitoring plans will be devised by a group of "Government agency experts" (*i.e.,* employees of Federal and State resource agencies with expertise in the given subject), which could include, but is not limited to, personnel from NMFS, USFWS, USFS, BLM, BOR, USGS, ODFW and CDFG. NMFS will retain final approval over monitoring and study designs with regard to their adequacy in monitoring and minimizing the impact of take.

D. Terms and Conditions

The following terms and conditions implement reasonable and prudent measure #1.

a. PacifiCorp shall monitor SONCC coho salmon take associated with passage through Project facilities, as documented within the Services' section 18 Fishway Prescriptions.

b. PacifiCorp shall determine the extent of SONCC coho salmon take during upstream and downstream passage through project reservoirs, and then monitor this take on a regular basis. The focus and design, and frequency of the studies and monitoring plan shall be determined through a working group composed of PacifiCorp and government agency experts, and will be implemented at the time fish are reintroduced above each respective Project dam. The studies may be partitioned out to deal with each reservoir individually, with each study started upon fish reintroduction into the specific Project reach.

c. PacifiCorp shall investigate and monitor take of SONCC coho salmon arising from peaking operations within the J.C. Boyle Peaking reach. Specifically, PacifiCorp shall work with government agency experts to design studies and monitoring protocols to investigate and monitor the following:

1) Effects to the macroinvertebrate community within the J.C. Boyle Peaking reach, and potential measures to minimize those effects.

2) Extent of coho salmon redd dewatering resulting from peaking operations, and possible measures to minimize any dewatering effects.

If measures to minimize take are discovered during the study, and NMFS determines they are necessary or appropriate, then PacifiCorp shall implement them.[10] The

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[10] Additional minimization measures arising from the studies required under these reasonable and prudent measures may require reinitiation of consultation and changes to the ITS.

macroinvertebrate study/monitoring, and any identified methods to minimize associated take, shall be completed and implemented prior to coho salmon being reintroduced into the study area. The redd dewatering study/monitoring will begin when coho salmon are reintroduced into the area, and will be completed within five years.

d. FERC shall provide annual monitoring reports identified in this ITS prior to January 31st of each year for the duration of Project implementation. These reports, as well as any other study reports identified within this ITS, shall be submitted to:

Attn: Ms. Irma Lagomarsino
National Marine Fisheries Service
Arcata Area Office
1655 Heindon Road
Arcata, California 95521

The following terms and conditions implement reasonable and prudent measure #2.

a. In conjunction with government agency experts, PacifiCorp shall design and implement a study to determine the extent the Project limits riparian function downstream of Iron Gate Dam. PacifiCorp shall implement any minimization measures NMFS considers necessary or appropriate to minimize the impact. The study shall be finalized, and the recommended methods implemented, within 5 years of license issuance.

b. To limit disease effects to coho salmon, PacifiCorp, in conjunction with government agency experts, shall design and implement a study to determine possible methods to minimize the density of the *M. speciosa* population downstream of Iron Gate Dam. Potential methods to be studied may include channel maintenance flows from Iron Gate Dam and mechanical disruption of *Cladophora* dominated portions of the streambed. The study will be finalized, and any minimization measures NMFS considers necessary or appropriate will be implemented, within 5 years of license issuance.

c. Beginning 3 years prior to fish passage at any Project dam, PacifiCorp shall work with NMFS and USFWS to jumpstart coho salmon reintroduction by seeding suitable tributary habitat with coho salmon from Iron Gate Dam Hatchery.[11]

d. In conjunction with government agency experts, PacifiCorp shall design a study to determine potential spawning, rearing and migration use of the Copco Bypass reach by coho salmon, and the necessary flow regime to ensure those uses are realized if warranted. The study will be completed and the resulting flows implemented, if NMFS considers them necessary or appropriate, prior to coho salmon passage into the area.

e. PacifiCorp shall work with government agency experts to investigate the potential for modifying or augmenting the outlet works at Copco 1 Reservoir to improve instream

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[11] This seeding of coho salmon prior to fish passage completion does not represent the "trigger" alluded to in other terms and conditions for fish being reintroduced into a specific area. In those instances, the intention is for fish to actually pass upstream through a fish ladder.

water quality conditions for coho salmon utilizing the Copco Bypass reach. The investigation shall be completed, and any feasible solutions recommended by the group implemented, prior to fish re-introduction into the Copco bypass reach.

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of threatened and endangered species. Conservation recommendations are discretionary measures suggested to minimize or avoid adverse effects of a proposed action on listed species, to minimize or avoid adverse modification of critical habitat, to help implement recovery plans, or to develop additional information.

1. PacifiCorp should study and monitor coho salmon spawning, juvenile rearing and dispersal, and smolt outmigration patterns within the Project reach, including both mainstem and tributary habitat, to better understand life history patterns and periodicities of the Upper Klamath River Historical Population.

2. PacifiCorp has proposed the development and implementation of a sediment and gravel resource management plan. This plan should be designed by PacifiCorp in conjunction with a group of government agency experts.

3. PacifiCorp should study the effect Copco 1 Dam has on gravel volumes and the quality of spawning habitat within the Copco bypass reach, and whether gravel augmentation at that location will restore spawning opportunities for coho salmon. The above studies should be designed by PacifiCorp in conjunction with a group of government agency experts, and completed prior to fish being reintroduced into the area.

4. Pacificorp should develop and implement a plan to remove the lower four Project dams (Iron Gate, Copco 2, Copco 1, and J.C. Boyle Dams), restore the riverine corridor, and bring upstream and downstream fish passage facilities at Keno Dam into compliance with NMFS' guidelines and criteria within 10 years of license issuance, expiration or surrender. Recommending dam decommissioning is consistent with NMFS' earlier recommendations under section 10(a) of the Federal Power Act (NMFS 2006).

5. PacifiCorp should fund, design and implement a HGMP for Iron Gate Hatchery, as described in NMFS (2003). NMFS has determined that a HGMP is the proper mechanism to cover direct take associated with hatchery broodstock operations. The 10 wild coho salmon annually captured and spawned at the Iron Gate Hatchery is an example of this type of take.

6. Pacificorp should work cooperatively with the State of California and the U.S. Environmental Protection Agency to meet future load allocations resulting from the upcoming Klamath River TMDL (due for release in 2009).

In order for NMFS to be kept informed of actions that minimize or avoid adverse effects or benefit listed species or their habitats, we request notification of the implementation of the conservation recommendations.

XII. REINITIATION NOTICE

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

If Keno Dam, Eastside Development and Westside Development are included within the new FERC license for the Project, consultation must be reinitiated. Furthermore, reinitiation of consultation may be necessary once the final disposition of Keno Dam is proposed.

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