National Marine Fisheries Service

Biological Opinion

on the

Proposed Issuance of an Incidental Take Permit to PacifiCorp Energy for Implementation of the PacifiCorp Klamath Hydroelectric Project Interim Operations Habitat Conservation Plan for Coho Salmon

Conducted By:

National Marine Fisheries Service
Southwest Region

February 22, 2012

NMFS file number: **151422SWR2010AR00523**

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

February 23, 2012

MEMORANDUM FOR: PacifiCorp HCP Project File
(#151422SWR2010AR00523)

FROM: For Rodney R. McInnis
Regional Administrator, Southwest Region

SUBJECT: Biological Opinion for the PacifiCorp Klamath Hydroelectric Project Interim Operations Habitat Conservation Plan for Coho Salmon

The attached Biological Opinion and Essential Fish Habitat (EFH) Consultation (Attachment 1) represent NOAA's National Marine Fisheries Service (NMFS) Southwest Region, Endangered Species Act sections 7(a)(2) and (a)(4) biological opinion on the PacifiCorp Klamath Hydroelectric Project Interim Operations Habitat Conservation Plan for Coho Salmon, dated February 16, 2012. The Biological Opinion also includes a report addressing Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Conservation Recommendations for the permit area. NMFS assessed the effects of the proposed issuance of an incidental take permit (ITP) to PacifiCorp which would authorize take of covered species for PacifiCorp's Covered Activities, and result in implementation of the Habitat Conservation Plan (HCP). Implementation of the HCP will minimize and mitigate for Covered Activity adverse effects on covered species to the maximum extent practicable. The covered species addressed in this Opinion includes the Southern Oregon/Northern California Coast (SONCC) coho salmon Evolutionarily Significant Unit (ESU), and its designated critical habitat.

NMFS has concluded that the proposed issuance of an ITP to PacifiCorp and implementation of the HCP is not likely to jeopardize the continued existence of SONCC coho salmon ESU, nor is it likely to result in the destruction or adverse modification of its designated critical habitat.

NMFS also concludes that the issuance of an ITP to PacifiCorp and implementation of the HCP does result in adverse effects on Salmon EFH in the Klamath River mainstem in that Covered Activities will continue a level of baseline adverse effects on Salmon EFH, however these adverse effects will be offset to a degree with implementation of conservation measures included in the HCP. As such, no additional Conservation Recommendations are needed.

Attachment (1)

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I. Background and Consultation History

1.1 Background

Only a century ago, the natural resources of the Klamath basin provided essential subsistence and cultural values to Indian Tribes and early Anglo-European settlers as well as opportunities for commercial, recreational, and tribal salmon fisheries. Today, the Klamath basin's hydrologic system consists of a complex of inter-connected rivers, lakes, marshes, dams, diversions, wildlife refuges, and wilderness areas. Alterations to the natural hydrologic system began in the late 1800s, accelerating in the early 1900s, including water diversions by private water users, water diversions by the Klamath Project operated by the Bureau of Reclamation (Reclamation), and by the construction of several hydroelectric dams operated by a private company now known as PacifiCorp. The first PacifiCorp development was constructed in 1918 (Copco Dam) on the Klamath. Additional hydroelectric dams were constructed with the last being the construction of Iron Gate Dam (IGD) in the 1960's. PacifiCorp has operated its Klamath Hydroelectric Project (Project) under a 50-year license issued by the Federal Energy Regulatory Commission (FERC) in March 1956, which expired in 2006. PacifiCorp continues to operate the Project under annual licenses based on the terms of the previous license. While Reclamation's Link River Dam and PacifiCorp's Keno Dam upriver of IGD currently have fish ladders for resident trout species, PacifiCorp's J.C. Boyle Dam upriver of IGD has a fish ladder designed for resident trout species that does not meet current anadromous fish passage requirements, and none of PacifiCorp's other Project dams were constructed with fish ladders. As a result, salmon and steelhead have effectively been blocked from accessing the upper reaches of the basin for close to a century. Beginning in 1956, flow releases from IGD (the lowest dam in the system) were generally governed by guidelines outlined within the FERC license. As the license was issued prior to implementation of the Endangered Species Act (ESA) of 1973, as amended, FERC's original license to PacifiCorp to operate its hydroelectric Project on the Klamath River never underwent Endangered Species Act (ESA) consultation.

The Project is located on the Upper Klamath River in Klamath County (south-central Oregon) and Siskiyou County (north-central California) (Figure 1). The Project consists of eight developments. Seven of the developments are located on the mainstem Klamath River between river mile (RM) 190.1 and 254.3, including (in order moving upstream) Iron Gate (RM 190.1 to 196.9), Copco No. 2 (RM 198.3 to 198.6), Copco No. 1 (RM 198.6 to 203.1), J.C. Boyle (RM 220.4 to 228.3), Keno (RM 233 to 253.1), East Side and West Side (both in Link River at RM 253.1 to 254.3). The eighth development is on Fall Creek, a tributary to the Klamath River at RM 196.3. Water flow for operation of the Project, with the exception of Fall Creek, is generally subject to water releases by the U.S. Bureau of Reclamation (Reclamation) from Upper Klamath Lake via Link River dam (RM 254.3). Link River dam is a facility owned by Reclamation and operated by PacifiCorp under an agreement with Reclamation, but it is not part of PacifiCorp's Klamath Project.

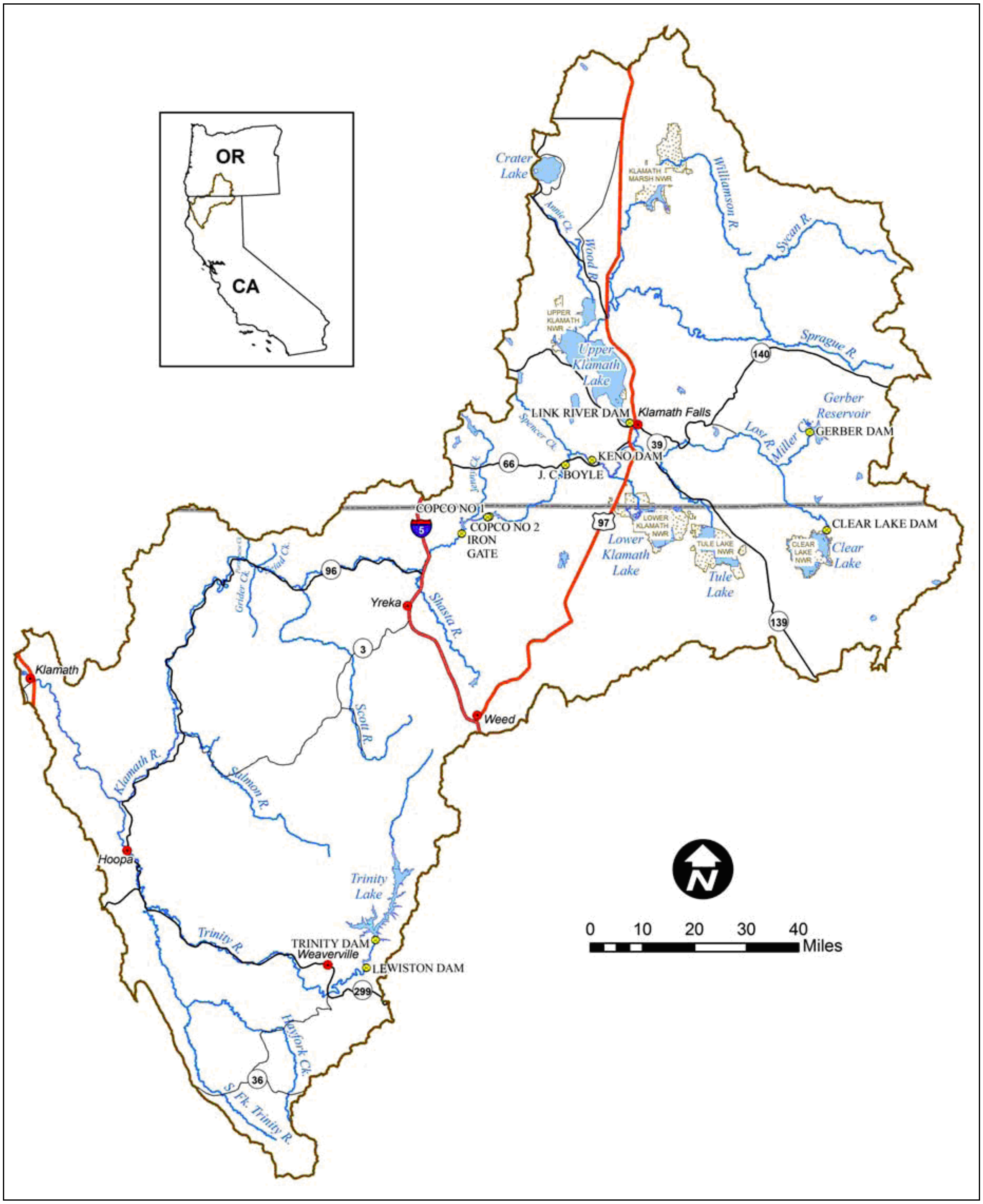

Figure 1. Map of Klamath River basin showing locations of rivers and lakes, and Klamath Hydroelectric Project facilities within the basin.

1.2 History of Consultation

There are several consultations that relate to PacifiCorp's hydroelectric facilities on the Klamath River.

1.2.1 Biological Opinion on Federal Energy Regulatory Commission Relicensing (2007)

On February 25, 2004, PacifiCorp filed an application with the Federal Energy Regulatory Commission (FERC) for a new 50-year license for the Project. PacifiCorp's application did not include provisions for volitional fish passage. Under its Federal Power Act (FPA) authorities, the National Marine Fisheries Service (NMFS) and the U.S. Department of the Interior (U.S. DOI) issued modified mandatory prescriptions for fishways and recommended certain fishery protection, mitigation and enhancement measures in the FERC relicensing proceeding on January 26, 2007 (U.S. DOI 2007, NMFS 2007a). The mandatory fishway prescriptions provide for volitional fish passage around Project dams. Therefore, FERC would be required to include in a new license for the Project conditions requiring PacifiCorp to implement the fishway prescriptions to provide volitional fish passage around all of its' Project dams. On November 16, 2007, FERC issued a Final Environmental Impact Statement (FEIS) on PacifiCorp's application to FERC for a new 50-year license for the Project (FERC 2007). The FEIS includes a detailed analysis of the environmental benefits and costs associated with PacifiCorp's proposed operations and environmental measures, and four other alternatives considered in the FEIS, including: (1) a No-Action Alternative; (2) a FERC Staff Alternative; (3) a FERC Staff Alternative with Mandatory Agency Conditions; and (4) Retirement of Copco No. 1 and Iron Gate with FERC Staff Measures. The FEIS concluded that the preferred alternative for the Project would be the FERC Staff Alternative, which incorporated most of PacifiCorp's proposed environmental measures, and also included a number of additional environmental measures developed by FERC staff, including but not limited to, implementation of anadromous and resident fish passage and disease management programs.

Following issuance of the FEIS, NMFS issued a Biological Opinion (BiOp) to FERC in December 2007 (NMFS 2007) under Section 7 of the ESA analyzing the effects on the Southern Oregon/Northern California Coast (SONCC) Evolutionarily Significant Unit (ESU) of coho salmon and its critical habitat from proposed Project operations for the 50-year term of a proposed new FERC license. The Proposed Action evaluated in the BiOp contains measures listed in the FERC Staff Alternative and PacifiCorp's relicensing proposal, and also includes measures contained within mandatory agency conditions, including FPA Section 4(e) Conditions of the Bureau of Land Management (BLM) and Reclamation, and NMFS' mandatory fishway prescriptions for volitional passage of anadromous fish around the Project dams (Federal Power Act (FPA) Section 18 Fishway Prescriptions). The BiOp identifies Project effects that may result in incidental take of SONCC ESU coho salmon. The incidental take statement of the BiOp includes reasonable and prudent measures and terms and conditions to minimize and monitor the incidental take of SONCC ESU coho salmon from Project effects. The BiOp also identified conservation recommendations that could be implemented to minimize or avoid adverse Project impacts to SONCC ESU coho salmon and its critical habitat. PacifiCorp's Habitat Conservation Plan (HCP), which is included in the analysis for this Opinion, to some degree adopted development and implementation of the following terms and conditions and conservation recommendations from the BiOp on FERC's proposed relicensing action: (1) a sediment and gravel resource management plan, (2) a Hatchery and Genetic Management Plan for the Iron Gate Hatchery (IGH), and (3) a study to determine methods to minimize disease pathogen densities. In addition, as is described below, PacifiCorp used the Project effects described in this BiOp as the starting point for the conservation measures in its HCP, although the HCP addresses a much shorter ten-year period. FERC has not completed relicensing the Project and its relicensing process would be put into abeyance under the terms of the Klamath Hydroelectric Settlement Agreement, which is described in greater detail below.

1.2.2 Biological Opinions on Reclamation's Klamath Project

A. 1999 Consultation

On March 9, 1999, Reclamation requested formal consultation under ESA section 7 on the effects of Reclamation's Klamath Project operations on SONCC ESU coho salmon. On July 12, 1999, NMFS issued a final biological opinion on Reclamation's Klamath Project Operations through March 2000 that concluded the proposed one-year operation of the Project was not likely to jeopardize the continued existence of SONCC ESU coho salmon or destroy or adversely modify designated critical habitat. After NMFS advised Reclamation on April 4, 2000, that it should request reinitiation of section 7 consultation, Reclamation responded in a letter dated April 26, 2000, that Reclamation determined its proposed flows were sufficient to avoid foreclosures under ESA section 7(d).

B. 2001 Consultation

On January 22, 2001, Reclamation requested initiation of formal consultation on Reclamation's proposed Klamath Project Operations to "cover the time period from when a BO (biological opinion) is issued by NMFS until that BO is superseded by another consultation." On April 6, 2001, NMFS issued a final biological opinion that concluded that Reclamation's proposed operations were likely to jeopardize the continued existence of SONCC ESU coho salmon and/or destroy or adversely modify designated critical habitat. NMFS' biological opinion also provided a reasonable and prudent alternative (RPA) that included minimum instream flows at IGD for the period between April and September 2001.

In 2001, the combination of the NMFS biological opinion's minimum flow requirements, the U.S. Fish and Wildlife Service's (FWS) biological opinion requiring minimum lake levels in Upper Klamath Lake (UKL) for endangered sucker fish, and a severe drought in the Upper Klamath basin precluded Reclamation from delivering water to Project water users for much of the 2001 irrigation season. As a result, the Departments of the Interior and Commerce requested that the National Academy of Sciences National Research Council (NRC) form a committee to evaluate the strength of scientific support for the 2001 biological assessment (BA) and biological opinions. The NRC Committee on Endangered and Threatened Fishes in the Klamath River Basin (Committee) conducted the review and released an Interim Report in February 2002 and a Final Report in 2004 that also assessed issues related to the long-term survival and recovery of the listed species of concern. The Committee found substantial scientific support for the RPAs and associated Terms and Conditions issued by NMFS and FWS, except for portions requiring more stringent controls over water levels in UKL and flows at IGD (NRC 2002, 2004). The Committee also noted that Reclamation had not provided "substantial scientific support" for its own proposal of revised operating procedures which might have led to "lower minimum flows" at IGD.

C. 2002 Consultation

In March 2002, and one month after the Committee issued its Interim Report, Reclamation finalized a new BA that covered its Klamath Project operations from May 31, 2002, to March 31, 2012, and requested consultation with NMFS and FWS. In its biological opinion finalized on May 31, 2002, NMFS concluded that Reclamation's proposed operations would likely jeopardize the continued existence of SONCC ESU coho salmon. In coordination with Reclamation, the biological opinion also included a reasonable and prudent alternative that consisted of Reclamation operating the Project to ensure that IGD minimum flows increased gradually over 3 phases of the eight-year period.

During Phase I (May 2002-March 2005), Reclamation had to meet the minimum IGD flow requirements identified in Table 5.9 of Reclamation's 2002 BA for Project Operations. Also during Phase I, Reclamation had to develop a water bank, to augment the minimum IGD flow requirements, which must increase in size each year and reach 100 thousand acre-feet (TAF) by April 2005. During Phase II (April 2006 through March 2010), Reclamation had to meet 57 percent of the long-term IGD flow requirements identified in Table 9 of the RPA or the flow requirements identified in modified Table 5.9, whichever was greater. During Phase II, Reclamation had to also annually develop a 100 TAF water bank. By Phase III (April 2010 through March 2012), Reclamation had to implement the long-term IGD flows (NMFS 2002, Table 9).

Several fisheries groups, environmental organizations, and tribes, filed a lawsuit against Reclamation and NMFS in federal district court arguing that the structure of the RPA's phased-in flow requirements were not adequate to protect listed SONCC ESU coho salmon. The district court later ruled that the NMFS RPA was arbitrary and capricious and did not fully explain how its implementation would avoid the likelihood of jeopardy to coho salmon. The district court's ruling was upheld on appeal by the Ninth Circuit Court of Appeals, which later remanded the case to the district court with instruction for the "issuance of appropriate injunctive relief." The district court then issued an injunction on March 27, 2006, ordering: (1) NMFS and Reclamation to reinitiate consultation on Reclamation's Klamath Project; (2) NMFS to issue a new biological opinion based on the current scientific evidence and the full risks to threatened coho salmon; and (3) Reclamation to limit Project irrigation deliveries if they would cause water flows in the Klamath River at and below IGD to fall below 100 percent of the Phase III flow levels specifically identified by NMFS in its 2002 biological opinion (*i.e.,* Table 9 also referred to as "Phase III flows"), until the new consultation for Reclamation's Klamath Project was completed.

D. 2007/2008 Consultation

On October 22, 2007, NMFS received Reclamation's final BA and request for formal consultation under section 7 of the ESA on its Klamath Project Operations from 2008 to 2018. Despite having requested initiation of consultation, in its letter, Reclamation also explained that it would be considering future modifications to the Proposed Action to "provide for maximum flexibility to meet coho salmon needs." On November 14, 2007, NMFS responded to Reclamation's request for formal consultation and concurred there was enough information to proceed on the Proposed Action described in the BA. However, NMFS' letter clarified that future modifications to the Proposed Action may constitute re-initiation of consultation and reset the consultation timeline. NMFS agreed to spend time working with Reclamation on evaluating alternatives to its Proposed Action.

After Reclamation provided Proposed Action alternatives, model runs and a new narrative description associated with those alternatives in November 2007, Reclamation, FWS, and NMFS met to discuss the new information. In December 2007, Reclamation decided not to modify its Proposed Action and NMFS resumed its analysis of the original Proposed Action found in Reclamation's October 2007 BA.

NMFS released a draft Opinion on June 3, 2008, concluding that Reclamation's Proposed Action was likely to jeopardize the continued existence of SONCC ESU coho salmon and likely to destroy or adversely modify its designated critical habitat. In a June 3, 2008, transmittal letter (NMFS 2008) we stated that "NMFS is required to develop a reasonable and prudent alternative (RPA) to Reclamation's Proposed Action and in coordination with Reclamation." Reclamation provided its comments on our June 3 draft Opinion on June 20, 2008. NMFS, Reclamation, and the FWS continued to coordinate efforts to develop a reasonable and prudent alternative for coho salmon while also protecting suckers in Upper Klamath Lake and minimizing shortages to water users. NMFS provided its draft Opinion to affected tribes on June 3, 2008, met with technical representatives of the Hoopa Valley Tribe and Yurok Tribe, and received comments on the draft Opinion from the Hoopa Valley Tribe and the Yurok Tribe on July 9, 2008. Considering these comments, NMFS revised its draft Opinion and prepared a draft reasonable and prudent alternative and discussed the draft Opinion and draft RPA with Reclamation and FWS on August 27, 2008.

On October 6, 2008, Reclamation requested that NMFS extend the consultation duration until further notice. However, Reclamation also requested that "our staffs continue to exchange biological and technical data" in order to expedite the consultation process once it resumes. Several technical meetings were held and in November 2008, NMFS provided its revised draft RPA (referred to as "RPA2") to Reclamation, FWS and the tribes. On March 4, 2010, Reclamation requested that NMFS finalize its biological opinion on the proposed operations of the Project from 2008 and 2018, consistent with RPA2 by March 15, 2010.

E. 2010 Opinion

Over the past several years, NMFS, FWS, and Reclamation have worked together to better understand and consider the conservation needs of SONCC ESU coho salmon in the Klamath River and Shortnose (*Chasmistes brevirostris*) and Lost River (*Deltistes luxatus*) suckers in the Upper Klamath basin above IGD while also considering the water resource objectives of Reclamation's Klamath Project.

On March 18, 2010, NMFS released its biological opinion (NMFS 2010 Opinion) on Reclamation's Klamath Project operations from 2010-2018 and concluded jeopardy with the provision of an RPA. The 2010 Opinion evaluated the Proposed Action of the continuing operation of Reclamation's Klamath Project until March 31, 2018, to store, divert, and manage flows of the Klamath and Lost Rivers. The Proposed Action included an arrangement of operational rules and an Interactive Management (IM) process was proposed by Reclamation to manage the distribution of stored water and the flows of the Klamath and Lost Rivers. Any RPA must meet the following criteria: (1) can be implemented in a manner consistent with the intended purpose of the action; (2) can be implemented consistent with the scope of the action agency's legal authority and jurisdiction; (3) is economically and technologically feasible; and (4) would, NMFS believes, avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat (50 CFR 402.02). NMFS determined that the implementation of the RPA is necessary for Reclamation to avoid the likelihood of jeopardizing the continued existence of the SONCC coho salmon ESU and to avoid the destruction or adverse modification of the ESU's designated critical habitat. One element of the RPA provides for Reclamation to modify Project operations to increase spring flows in average and wetter hydrologic conditions compared to the flows that Reclamation included in its Proposed Action. In order to implement the NMFS RPA flows, cooperation between Reclamation and PacifiCorp is required to meet these instream flow requirements downstream of IGD. Table 1 of this Opinion reproduces, from Table 18 of the RPA in NMFS' 2010 Opinion, the modified monthly instream flow releases in cubic feet per second (cfs) from IGD by percent flow exceedence. Exceedence tables are defined as the probability that flow (in cfs) will exceed a specified reference level during a given exposure time (NMFS 2010).

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	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	August 1-15	August 16-31	Sept
95%	1,000	1,300	1,260	1,130	1,300	1,275	1,325	1,175	1,025	805	880	1,000	1,000
90%	1,000	1,300	1,300	1,245	1,300	1,410	1,500	1,220	1,080	840	895	1,000	1,000
85%	1,000	1,300	1,300	1,300	1,300	1,450	1,500	1,415	1,160	905	910	1,001	1,000
80%	1,000	1,300	1,300	1,300	1,300	1,683	1,500	1,603	1,320	945	935	1,005	1,006
75%	1,000	1,300	1,300	1,300	1,300	2,050	1,500	1,668	1,455	1,016	975	1,008	1,013
70%	1,000	1,300	1,300	1,300	1,300	2,350	1,500	1,803	1,498	1,029	1,005	1,014	1,024
65%	1,000	1,300	1,300	1,300	1,323	2,629	1,589	1,876	1,520	1,035	1,017	1,017	1,030
60%	1,000	1,300	1,300	1,309	1,880	2,890	2,590	2,029	1,569	1,050	1,024	1,024	1,041
55%	1,000	1,300	1,345	1,656	2,473	3,150	2,723	2,115	1,594	1,056	1,028	1,028	1,048
50%	1,000	1,300	1,410	1,751	2,577	3,177	3,030	2,642	1,639	1,070	1,035	1,035	1,060
45%	1,000	1,300	1,733	2,018	2,728	3,466	3,245	2,815	1,669	1,077	1,038	1,038	1,066
40%	1,000	1,300	1,837	2,242	3,105	3,685	3,485	2,960	1,682	1,082	1,041	1,041	1,071
35%	1,000	1,300	2,079	2,549	3,505	3,767	3,705	3,115	1,699	1,100	1,050	1,050	1,085
30%	1,000	1,434	2,471	2,578	3,632	3,940	3,930	3,225	1,743	1,118	1,053	1,053	1,089
25%	1,000	1,590	2,908	2,627	3,822	3,990	4,065	3,390	2,727	1,137	1,058	1,058	1,097
20%	1,000	1,831	2,997	2,908	3,960	4,160	4,230	3,480	2,850	1,152	1,066	1,066	1,135
15%	1,000	2,040	3,078	3,498	4,210	4,285	4,425	3,615	2,975	1,223	1,093	1,093	1,162
10%	1,000	2,415	3,280	3,835	4,285	4,355	4,585	3,710	3,055	1,370	1,126	1,126	1,246
5%	1,000	2,460	3,385	3,990	4,475	4,460	4,790	3,845	3,185	1,430	1,147	1,147	1,281

Table 1. NMFS Modified RPA Monthly Instream Flow Releases (cfs) from Iron Gate Dam by Percent Flow Exceedence

According to Table 1, NMFS has prescribed increased spring flows in average and wetter exceedences in the months of March-June. The prescribed increase in spring flows is expected to support a greater abundance of life history strategies, resulting in increases to the diversity of affected populations; and enhance fitness benefits of juvenile individuals in the upper Klamath, Shasta, and Scott River population units, including increased growth, lower risks of disease infection, reduced competition with hatchery-reared salmonids, and lower risks of predation. Also included in the operational rules is the implementation of specific ramping rates to minimize effects to SONCC ESU coho salmon. Ramping is the process by which flows out of IGD are gradually mechanically reduced.

When the outflow at IGD is greater than 3,000 cfs, IGD ramp down rates will follow the rate of decline of inflows into Upper Klamath Lake combined with accretions between Keno Dam and IGD. When the flows at IGD are above 1,750 cfs, but less than 3,000 cfs, IGD ramp down rate will be 300 cfs or less per 24-hour period and no more than 125 cfs per 4-hour period. When the flows at IGD are 1,750 cfs or less, IGD ramp down rate will be 150 cfs or less per 24-hour period and no more than 50 cfs per two-hour period (NMFS 2010). The 2010 Opinion RPA also required Reclamation to implement a fall and winter flow variability program to enhance flow variability to mimic the natural hydrologic response that would naturally occur at the point of IGD releases due to precipitation. To implement this program, NMFS requires the development of a flow variability team, comprised of technical staff from state and federal agencies, tribes and stakeholders, including PacifiCorp (NMFS 2010). The Team is charged with making recommendations to Reclamation to enhance flow variability between September 1, and March 1. Team recommendations may include all components of the hydrological response, including the ascending and descending limb of the hydrograph and sustained peak flows resulting from precipitation. The Team may also recommend higher sustained base flows following extended periods of precipitation to reflect the natural ascension of the hydrologic base flow (NMFS 2010). The maximum volume of water available for the Team's combined annual (September 1 through March 1) recommendations will be 18,600 acre-feet, which is equal to the volume of water conserved as a result of flow modifications described in the other element of the RPA (modified instream flow releases). Recommendations to enhance flow variability at other times of the year may be implemented, based on water availability. Flow recommendations will be required to be consistent with ramp-down rates described in the NMFS 2010 Opinion, unless otherwise evaluated and determined to not result in additional adverse effects to coho salmon as described in that biological opinion. Reclamation, in coordination with PacifiCorp, will implement the Team's recommendations for the September 1 through March 1 time period unless: (1) operational constraints prohibit implementation; or (2) the implementation of the recommendation will result in a risk to human safety or property. In the event that (1) or (2) prohibit the implementation of the Team's recommendation, the Team will have the opportunity to modify its recommendation. Implementation of the fall and winter flow variability program of the RPA is expected to provide environmental conditions necessary to trigger fall redistribution of juvenile coho salmon to overwintering habitat and help disrupt the fine sediment habitat of the polychaete host for myxosporean parasites and increase the redistribution of adult salmon carcasses in the mainstem Klamath River, ultimately reducing disease rates in juvenile salmonids in the mainstem Klamath River.

1.3 Key Consultation Considerations

1.3.1 Klamath Hydroelectric Settlement Agreement/Klamath Basin Restoration Agreement and Process Used to Develop Proposed Action (Issuance of Incidental Take Permit for the Implementation of the Habitat Conservation Plan)

FERC Relicensing Settlement Process

As it became clear during the examination of alternatives for a new FERC license that installation of volitional fish passage facilities would be very costly following the submittal of its application for a new FERC license, PacifiCorp began settlement discussions with a diverse group of stakeholders to resolve issues related to relicensing of the Project. On February 18, 2010, these diverse parties came together to sign the Klamath Hydroelectric Settlement Agreement (KHSA) and the Klamath Basin Restoration Agreement (KBRA). Instead of proceeding with the FERC relicensing process for the Project, the KHSA provides a process for potential removal of the four most downstream Project dams on the Klamath River: J.C. Boyle, Copco No. 1, Copco No. 2, and IGD (KHSA 2010). The companion agreement to the KHSA, the KBRA, is intended to: (1) restore and sustain natural fish production and provide for full participation in ocean and river harvest opportunities of fish species throughout the Klamath basin; (2) establish reliable water and power supplies which sustain agricultural uses, communities, and National Wildlife Refuges; and (3) contribute to the public welfare and the sustainability of all Klamath basin communities (KBRA 2010).

Under the KHSA, the Secretary of the Interior is to make a determination (Secretarial Determination) whether certain conditions have been met for removal of the four Project dams to proceed. If the Secretarial Determination is affirmative and certain other conditions are met, the KHSA provides an expected target date for removal of the four Project dams by the end of 2020(KHSA 2010). The KHSA provides that Project operations will continue over an interim period from February 18, 2010, until decommissioning of the four Project dams or, if dam removal does not proceed, the FERC relicensing process would resume for the Project. This biological opinion focuses on effects of Project operations during this interim period with inclusion of the effects of implementation of the proposed PacifiCorp HCP as would occur if NMFS issues an Incidental Take Permit (ITP) for PacifiCorp's Project operations during this interim period.

The KHSA establishes the process for studies and environmental review, including the development of a "Detailed Plan to implement Facilities Removal," to inform the Secretarial Determination as to whether removal of the four Project dams will: (1) advance restoration of the salmonid fisheries of the Klamath Basin and (2) is in the public interest, which includes, but is not limited to, consideration of the potential impacts on affected local communities and tribes. The Secretarial Determination is subject to provisions regarding concurrence by the States of Oregon and California. As lead agencies, the Department of the Interior and California Department of Fish and Game (CDFG) have prepared a draft Environmental Impact Statement and Environmental Impact Report (EIS/EIR) evaluating the effects of removing the four Project Dams (76 FR 58833, September 22, 2011). More information related to the draft EIS/EIR and Secretarial Determination is available at http://klamathrestoration.gov.

The KHSA provides for the abeyance of the FERC relicensing process pending the outcome of the Secretarial Determination and other contingencies related to removal of the four Project dams. If the Secretary of the Interior determines that dam removal should not proceed, or the KHSA terminates for other reasons, the FERC relicensing process for the Project would resume.

Since submitting the new license application to FERC in 2004, PacifiCorp has worked with technical assistance from NMFS to develop "interim conservation measures" for listed coho salmon to be implemented in the interim period until issuance of a new FERC license or Project dam removal. In November 2008, PacifiCorp submitted an Interim Conservation Plan (ICP) to NMFS with interim conservation measures (PacifiCorp 2008). On November 12, 2008, NMFS confirmed receipt of the ICP, noting that the ICP contained an important set of actions that, if fully implemented, would reduce and help minimize potential adverse Project impacts on listed species, and provide benefits to listed aquatic species and their habitats. NMFS noted plans to subsequently review the measures of the ICP pursuant to the ESA (NMFS and USFWS 2008). The KHSA incorporates ICP measures intended to benefit coho salmon with some revisions from the ICP, as well as additional interim measures that were not part of the ICP. The ICP measures pertaining to coho salmon as revised in the KHSA formed a basis for development of

PacifiCorp's Habitat Conservation Plan for interim Project operations pertaining to SONCC ESU coho salmon.

Incidental Take Permit Process

As the ICP did not provide incidental take authorization for any potential take of listed species associated with Project operations, on March 15, 2011, PacifiCorp filed an application for an Incidental Take Permit (ITP) under the ESA for interim Project operations. The application includes an HCP that identifies Project activities and facilities that have the potential to result in the incidental take of SONCC ESU coho salmon, identifies the impact that will likely result from such incidental take, and outlines conservation actions PacifiCorp proposes to undertake to avoid, minimize, or mitigate the effects of Project related incidental take of SONCC ESU coho salmon. The ITP would authorize potential incidental take[1] under section 10(a)(1)(B) of the ESA of SONCC ESU coho salmon for an interim 10-year period expected for Project operations and maintenance activities until Project dam removal, as specified in the KHSA, or if the KHSA is terminated, operation under a new FERC license with fish passage requirements. The ITP would address effects of potential incidental take of SONCC ESU coho salmon associated with existing Project operations as described in Section VI, *Effects of the Proposed Action*, of this Opinion.

Iron Gate Hatchery (IGH) Hatchery and Genetic Management Plan Process

IGH is located adjacent to the Klamath River below IGD near RM 189 (Figure 1). IGH was established in 1966 as mitigation for blocked anadromous fish habitat between Iron Gate and Copco 1 dams. The hatchery is operated by CDFG and funded by PacifiCorp. PacifiCorp and CDFG have developed a Hatchery and Genetic Management Plan (HGMP) with technical assistance from NMFS (CDFG 2011). The primary purpose of the HGMP is to devise biologically-based hatchery management strategies that aid the conservation and recovery of the Upper Klamath coho population by conserving genetic resources and reducing short-term extinction risks prior to future restoration of fish passage above IGD (CDFG 2011). The HGMP contains measures to ensure hatchery operations are consistent with the most current plans for species conservation and reintroduction efforts. Although IGH is operated as a mitigation hatchery to compensate for habitat blocked between IGD and the Copco developments, a conservation focus for the coho program has been deemed necessary to protect the remaining genetic resources of the Upper Klamath coho population unit. The process for implementing the HGMP will undergo a separate ESA permitting action and ESA Section 7 consultation in the near future as the hatchery will directly take coho salmon under an HGMP for the express purpose of enhancing the continued survival of SONCC ESU coho salmon. PacifiCorp and CDFG have submitted the HGMP to NMFS with an application for a permit for the enhancement of propagation or survival of SONCC ESU coho salmon, and NMFS is in the process of reviewing this permit application pursuant to ESA Section 10(a)(1)(A) and its implementing regulations. PacifiCorp has included the HGMP as part of the HCP conservation strategy as they

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[1] ESA Section 10(a)(1)(B) (16 U.S.C. 1539(a)(1)(B) provides that a permit may be issued for any otherwise prohibited taking of a listed species "if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity." In its ESA implementing regulations (50 CFR 402.02), NMFS defines "incidental take" as "takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant."

have agreed to provide the funding necessary for CDFG to implement an approved HGMP. Because PacifiCorp will be providing funding for improved hatchery management practices at IGD, NMFS considers the HGMP as interrelated to the proposed action, issuance of an ITP to PacifiCorp for interim Project operations, as the HGMP is part of a broader conservation strategy to address threats to the SONCC coho salmon ESU in the Klamath River basin related to Project operations even though the HGMP will undergo a separate NMFS permitting process. Without PacifiCorp's commitment to fund the HGMP, improvements in hatchery practices would likely be delayed until other sources of funding could be found.

II. DESCRIPTION OF THE PROPOSED ACTION

The proposed action in this intra-service consultation is NMFS' issuance of an Incidental Take Permit (ITP) to PacifiCorp under section 10(a)(1)(B) of the ESA for implementation of the PacifiCorp Klamath Hydroelectric Project Interim Operations Habitat Conservation Plan for Coho Salmon. PacifiCorp is applying to NMFS for authorization to incidentally take SONCC ESU coho salmon, which are listed as threatened under the ESA, for take that may occur specifically as a result of the operation and maintenance of PacifiCorp's facilities, for a period of 10 years. To be clear, the HCP does not include installation of volitional fish passage around Project dams during the term of the ITP, because the ITP and related HCP would cover the 10-year interim period until anadromous fish passage is expected to be provided around Project dams either through dam removal under the KHSA or, if the KHSA terminates, volitional fish passage facilities are required under a new Project license issued by FERC as previously explained. PacifiCorp is separately applying to the U.S. Fish and Wildlife Service for an ITP for a 10-year period that would authorize incidental take of Lost River sucker and shortnose sucker, which are listed as endangered under the ESA.

Interim operations of the Project during the 10-year period will involve two general categories of activities: (1) operation of existing Project facilities as described in the following sections, and (2) implementation of conservation measures detailed in the PacifiCorp HCP (PacifiCorp 2012) that were developed with technical assistance from NMFS. Conservation measures were developed to minimize and mitigate the effects of operations and maintenance of the Project on listed coho salmon during the interim period. As is described in greater detail below in this Opinion, take that may occur from implementation of some of the HCP's conservation measures will be addressed under separate ESA processes, as specific details of projects meeting HCP goals and objectives become defined in sufficient detail for NMFS to analyze the specific effects of these projects.

2.1 Location and Description of Klamath Hydroelectric Project Facilities

PacifiCorp operates eight Project facilities, seven of which are located on the Upper Klamath River in Klamath County (Oregon) and Siskiyou County (California). The remaining facilities are on the Fall Creek tributary of the Klamath River and on Spring Creek, a tributary of Jenny Creek which is a tributary of the Klamath River. The location of Project facilities within the Klamath River basin is shown in Figure 1.

The current Project facilities in Oregon include the following:

- <u>East Side and West Side Developments on the Klamath River at Approximately River Mile (RM) 253</u>. Link River dam at the head of the Klamath River at RM 254.3

is downstream of Upper Klamath Lake (UKL), which is the source of the Klamath River. The dam is owned by the Reclamation but operated by PacifiCorp under an agreement with Reclamation. Although the dam is not part of the FERC-licensed Project, PacifiCorp diverts water from the dam to two downstream powerhouses, where the water is returned to the river after generating electric power. The East Side powerhouse at RM 253.7 has a turbine with a nameplate generating capacity of 3.2 MW; the West Side powerhouse at RM 253.3 has a turbine with a nameplate generating capacity of 0.6 Megawatt. In its application to FERC for a new Project license, PacifiCorp proposes to decommission the East Side and West Side developments and to remove them from the FERC-licensed Project.

- Keno Dam on the Klamath River at RM 233. Keno dam is approximately 20 miles downriver from Link River dam. Keno dam is owned by PacifiCorp but operated under an agreement with Reclamation. No power generation is associated with the dam.
- J.C. Boyle Dam on the Klamath River at RM 224.7. J.C. Boyle dam is approximately 9 miles downriver from Keno dam. J.C. Boyle dam is owned and operated by PacifiCorp. The dam impounds a reservoir that is approximately 3 miles long. Water is diverted from the dam to a powerhouse approximately 4 miles downriver at RM 220.4. The powerhouse contains two generating turbines with a nameplate generating capacity of 50.35 MW at unit 1 and 47.63 MW at unit 2.
- Spring Creek Diversion. PacifiCorp diverts water from Spring Creek to Fall Creek in Jackson County, Oregon. PacifiCorp diverts a portion of Fall Creek to the Fall Creek powerhouse, which is located in California. Although the Spring Creek diversion is not currently within the FERC license boundary for the Project, in its application to FERC for a new Project license, PacifiCorp has proposed to include it. Spring Creek is a tributary to Jenny Creek, which enters the Klamath River.

The current Project facilities in California include the following:

- Copco No. 1 Development at RM 198.6. The Copco No. 1 Development consists of a reservoir, dam, spillway, intake, and outlet works and powerhouse located on the Klamath River between approximately RM 204 and RM 198 near the Oregon-California border. Copco No. 1 is downstream of the J.C. Boyle dam and upstream of Copco No. 2 dam. The powerhouse has a turbine with a nameplate generating capacity of 20 MW.
- Copco No. 2 Development at RM 196.8. The Copco No. 2 Development consists of a diversion dam, small impoundment, water conveyance system, and powerhouse. The dam is located approximately ¼ mile downstream of Copco No. 1 dam. The powerhouse has a turbine with a nameplate generating capacity of 27 MW.
- Iron Gate Development at RM 190. The Iron Gate Development consists of a reservoir, an earth embankment dam, an ungated side-channel spillway, intakes for the diversion tunnel and penstock, a steel penstock from the dam to the powerhouse, and the powerhouse. The powerhouse has a turbine with a nameplate generating

capacity of 18 MW. It is located approximately 20 miles northeast of Yreka, California, and is the farthest downstream hydroelectric facility of the Project.

- Fall Creek Development. The Fall Creek Development is located on Fall Creek, a tributary to the Iron Gate reservoir, approximately 0.4 mile south of the Oregon-California border. As noted above, an additional diversion facility is located on Spring Creek in Oregon. The facilities on Fall Creek consist of a concrete and timber flashboard spillway structure, an earth- and-rock-filled diversion dam, 4,560 feet of earthen and rock-cut power canal, 2,834 feet of steel penstock, and a powerhouse.

2.2 Proposed Action Covered Activities for Authorization of Incidental Take

Activities covered under the ITP ("Covered Activities") that may result in the incidental take of SONCC ESU coho salmon include activities that are necessary to operate and maintain Project facilities for the duration of the proposed permit term, as well as a subset of conservation measures identified in the HCP as described in the next section. Because the HCP includes projects for restoration of coho salmon habitat that have to be site-specifically designed by third parties seeking funding for the projects and then evaluated for potential site-specific impact to SONCC ESU coho salmon or critical habitat, this Opinion considers the effects of conservation measures that include these projects in general terms. However, this Opinion does not evaluate nor authorize levels of incidental take for these conservation measures and related projects as this cannot be evaluated until projects are submitted for funding, when projects are expected to be defined in sufficient detail to determine specific project effects and any levels of incidental take.

Hydroelectric generation is the primary activity conducted at Project facilities, with the exception of the Keno development, which does not include power-generating equipment. Many of these activities are governed by annual licenses for the Project under the conditions of the previous FERC license or agreements with other entities (e.g., Reclamation), or through voluntary commitments from PacifiCorp. The HCP provides detailed descriptions of Project facilities and their operations in Chapter IV (Current Conditions), and information on HCP Covered Activities in Chapter II (Description of Covered Activities) of the HCP (PacifiCorp 2012). For purposes of this Opinion, summaries of these descriptions are presented below and Table 2 gives information on the characteristics of dams and reservoirs in the Klamath hydroelectric development.

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

Table 2. Dam, powerhouse and reservoir information for the Klamath Hydroelectric power developments (From: PacifiCorp 2012).

2.2.1 Operations and Maintenance Activities for Project Facilities Above Iron Gate Dam

Although IGD is currently the terminus for coho salmon migration in the Klamath River, as it was constructed without anadromous fish passage facilities, continued operation of Project facilities above IGD have the potential to contribute towards the incidental take of SONCC ESU coho salmon downstream of IGD indirectly via interruptions to the natural flow regime of the Klamath River, blockages of passage to historical coho habitat, impairment of natural conveyance of habitat-forming wood and sediment in the Klamath River mainstem, and contribution to instream conditions that result in poor water quality for a distance downstream of IGD. As is described in more detail in the HCP, the Covered Activities necessary to operate and maintain Project facilities above IGD are:

- Operate and maintain the spill gates at Link River dam for regulation and releases of flows from Link River dam to maintain water in the East Side and West Side water conveyance features, and for purposes of hydroelectric generation (PacifiCorp operates Link River dam, however, Reclamation owns it).
- Operate and maintain the East Side and West Side canals and flowlines of the East Side and West Side powerhouse facilities, and operate and maintain penstocks, turbines, and powerhouse facilities prior to both facilities being decommissioned and removed from the Project.
- Operate and maintain Keno dam, spill gates, and fish ladder
- Regulate the water level upstream of Keno dam in accordance with the agreement with Reclamation (per PacifiCorp's existing FERC license) and for irrigation withdrawal activities
- Operate and maintain J.C. Boyle dam, fish bypass system, water conveyance system, turbines, and powerhouse facilities
- Maintain an instream flow release from the J.C. Boyle dam to the river of not less than 100 cfs (per PacifiCorp's existing FERC license)
- Regulate flows from J.C. Boyle dam and powerhouse during normal operations, such that ramping rates of flow in the river do not exceed 9 inches per hour (as measured at the United States Geological Survey (USGS) gage located 0.5 mile downstream of the J.C. Boyle powerhouse) per PacifiCorp's existing FERC license
- Operate and maintain Copco No. 1 and Copco No. 2 dams, water conveyance systems, turbines, and powerhouse facilities
- Regulate water levels at Keno, J.C. Boyle, and Copco reservoirs

2.2.2 Operations and Maintenance of Iron Gate Dam and Water Releases from Iron Gate Dam in Accordance with Reclamation's Klamath Project Biological Opinions

Covered Activities associated with Project operations at IGD that have the potential to result in the incidental take of SONCC ESU coho salmon downstream of the dam include:

- Operate and maintain IGD (and associated appurtenances), penstocks, turbines, and powerhouse facilities
- Regulate water levels in Iron Gate reservoir
- Regulate releases from IGD in accordance with NMFS' BiOp on Reclamation's Klamath Project operations (NMFS 2010, and future consultations) which identify instream flow and ramping rate requirements (as measured at the USGS gage located 0.5 mile downstream of IGD).

2.2.3 Implementation of Habitat Conservation Plan Coho Salmon Conservation Strategy

Covered Activities under the proposed ITP also include the implementation of conservation measures identified in the HCP that comprise the *Coho Salmon Conservation Strategy* (PacifiCorp 2012). Table 3 below is taken from the PacifiCorp HCP (PacifiCorp 2012) and includes a summary of covered activities that could result in the take of SONCC ESU coho salmon, the type of take that may occur, the impacts of such taking, and the measures proposed to avoid, minimize, or mitigate for such take.

Table 3. Summary of Covered Activities That Could Potentially Result in Incidental Take of Listed Coho Salmon, the Type of Take, Impacts of the Taking, and Whether Take Can Be Avoided, Minimized, or Addressed through Conservation Actions (Adopted and modified from PacifiCorp 2012).

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

Table 3. Summary of Covered Activities That Could Potentially Result in Incidental Take of Listed Coho Salmon, the Type of Take, Impacts of the Taking, and Whether Take Can Be Avoided, Minimized, or Addressed through Conservation Actions (Adopted and modified from PacifiCorp 2012).

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

Table 3. Summary of Covered Activities That Could Potentially Result in Incidental Take of Listed Coho Salmon, the Type of Take, Impacts of the Taking, and Whether Take Can Be Avoided, Minimized, or Addressed through Conservation Actions (Adopted and modified from PacifiCorp 2012).

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

Table 3. Summary of Covered Activities That Could Potentially Result in Incidental Take of Listed Coho Salmon, the Type of Take, Impacts of the Taking, and Whether Take Can Be Avoided, Minimized, or Addressed through Conservation Actions (Adopted and modified from PacifiCorp 2012).

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

Table 3. Summary of Covered Activities That Could Potentially Result in Incidental Take of Listed Coho Salmon, the Type of Take, Impacts of the Taking, and Whether Take Can Be Avoided, Minimized, or Addressed through Conservation Actions (Adopted and modified from PacifiCorp 2012).

Mechanism for Potential Take	Type of Take	Effect on Coho Salmon	Life Stage(s) Affected	Populations Impacted	Extent and Impact of Potential Take	Potential Take Avoidance	Impact Minimization	Conservation Actions	Methods for Monitoring Effectiveness
Disease	Indirect Harm	Modifications to the river's historical hydrologic regime, along with large loads of nutrients and organic matter in the river, may create instream conditions that favor disease proliferation and fish infection. These disease pathogens will impact coho salmon populations inhabiting the Klamath River below Iron Gate dam. NMFS (2007) indicates that Project reservoirs may continue to contribute to the conditions favoring the population of *Manayunkia speciosa*, the intermediate host for the pathogens *Ceratomyxa shasta* and *Parvicapsula minibicornis* that occurs below Iron Gate Dam. Potential linkages to project reservoirs include reductions in coarse sediment, flow variability, blockage to upstream habitat, and reductions in water quality resulting in increased incidence and susceptibility of disease.	Juveniles	Primarily Upper Klamath but potentially Scott and Shasta	Incidences and severity of disease vary by location and environmental conditions within the mainstem Klamath River. Once infected with C. shasta, fish survival rates are generally low. Incidence of disease is highest within the reach between the Shasta and Scott Rivers with decreasing incidences downstream. Disease effects are most pronounced for juveniles that are rearing or migrating in the mainstem Klamath River when water quality conditions make them more susceptible to disease and when actinospore concentrations are high.	The key conditions that favor disease proliferation are reductions in coarse sediment, flow variability, simplified habitat, and reductions water quality. Avoidance of these factors would entail removal of project dams. Improving conditions in tributary streams may help avoid potential impacts because fish may avoid the mainstem. As described above, avoidance of this impact may not be practicable under interim operations. Existing project-related effects are the result of the presence of the facilities. In the longer term, outside the term of this HCP, impacts will be addressed through dam removal as specified in the KHSA or otherwise addressed under a new FERC license and issuance of a 401 certification.	Any disruption of the disease pathogen's life cycle would contribute to impact minimization. Potential minimization measures include increased flow variability, increased coarse sediment, water quality improvements, increases in habitat complexity, and reductions in nutrient load. It is unclear at this time what if any other minimization measures are available to address these impacts; however, additional research may clarify measures.	Any improvements to habitat in tributary reaches would enhance opportunities for avoidance and reduced effects on coho, and would further minimize disease impacts. Such actions could include enhancements to improve the extent, duration and access to habitats.	Ongoing fish disease research and monitoring assist in the identification and effectiveness of management measures or Project operational changes. In addition, effectiveness of measures to increase flow variability, increase coarse sediment, improve water quality, increase habitat complexity, reduce nutrient load, and improve habitat in tributary reaches are listed in other rows of the table and can be linked to disease monitoring. .
Blockage of Downstream Transport of Sediment and Wood	Indirect Harm	Iron Gate and other upstream dams will continue to impede the downstream transport of sediment (i.e., gravel and fine sediment) and large woody debris (LWD). Coho salmon downstream of Iron Gate dam may be indirectly harmed by a reduction of spawning habitat resulting from long-term depletion of spawning gravel. Also, reduction of coho salmon rearing habitat may result from disruption of the habitat-forming channel, riparian, and floodplain processes that rely on supplies of sediment and LWD. The absence of coarse sediment reduces the scouring ability of flow events, resulting in more favorable habitat conditions for *M. speciosa* and potentially higher disease rates.	Juveniles, Adults	Primarily Upper Klamath and potentially Scott and Shasta	The effect of loss of sediment and LWD affect prevalence of disease, the complexity of juvenile rearing and adult holding habitats. The loss of coarse sediment also impacts the amount and extent of spawning habitat for mainstem spawners.	The blockage of sediment and LWD is a product of the system of dams and reservoirs in place. As described above, avoidance of this impact may not be practicable under interim operations. Existing project-related effects are the result of the presence of the facilities. In the longer term, outside the term of this HCP, impacts will be addressed through dam removal as specified in the KHSA or otherwise addressed under a new FERC license and issuance of a 401 certification.	Minimizing the impact of the take potentially resulting from blockage of sediment and LWD is not practicable given the systemic nature of this effect. The blockage of sediment and LWD is a product of the system of dams and reservoirs in place. As described above, avoidance of this impact may not be practicable under interim operations. Existing project-related effects are the result of the presence of the facilities. In the longer term, outside the term of this HCP, impacts will be addressed through dam removal as specified in the KHSA or otherwise addressed under a new FERC license and issuance of a 401 certification.	Conservation actions would entail gravel augmentation and placement of LWD below Iron Gate dam. Improvements to floodplain habitats could also contribute to conservation.	The effectiveness of actions to address effects of sediment and LWD blockage can be monitored through implementation of monitoring plans focused on the specific actions.

Table 3. Summary of Covered Activities That Could Potentially Result in Incidental Take of Listed Coho Salmon, the Type of Take, Impacts of the Taking, and Whether Take Can Be Avoided, Minimized, or Addressed through Conservation Actions (Adopted and modified from PacifiCorp 2012).

Mechanism for Potential Take	Type of Take	Effect on Coho Salmon	Life Stage(s) Affected	Populations Impacted	Extent and Impact of Potential Take	Potential Take Avoidance	Impact Minimization	Conservation Actions	Methods for Monitoring Effectiveness
Flows and Rearing Habitat Conditions Downstream of Iron Gate Dam	Indirect Harm	Iron Gate dam provides relatively stable downstream flows over long time periods. Stable flows can remove or reduce hydrological cues that stimulate downstream migration by juvenile coho salmon, reduce flooding/flushing flows necessary to create and maintain floodplain habitat, and contribute to conditions favorable for disease. In addition, these factors may affect coho salmon by reducing access to habitat, impeding their ability to redistribute within the system, reducing overwinter survival, altering the timing of outmigration, , and reducing the quality of refugia areas at creek mouths.	All	Upper Klamath, Shasta, Scott	NMFS (2010) describes the extent and impact of potential take associated with flows and rearing habitat conditions below Iron Gate Dam. The accretion between Keno and Iron Gate provide flows that PacifiCorp possesses some incremental control, subject to the direction of Reclamation. Flow releases from Iron Gate dam are made in compliance with the NMFS BiOp (NMFS 2010) covering Reclamation's Klamath River operations. These flow releases are intended to minimize and mitigate Reclamation's impacts on coho salmon.	PacifiCorp operates its facilities at Iron Gate dam in compliance with the minimum flow requirements placed on Reclamation by NMFS (NMFS 2010). As described above, avoidance of this impact may not be practicable under interim operations. Existing project-related effects are the result of the presence of the facilities. In the longer term, outside the term of this HCP, impacts will be addressed through dam removal as specified in the KHSA or otherwise addressed under a new FERC license and issuance of a 401 certification.	Although PacifiCorp has little operational flexibility to influence flows downstream of Iron Gate dam, it may be able to minimize the potential for flow-related take by increasing (in cooperation with Reclamation) the seasonal variability of flows downstream of Iron Gate dam.	Given that PacifiCorp operations are in compliance with the flow requirements contained in the NMFS BiOp, any residual effects of reduced survival could be addressed by conservation actions that improve habitat conditions, reduce juvenile mortality, and increase access and connectivity to tributary habitat. Habitat actions that mimic flow variability effects include restoring mainstem habitats, improving floodplain and tributary connectivity, and reducing water diversions.	The effectiveness of actions to address effects of reduced juvenile survival can be monitored through implementation of monitoring plans focused on the specific actions as they are developed.

Conservation measures are designed to minimize and mitigate to the maximum extent practicable the adverse effects of incidental take of SONCC ESU coho salmon from Project operations and maintenance during the period of the ITP. The majority of the Project operations activities (as described in the section above) were considered in the 2007 BiOp on FERC's proposed issuance of a new Project license. The terms and conditions of NMFS' 2007 BiOp served as an initial basis for developing the conservation measures described in the HCP (PacifiCorp 2012). Chapter VI (Conservation Program) of the HCP provides detailed descriptions of the conservation strategy. Additional details on the conservation measures are also provided in the "Effects of the Action" chapter of this Opinion.

The conservation measures presented in the HCP focus on enhancement of coho salmon habitat availability and use in the Klamath River basin downstream of IGD during the interim period. The interim conservation measures proposed in the HCP are based on a foundation of seven biological goals to minimize and mitigate to the maximum extent practicable for adverse effects due to Project operations and maintenance, and to aid the viability of SONCC ESU coho salmon, in the 10-year interim period. These stated biological goals are:

- Goal I: Offset biological effects of blocked habitat upstream of IGD by enhancing the viability of the Upper Klamath coho salmon population.
- Goal II: Enhance coho salmon spawning habitat downstream of IGD.
- Goal III: Improve instream flow conditions for coho salmon downstream of IGD.
- Goal IV: Improve water quality for coho salmon downstream of IGD.
- Goal V: Reduce disease incidence and mortality in juvenile coho salmon downstream of IGD.
- Goal VI: Enhance migratory and rearing habitat for coho salmon in the Klamath River mainstem corridor.
- Goal VII: Enhance and expand rearing habitat for coho salmon in key tributaries.

The HCP provides objectives and specific measures to implement these goals to improve habitat conditions during the interim period. The biological objectives identify the components (e.g. enhancement actions or projects) needed to achieve the biological goal. The objectives also provide benchmarks to determine the effectiveness of the measures that comprise the *Coho Salmon Conservation Strategy* for the HCP. Each objective includes metrics to track progress towards achieving goals, and these metrics are referred to as targets.

Restoration projects meeting the above goals will be selected and implemented through the already-established Coho Enhancement Fund (CEF). PacifiCorp contributed $510,000 to this fund annually since 2009, and will continue to provide this amount of funding annually by January 31 of each year of the 10-year term of the ITP. PacifiCorp has established this fund to be administered in consultation with a Technical Review Team (TRT) consisting of PacifiCorp, CDFG, NMFS, and affected Tribes. CDFG coordinates with the State Water Resources Control

Board and North Coast Regional Water Quality Control Board in its capacity as a part of this TRT.

The CEF is administered by the National Fish and Wildlife Foundation (NFWF) upon receiving a list of coho salmon enhancement projects that have been agreed upon by NMFS, CDFG, and PacifiCorp in consultation with the TRT. As described in the HCP, PacifiCorp will make a final approval of projects for funding to ensure consistency with HCP objectives, and with applicable FERC license conditions and other regulatory requirements. NFWF will then oversee contracts to implement projects with funds provided from the CEF.

2.2.3.1 Goal I: Offset the Biological Effects of Blocked Habitat Upstream of Iron Gate Dam by Enhancing the Viability of the Upper Klamath Coho Salmon Population

a. Fish Passage

Under the HCP's *Coho Salmon Conservation Strategy*, specific projects will be selected and implemented to create, maintain, or improve access by coho salmon to habitats downstream of IGD. The objective of these projects is to increase the distribution of coho salmon and improve the spatial structure of Klamath River populations. Specific access-related projects are proposed in the HCP to maintain and improve access to coho salmon spawning and rearing habitat in Klamath River tributaries downstream of IGD that are within the range of the Upper Klamath coho salmon population unit. These specific conservation actions are based on achieving two targets: (1) maintain and improve access to existing spawning and rearing habitat in approximately 60 miles of Upper Klamath tributaries between April and November of each year; and (2) remove existing fish passage barriers to create permanent access to at least one mile of potential spawning and rearing habitat in Upper Klamath tributaries.

For achieving the first target, projects and actions undertaken would include maintenance and possible modifications of key tributary mouths of the upper Klamath River to ensure access by coho salmon from the river, including removal of swimmer dams, gradient barriers, log jams, and other types of impediments. Specific sites for these actions identified in the HCP include sites prioritized by the Klamath River Tributary Fish Passage Improvement Project[2] and other tributaries in the Upper Klamath that contain coho salmon habitat. These include 13 tributary sites as shown in Figure 2 (indicated as symbol numbers 1-13). The HCP indicates that actual sites where these actions are implemented may be different than those shown in Figure 2 if: (1) on-site conditions (such as access to, or physical conditions at the site) preclude planned work; or (2) new technical information (such as related to habitat conditions or coho salmon use) is obtained that suggests priority of sites should be adjusted. However, possible adjustments in sites under this measure are expected to have similar value for coho salmon and must meet the HCP's goals and objectives.

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[2] The Klamath River Tributary Fish Passage Improvement Project plan by the Mid-Klamath Watershed Council and its partners in the basin identifies and prioritizes restoration actions in the sub-basin to complement the Mid Klamath Sub-basin Fisheries Resource Recovery Plan and other existing planning documents. The development of this plan was funded in 2010 by PacifiCorp under the CEF.

For achieving the second target, projects and actions undertaken would include removal of certain known barriers to allow permanent access by coho salmon to additional spawning and rearing areas. Specific actions identified in the HCP include barrier removals caused by road crossings (e.g., culverts) at four tributary sites as shown in Figure 2 (indicated as symbol numbers 14-17). The HCP indicates that, if these barrier removal projects are not available for funding within the term of the ITP, then other fish passage projects with comparable benefits for coho salmon will be implemented. These could include road-crossing diversion or other permanent or seasonal barriers that impede fish passage.

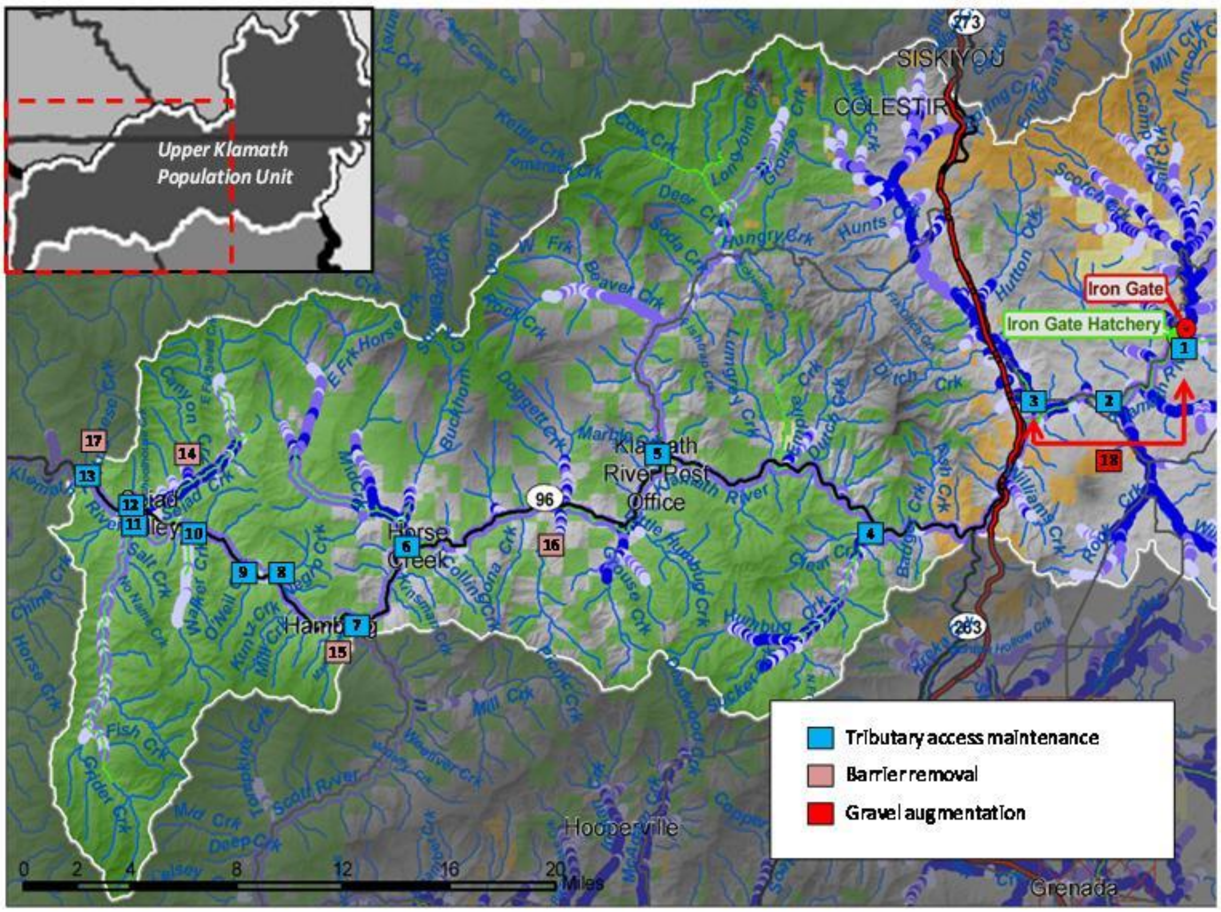

Figure 2. Locations for actions proposed in PacifiCorp's HCP in the Upper Klamath Population Unit related to tributary access maintenance, barrier removal, and gravel augmentation. (Source: NMFS Northern California Office, 2011).

b. Hatchery Production

Iron Gate Hatchery (IGH), which was originally constructed in 1966 as mitigation for blocked habitat between Iron Gate and Copco 1 dams, will continue operations through the 10-year term of the ITP. As described in the HCP, an HGMP will be implemented as an additional conservation action to mitigate for the Project effects on SONCC ESU coho salmon. During the 10-year term of the ITP, the coho program at the IGH will be operated in support of the basin's coho salmon recovery efforts by implementing measures that will assist in conserving the genetic, phenotypic, behavioral, and ecological diversity of coho salmon in the Klamath River basin. Measures contained in the HGMP include an active broodstock management plan, based on real-time genetic analysis, which will be implemented each year to reduce the rate of inbreeding that has occurred in the hatchery population over time. The objective of the program is to release at least 75,000 coho smolts annually under an HGMP. The number of smolts released is similar to historical releases which have occurred in the past without the benefit of an HGMP. HGMP measures will also include hatchery culture improvements to increase egg-to-smolt survival rates. Egg incubation survival will be investigated to identify measures that will improve survival such as changes to incubation methods, improvements in egg rearing water quality, filtering organic matter from the water source and/or decreasing egg density in incubation trays. Increases in survival of rearing juveniles will be achieved by covering raceways with netting to reduce bird predation on the rearing juveniles.

Although the HGMP is included in an application for a separate NMFS permitting action under section 10(a)(1)(A) of the ESA (enhancement of the propagation or survival permit), PacifiCorp will fund the costs associated with implementation of the HGMP for IGH under its HCP. Implementation of the HGMP will proceed through cooperation and coordination among PacifiCorp, CDFG, and NMFS. As operators of the IGH, CDFG will be the entity implementing the HGMP. In this Opinion, implementation of the HGMP and the effects of the HGMP on SONCC ESU coho salmon are considered interrelated to the proposed action. As is previously described in the *Background and Consultation History* chapter of this biological opinion, issuance of an ESA section 10(a)(1)(A) permit for IGH coho propagation program along with the HGMP will undergo its own separate NMFS intra-service formal consultation and resultant biological opinion.

2.2.3.2 Goal II: Enhance Coho Salmon Spawning Habitat Downstream From Iron Gate Dam

a. Gravel Augmentation

A specific conservation measure is proposed in the HCP to improve the recruitment of gravel to the Klamath River downstream of IGD. Gravel augmentation as contemplated in the HCP will occur in phases: (1) one year to develop an augmentation plan, and (2) implementation of the plan, including monitoring and augmentation adjustments if necessary. The gravel augmentation plan, which will be reviewed by CDFG and NMFS prior to finalization, will include the following:

- An evaluation of its intended purpose,
- An evaluation of the current conditions of suitable spawning gravel from IGD to the confluence of the Shasta River,
- A determination of appropriate make-up (i.e., composition of sediment sizes and proportions in the mix) and amounts of gravels to be augmented, and
- Recommended techniques and locations for gravel placement

Gravel augmentation in the Klamath River downstream from IGD will be implemented annually in accordance with a gravel augmentation plan. The biological objective of gravel augmentation will be to provide 500 cubic yards of gravel annually in the river or a total of 3,500 cumulative cubic yards over the term of the ITP. This target is consistent with gravel augmentation measures recommended as a result of previous FERC relicensing analyses and agency recommendations (FERC 2007).

It is estimated that augmentation will occur in about 7 of the 10 years during the term of the ITP, since planning will occur during the initial year, and augmentation likely will not be required in every subsequent year of the ITP term. For example, during some years, it may not be necessary to provide any augmentation if previous gravel has remained at locations that would provide appropriate spawning habitat (e.g., during relatively dry years). Monitoring of gravel augmentation efforts would establish if the project objectives are being met and enable subsequent augmentation efforts to reflect findings from previous replenishment. Volume, location, and frequencies of recurring (approximately annually) gravel augmentation would be based on monitoring of initial gravel placements and assessment of bed mobilizing flow recurrence intervals.

The implementation of gravel augmentation will take place over the term of the ITP through the already-established CEF. The selected project(s) will comply with the provisions of the gravel augmentation plan.

2.2.3.3 Goal III: Improve Instream Flow Conditions for Coho Salmon Downstream of Iron Gate Dam

As described in the HCP, over the term of the ITP, PacifiCorp will implement measures to provide instream flows, flow variability, and flow ramp rates in the Klamath River downstream of IGD to minimize and mitigate Project-related flow effects on coho salmon. As discussed above, PacifiCorp operates the facilities from which flows are released to the Klamath River. Reclamation, which consults with NMFS on the effects of these flows, is responsible for providing a sufficient volume of water to PacifiCorp facilities to enable PacifiCorp to make water releases from IGD that will meet BiOp requirements for Reclamation's Klamath Project operations (NMFS 2010). Specific conservation actions proposed in PacifiCorp's HCP related to flow improvements and to be implemented over the term of the ITP include: (1) provide instream flow releases from IGD consistent with requirements contained in the NMFS 2010 Opinion on Reclamation's Klamath Project operations, or any new requirements for flow as a result of future consultations between NMFS and Reclamation during the interim period; (2) implement obligations under the Fall and Winter Flow Variability Program contained in the NMFS 2010 Opinion, which provides for up to 18,600 acre feet of water to be available to simulate natural flow variability at IGD; and (3) conduct maintenance actions at Iron Gate powerhouse that result in streamflow changes in a manner that adheres to the ramp rates prescribed in the NMFS 2010 Opinion, or future BiOps, to reduce potential fish stranding.

For instream flows, PacifiCorp will coordinate with Reclamation and NMFS to ensure releases from IGD are consistent with instream flow requirements stipulated in the NMFS 2010 Opinion, or future BiOps, on Reclamation's Klamath Project Operations. These consist of instream flow releases described for Reclamation's Proposed Action in the NMFS 2010 BiOp as modified by the Reasonable and Prudent Alternative (RPA). NMFS determined that the implementation of the RPA is necessary for Reclamation to avoid the likelihood of jeopardizing the continued existence of the SONCC coho salmon ESU and to avoid the destruction or adverse modification of the ESU's designated critical habitat. The RPA includes adjustments to flows from Reclamation's Proposed Action for some monthly exceedence categories (per Table 18 in the NMFS 2010 Opinion). During the interim period there is some possibility that instream flow requirements could change from the 2010 Opinion RPA through reinitiation of consultation on Reclamation's Klamath Project. It is expected that any modifications to the 2010 BiOp flow requirements will include coordination with and cooperation from PacifiCorp on such flow modifications. PacifiCorp will also coordinate with Reclamation to ensure implementation of any further adjustments to instream flow releases from IGD that may arise from related flow monitoring activities as stipulated in the Terms and Conditions of the NMFS 2010 Opinion.

PacifiCorp will coordinate with Reclamation to ensure implementation of the Fall and Winter Flow Variability Program (Flow Variability Program) as described in the NMFS 2010 Opinion, or any future BiOps. As described in RPA element A(1) of the NMFS 2010 Opinion, the Flow Variability Program will provide up to 18,600 acre-feet of water in the fall and winter period to simulate short-term flow increases from significant precipitation runoff events that would naturally occur at the point of IGD release. PacifiCorp intends to implement this measure within the operational capabilities of the existing Project without the need for construction of new equipment or the addition of new personnel.

NMFS has developed a recommended Flow Variability Protocol to assist in the implementation of the Flow Variability Program (NMFS 2010b). Under RPA A(1) of the NMFS 2010 Opinion, a flow variability team (Team), comprised of technical staff from NMFS, Reclamation, PacifiCorp, USFWS, NOAA Weather Service, U.S. Geological Service, CDFG and the Karuk, Hoopa Valley, and Yurok Tribes is charged with making recommendations to Reclamation to enhance flow variability between September 1 and March 1. Team recommendations may include all components of the hydrological response, including the ascending and descending limb of the hydrograph and the duration of peak flows resulting from precipitation runoff events, as well as Team recommendations for flow protocols and procedures which may change during the course of Reclamation's Project operations as new and improved methodology becomes available for use. The flow plan would be developed in a manner consistent with PacifiCorp's existing license requirements (e.g., ramping restrictions, minimum flow requirements, if any) as well as NMFS' 2010 Opinion, and would contain exceptions for forced and planned outages (such exceptions include unforeseeable equipment malfunctions or failures and foreseeable events, such as powerhouse maintenance, dam and spillway repairs, and other planned maintenance activities).

PacifiCorp will undertake maintenance actions at Iron Gate powerhouse to maintain flow ramp rates as specified in the NMFS 2010 BiOp. These ramp rates are designed to avoid or reduce potential stranding of fish that might otherwise occur due to flow changes from Project operations (as specified in NMFS 2010). The ramp rates specify that, if flows are greater than 1,750 cfs, but less than 3,000 cfs, the rate at which flows can be decreased will be no more than 300 cfs in 24 hours and no more than 125 cfs in any 4-hour period. If flows are less than or equal to 1,750 cfs, the rate at which flows can be decreased will be no more than 150 cfs in 24 hours and no more than 50 cfs in any 2-hour period.

The NMFS 2010 Opinion does not contain specific daily or hourly ramp rates when the flow release at IGD is greater than 3,000 cfs. The NMFS 2010 Opinion assumes Reclamation's proposed approach that the ramp-down of flows greater than 3,000 cfs should mimic natural hydrologic conditions of the basin upstream of IGD. PacifiCorp will coordinate with Reclamation to ensure that the ramp-down of flows greater than 3,000 cfs is done to be consistent with natural hydrologic conditions, as well as other safety considerations.

2.2.3.4 Goal IV: Improve Water Quality for Coho Salmon Downstream of Iron Gate Dam

In order to improve dissolved oxygen (DO) conditions downstream of IGD, PacifiCorp has proposed to continue to implement turbine venting operations at the Iron Gate powerhouse. Turbine venting is a specific conservation measure proposed in the HCP to improve water quality conditions for coho salmon in Klamath River downstream of IGD. The turbine venting measure is based on previous evaluations performed by PacifiCorp that demonstrated an increase in dissolved oxygen by up to about 2 mg/L and 20 percent saturation in the Klamath River below Iron Gate powerhouse when the turbines were vented (Carlson and Foster 2008, PacifiCorp 2012).

The turbine venting measure is based on achieving the stated biological objective of maintaining dissolved oxygen concentrations at or above 85 percent saturation in the Klamath River from the dam to the IGH bridge during the period from June 15 to September 30. Turbine venting is to be triggered at a dissolved oxygen saturation level of 87 percent in order to provide a margin of safety that helps ensure that dissolved oxygen levels do not fall below 85 percent. Turbine venting uses an air admission valve to allow the induction of air into the water passageways within the turbine to aerate the releases from the Iron Gate powerhouse. As the admitted air travels through the draft tube and into the powerhouse tailwaters, a fraction of the oxygen (and nitrogen) goes into solution, increasing dissolved oxygen (and dissolved nitrogen).

PacifiCorp is currently conducting additional testing and evaluation of turbine venting configurations and settings. The proposed action provides that upon permit issuance, PacifiCorp will finalize and implement a turbine venting plan, utilizing results from additional testing and will submit the final turbine venting plan to NMFS for review and approval, and will develop standard operating procedures in consultation with NMFS for on-going turbine venting and concurrent monitoring of dissolved oxygen conditions. NMFS expects turbine venting under the HCP will begin under a defined and approved plan by mid-2013 at the latest.

2.2.3.5 Goal V: Reduce Disease Incidence and Mortality in Juvenile Coho Salmon Downstream of Iron Gate Dam

The NMFS 2007 BiOp (NMFS 2007) indicated that Project reservoirs may contribute to the conditions favoring the population of *Manayunkia speciosa*, the intermediate polychaete host for the disease pathogens *Ceratomyxa shasta* and *Parvicapsula minibicornis* that impact coho salmon populations inhabiting the Klamath River below IGD. A specific conservation measure is included in the HCP to fund research to help improve understanding and management of conditions to reduce disease. PacifiCorp will implement the Klamath River Fish Disease Research Fund to proactively solicit and fund fish disease research projects to enhance understanding and fill knowledge gaps related to factors and conditions causing disease in coho salmon in the Klamath River. PacifiCorp will work with the Klamath River Fish Health Workgroup to identify research projects that address key scientific questions concerning fish disease and the survival and recovery of listed coho salmon in the Klamath River basin. These projects will be funded and implemented within the term of the ITP and the results used to inform management and further research decisions.

The HCP also indicates that the conservation measures related to the gravel augmentation and fall/winter flow variability (as described above) are expected to be designed to improve scour of the habitat of the disease host *M. speciosa*.

2.2.3.6 Goal VI: Enhance Migratory and Rearing Habitat for Coho Salmon in the Klamath River Mainstem Corridor

Conservation actions are proposed in the HCP to improve the quality and carrying capacity of refugia and rearing habitats along the mainstem Klamath River downstream of IGD. These conservation actions are based on achieving objectives to: (1) improve the quality and carrying capacity of thermal refugia along the Klamath mainstem downstream of IGD, (2) enhance coho juvenile rearing habitat in the mainstem Klamath River corridor downstream of IGD, and (3) increase the abundance of large woody debris (LWD) in the Klamath River downstream of IGD to contribute to the river's habitat elements and habitat forming features.

a. Refugia

For achieving the first objective, projects and actions will include maintenance and possible additions of cover features at thermal refugia sites to enhance and protect habitat suitability and carrying capacity for rearing juvenile coho salmon along the Klamath River. The specific biological objectives for refugia in the HCP include the following:

(1) Improve habitat cover and complexity (by about 30 to 50 percent of the total existing cover) or maintain habitat cover and complexity (if already suitable) at 28 coldwater refugia sites along the mainstem Klamath River, and

(2) Increase the extent and/or duration (by about 30 to 50 percent of the total existing extent and/or duration) of nine coldwater refugia sites along the Klamath River

Activities to add or enhance cover features will include riparian plantings, and placements of boulders, large woody debris, and brush bundles. The sites identified in the HCP include seven refugia sites in the Upper Klamath coho salmon population area and 21 refugia sites in the Middle Klamath coho salmon population area as shown in Figures 3 and 4 (indicated as symbol numbers 19-25 in Figure 3 and 36-56 in Figure 4).

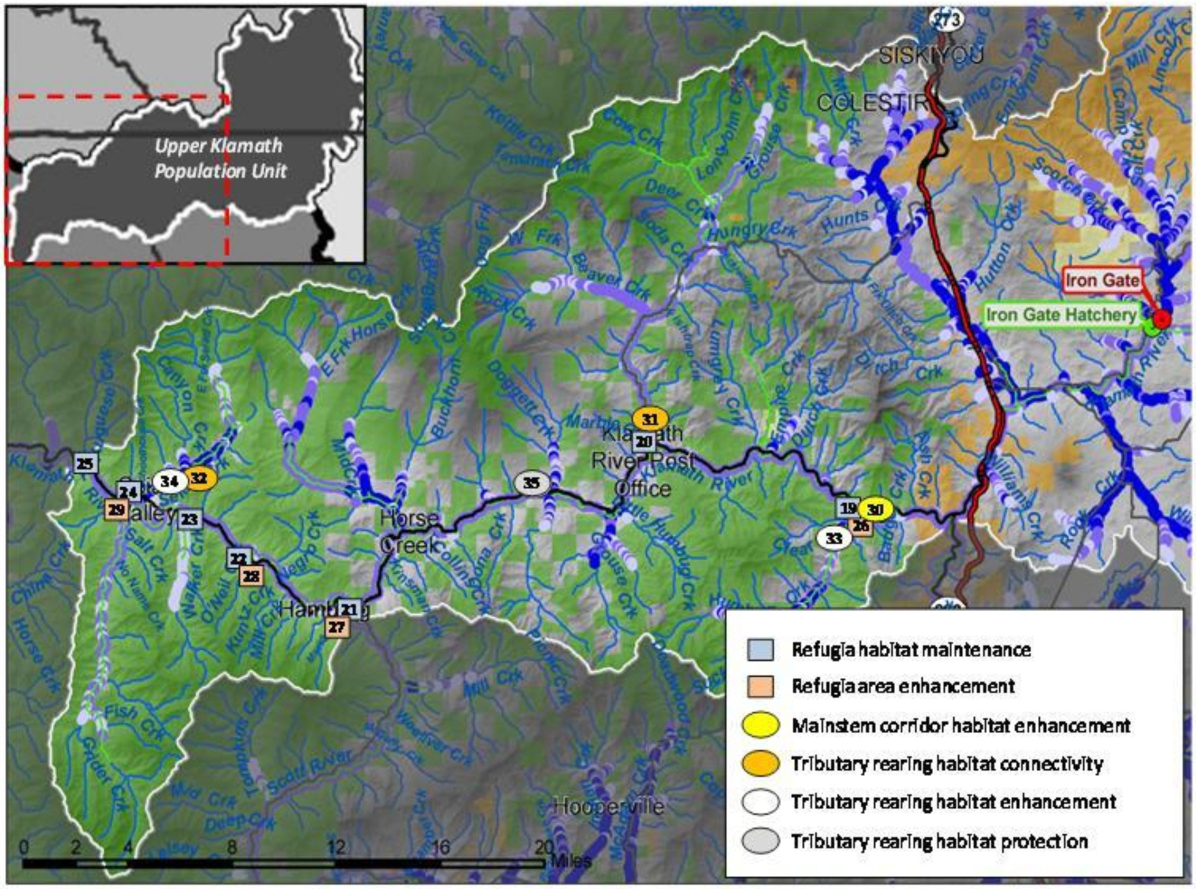

Figure 3. Locations for actions proposed in PacifiCorp's HCP in the Upper Klamath Population Unit related to thermal refugia habitat, mainstem corridor rearing habitat, and tributary rearing habitat. (Source: NMFS Northern California Office, 2011).

Actions to be implemented also will include additional projects to increase the extent or duration of specific refugia habitat sites through activities such as channel re-alignment, increasing the flow from tributaries to refugia, or adding structures at refugia sites. The additional sites identified in the HCP include four refugia sites in the Upper Klamath coho salmon population area and five refugia sites in the Middle Klamath coho salmon population area as shown in Figures 3 and 4 (indicated as symbol numbers 26-29 in Figure 3 and 57-61 in Figure 4). The HCP explains that these particular thermal refugia sites were considered most feasible and accessible to address the first objective based on prioritization by the Mid Klamath Coho Rearing Habitat Enhancement Project (conducted as a 2009 CEF Project). The actual sites used to achieve this objective may be different than those listed above. NMFS will participate, via the TRT, in the selection of sites to achieve the conservation goal, and expects that all sites selected will have similar values for coho conservation via improved rearing conditions.

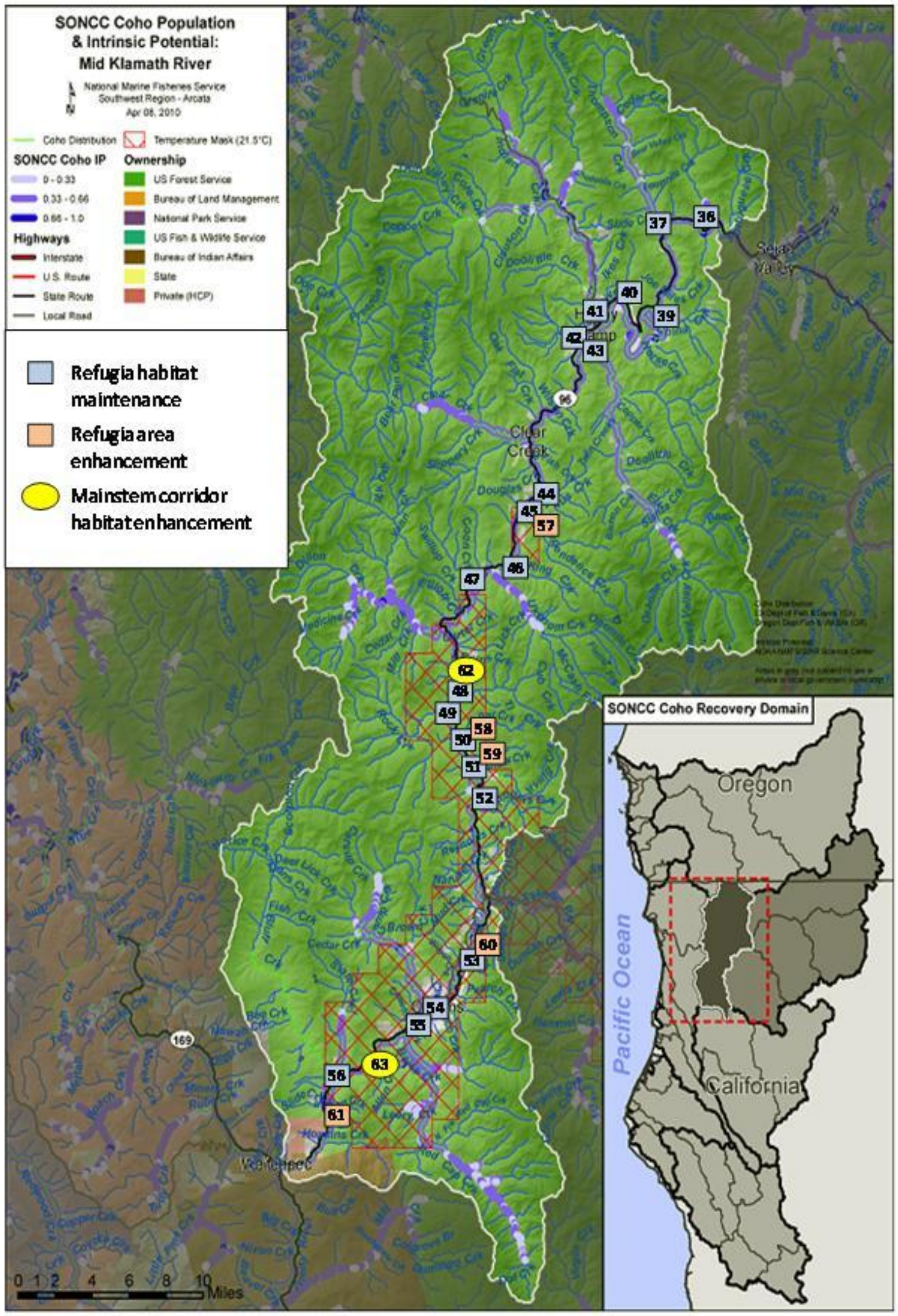

Figure 4. Locations for actions proposed in PacifiCorp's HCP in the Middle Klamath Population Unit related to thermal refugia habitat and mainstem corridor rearing habitat. (Source: NMFS Northern California Office, 2011).

b. Mainstem Rearing Habitat Enhancement

For achieving the second objective, projects and actions to be implemented over the term of the ITP will include enhancement activities at mainstem coho salmon rearing habitat locations, including side channels, or off-channel habitats (alcoves, ponds, and groundwater channels associated with the floodplain). The specific biological objective for this conservation measure is:

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

Examples of such enhancement activities include alcove or pond deepening, riparian planting, and placements of boulders, large woody debris, and brush bundles. The sites identified in the HCP include eight mainstem rearing sites in the Upper, Middle, and Lower Klamath coho salmon population areas as shown in Figures 3, 4, and 5 (indicated as symbol numbers 30 in Figure 3, 62 and 63 in Figures 4, 64-68 in Figure 5). The HCP explains that two of these particular mainstem rearing sites near Humbug and Ti Creek are presently considered most feasible and accessible to address the second objective of this goal based on prioritization by the Mid Klamath Coho Rearing Habitat Enhancement Project (2009 CEF Project) and consultation with the Yurok Tribe. Alternatively, pending additional planning and assessment, six other sites are identified that are also being considered for implementation during the interim. The actual sites used to achieve this objective may be different than those listed above. However, possible adjustments in sites are expected to result in similar value for coho salmon.

The projects proposed in the HCP to achieve the first and second objectives (related to Goal VI) as described above will be implemented through the already-established CEF. The process for funding, selection, administration, and implementation of projects under the CEF is described above in the section on proposed passage and access-related activities (related to Goal I). The CEF process also is described in further detail in the HCP.

c. Large Woody Debris (LWD)

For achieving the third objective, PacifiCorp will retrieve LWD trapped at or near Iron Gate, Copco 1, and Copco 2 dams, and release retrieved LWD pieces[3] to the river channel below IGD. The specific biological objective for this conservation measure consists of the following:

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

PacifiCorp will conduct retrieval and release of LWD trapped at or near Project dams on a quarterly basis as a part of PacifiCorp's Project maintenance activities. PacifiCorp will conduct initial planning to determine timing of retrieval and location of release below IGD based on feasibility, access, and efficiency considerations. PacifiCorp will also evaluate retrieval and release of LWD to ensure consistency with and adherence to applicable regulatory requirements. The HCP indicates that a potential alternative use of LWD retrieved at the dams may be to serve as elements for habitat enhancement projects conducted under other habitat-related HCP conservation measures (e.g., enhancement of thermal refugia areas as described above). Such alternative use of LWD retrieved at the dams will be determined in coordination with NMFS and CDFG as habitat enhancement projects are selected for implementation and funding under the CEF.

[3] The definition of LWD in the context of this conservation measure encompasses pieces of large wood greater than 16 inches in diameter and 15 feet in length.

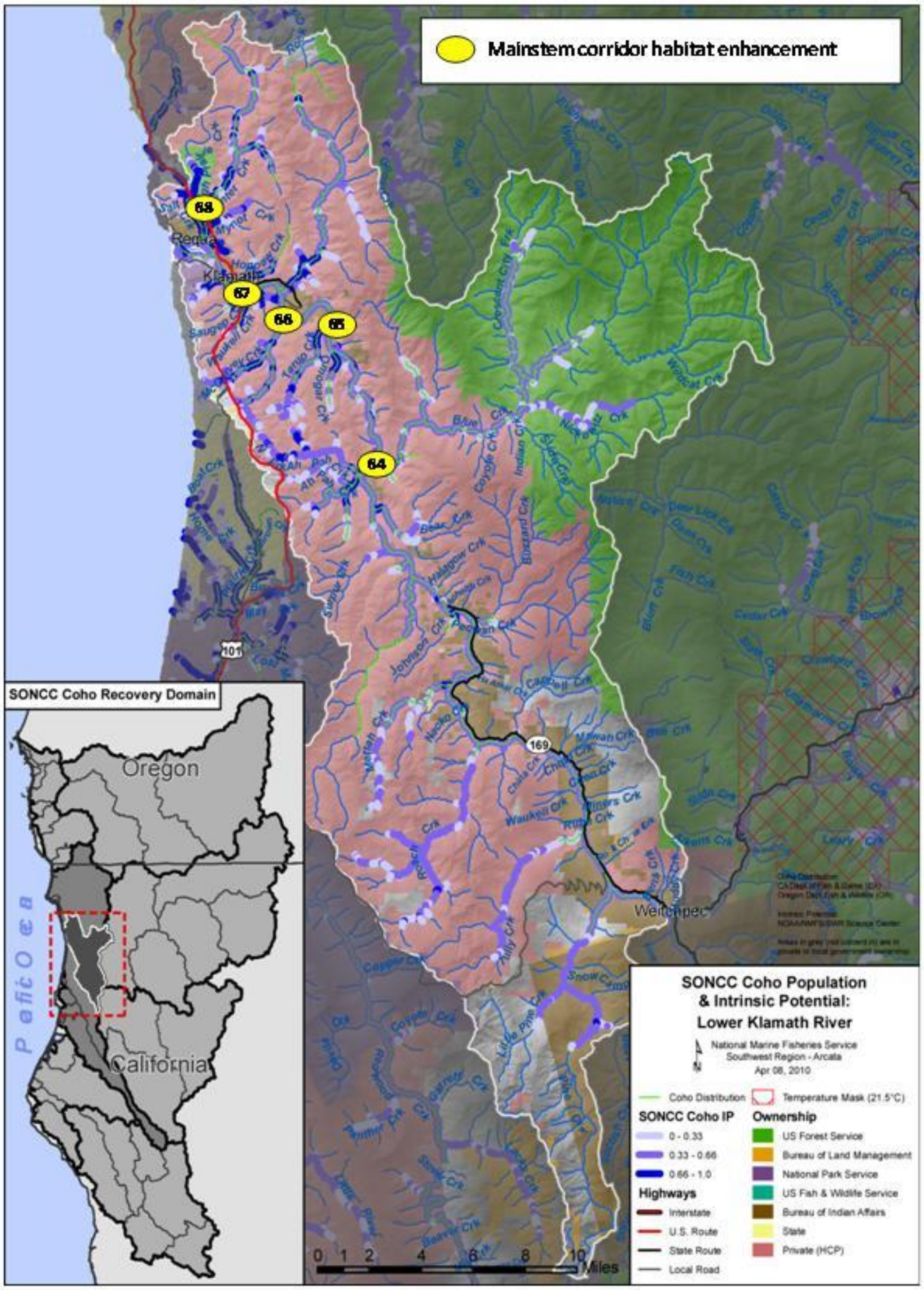

Figure 5. Locations for actions proposed in PacifiCorp's HCP in the Lower Klamath Population Unit related to mainstem corridor rearing habitat. (Source: NMFS Northern California Office, 2011).

2.2.3.7 Goal VII: Enhance and Expand Rearing Habitat for Coho Salmon in Key Tributaries

Conservation actions are proposed in the HCP to improve rearing habitat for coho salmon in key tributaries of the Klamath River downstream of IGD. These conservation actions are based on achieving objectives to: (1) restore connectivity in certain stream reaches providing juvenile rearing habitat in key tributaries; (2) fund a water transaction program to provide flow augmentation in key reaches used for coho spawning and juvenile rearing in key tributaries; and (3) protect or enhance rearing habitat conditions in key tributaries.

a. Connectivity

For achieving the first objective, projects and actions will be implemented over the term of the ITP at selected locations associated with key tributaries to eliminate flow-related impediments and provide connectivity between coho habitats. The specific biological objectives for this conservation measure include the following:

(1) Restore connectivity in 10 stream reaches of juvenile rearing habitat in tributaries of the Upper Klamath, Scott River, and Shasta River, and

(2) Fund a water transaction program to provide flow augmentation in key reaches used for coho spawning and juvenile rearing in tributaries of the Upper Klamath, Scott River, and Shasta River

Sufficient streamflows for coho spawning, shelter, feeding, and migration are comprised of suitable water depths, velocities, and cover conditions to allow connected movements and use within tributary habitats. Projects to protect or restore connectivity would include removal or functional upgrades of diversion structures or screens, channel modifications or impediment removal to improve flow and access.

Specific sites to achieve the first biological objective identified in the HCP include sites prioritized in consultation with key stakeholders involved in the planning and implementation of these projects. Stakeholders included the Mid-Klamath Watershed Council, Karuk Tribe, Shasta Valley Resource Conservation District, and Siskiyou County Resource Conservation District. These projects and sites include fish access and connectivity projects in key reaches in Beaver Creek and Seiad Creek in the Upper Klamath population area (indicated as symbol numbers 31-32 in Figure 3); Little Shasta Creek, Parks Creek, and the mainstem Shasta River in the Shasta River population area (indicated as symbol numbers 69-71 in Figure 6); and Shackleford Creek, Mill Creek, French Creek, East Fork, and the mainstem Scott River in the Scott River population area (indicated as symbol numbers 75-79 in Figure 7). The actual sites used to achieve this objective may be different than those listed above as sites will be determined via selection in consultation with the TRT annually throughout the permit. NMFS believes selected sites will have similar values for coho conservation via enhancement and expansion of rearing habitat through actions that restore or improve connectivity between rearing habitats. Possible adjustments in sites are expected to result in similar value for coho salmon.

To achieve the second biological objective, an emergency water transaction program will be implemented to increase instream flows for passage to and from key tributary rearing areas. The emergency water transaction program will be implemented by providing the Scott and Shasta Water Trusts, and other water transaction programs, with funding at key times when rearing or spawning are impaired by flows. For example, funds from the CEF would be available for temporary leases of water from those with active water rights to keep water instream for the benefit of coho juveniles. The water enhancement program will also provide prioritization and pricing for water transactions in the Scott, Shasta, and Upper Klamath. The program will help prevent seasonal and temporary fish passage barriers and improve water quality in key rearing and spawning areas. For water transaction projects, NMFS and CDFG will jointly recommend final projects and actions. PacifiCorp will then evaluate the recommendations and make approvals based on consistency with the HCP and other requirements.

b. Tributary Rearing Habitat Enhancement

For achieving the third objective, projects and actions will be implemented over the term of the ITP at selected locations associated with key tributaries to protect and enhance coho rearing habitats. Enhancement projects are expected to include such actions as channel reconstruction, floodplain connection, off-channel habitat creation and connection, and beaver introduction or protection. Protection projects will include fencing to protect riparian areas and streambanks along reaches that provide important summer rearing habitat. Specific sites for rearing habitat enhancement actions identified in the HCP include Humbug Creek and Seiad Creek (tributaries to the Upper Klamath), Shackleford Creek and French Creek (tributaries to the Scott River), and the mainstem Shasta River (indicated as symbol numbers 33-34 in Figure 3, 72 in Figure 6, and 80-81 in Figure 7). Specific sites for protection (i.e., riparian fencing) actions identified in the HCP include McKinney Creek (tributary of the Upper Klamath), the mainstem Shasta River and Little Shasta River, and Shackleford Creek and French Creek (tributaries to the Scott River) (indicated as symbol numbers 35 in Figure 3, 73-74 in Figure 6, and 82-83 in Figure 7). The actual sites used to achieve this objective may be different than those listed above as sites will be determined via consultation with the TRT annually throughout the permit. NMFS believes selected sites will have similar values for coho conservation via protection and enhancement of rearing habitat. Possible adjustments in sites are expected to result in similar value for coho salmon.

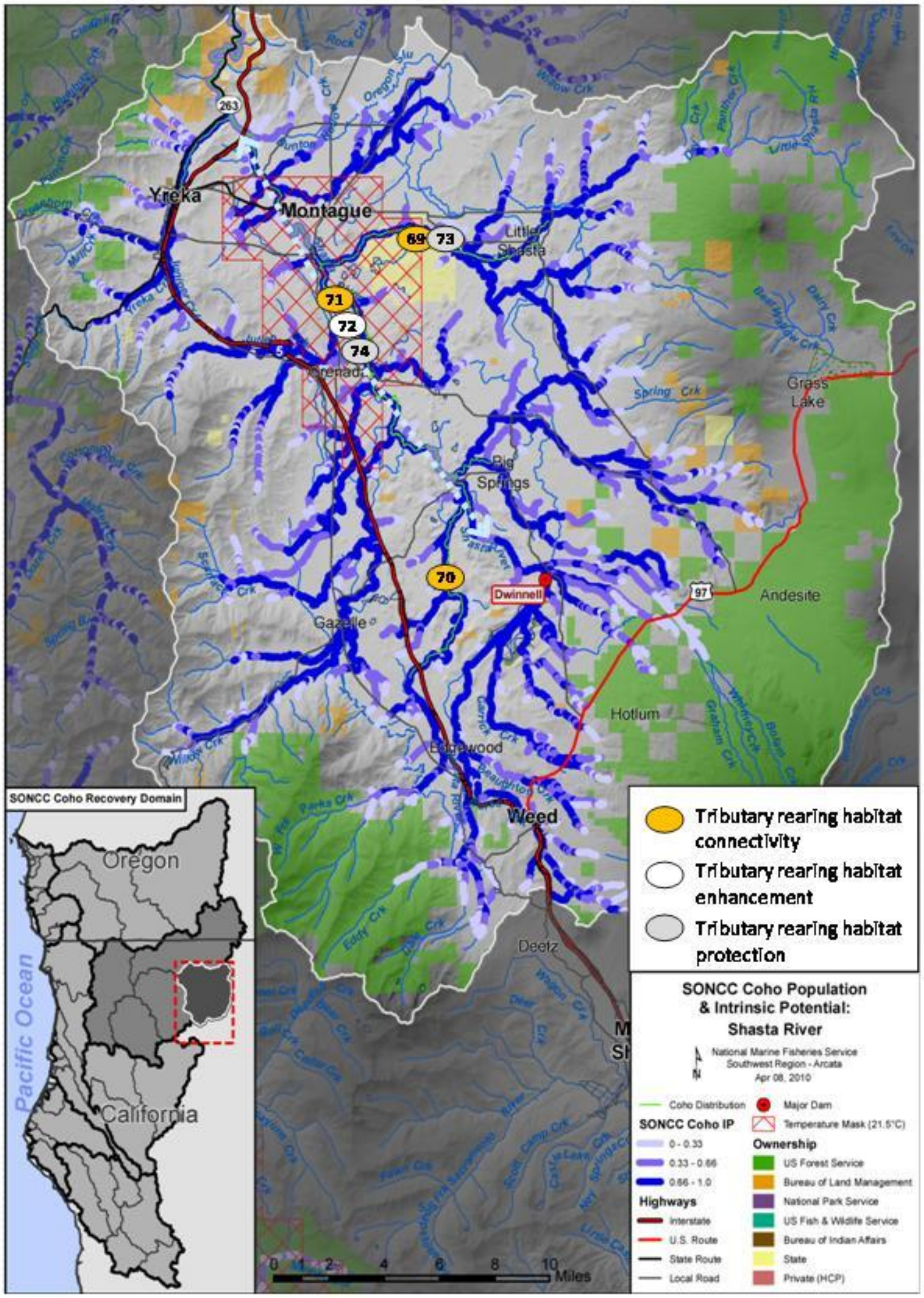

Figure 6. Locations for actions proposed in PacifiCorp's HCP in the Shasta River Population Unit related to rearing habitat connectivity, protection, and enhancement. (Source: NMFS Northern California Office, 2011).

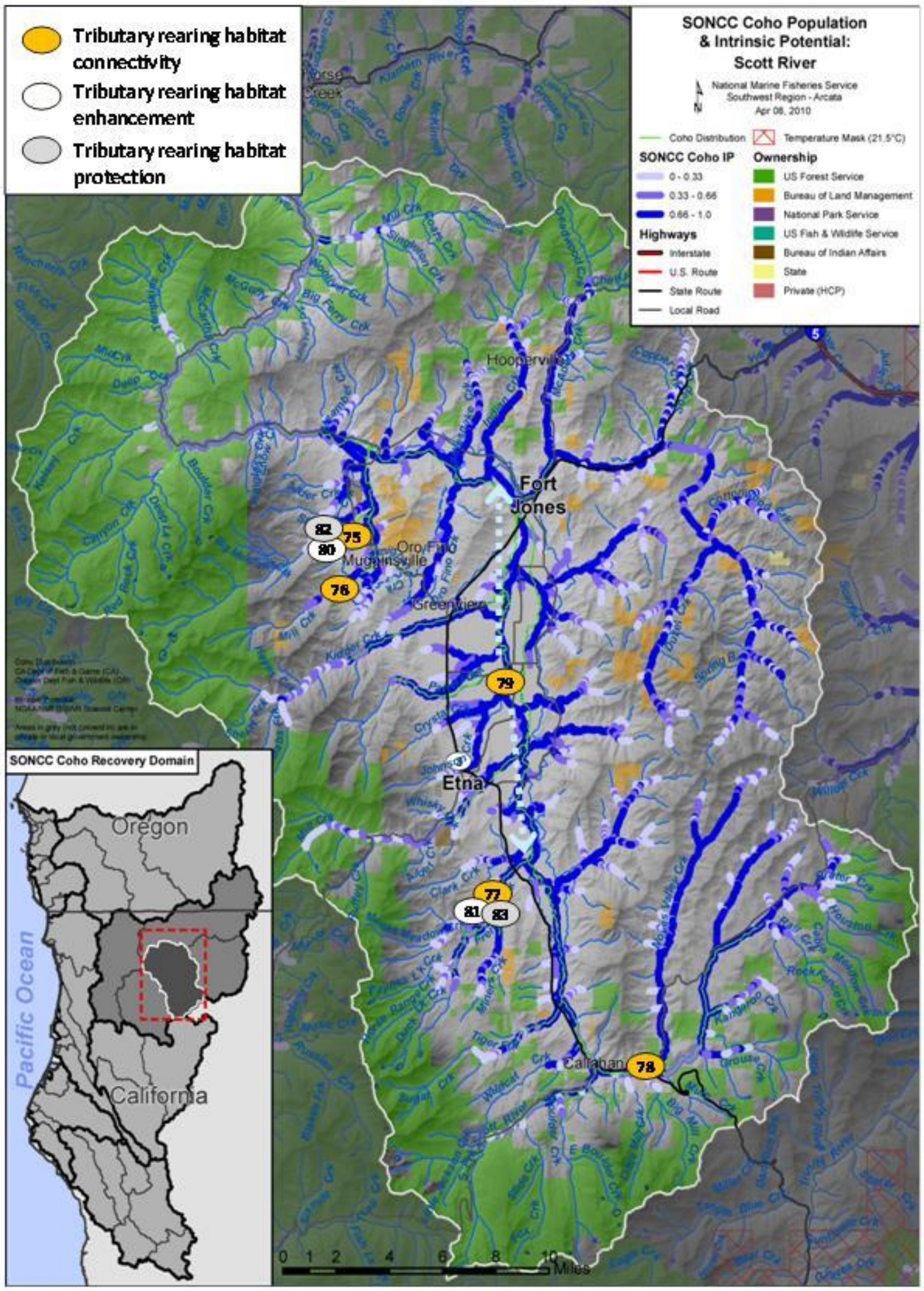

Figure 7. Locations for actions proposed in PacifiCorp's HCP in the Scott River Population Unit related to rearing habitat connectivity, protection, and enhancement. (Source: NMFS Northern California Office, 2011).

These projects to achieve connectivity and key tributary rearing habitat, or to enhance and expand rearing habitat (related to Goal VII) as described above will be implemented through the already-established CEF. The process for funding, selection, administration, and implementation of projects under the CEF is previously described.

2.3 Habitat Conservation Plan Monitoring and Adaptive Management

Included in the HCP is a strategy for monitoring compliance and effectiveness of the conservation program as well as procedures for adaptively managing the HCP based on monitoring results or other pertinent information. The purpose of HCP monitoring and adaptive management is to ensure the biological goals and objectives of the HCP are achieved. Appendix A presents the compliance and effectiveness monitoring strategy for the HCP (PacifiCorp 2012). Essentially, all objectives of the HCP will be evaluated for whether the action(s) taken comply with the HCP, and whether the action(s) has been effective at meeting its intended purpose. For many projects this will be accomplished via before/after comparisons of habitat or other physical conditions (e.g., DO levels) at the project sites, and whether coho appear to have benefitted from the project (e.g., post-project habitat utilization surveys). PacifiCorp will compile the information and results of effectiveness monitoring as described above into an annual report to NMFS. NMFS will utilize these results to determine whether modifications to protocols or methodology are prudent to achieve HCP biological goals and objectives.

The adaptive management program outlined in the HCP (PacifiCorp 2012) includes two components: (1) convening of the TRT; and (2) an adaptive response process. The TRT formed to implement the HCP will convene at a minimum, an annual meeting to review progress and priorities for HCP-related projects and actions. At the TRT meetings, results of compliance and effectiveness monitoring will be reviewed and discussed as well as a review of upcoming projects. Based upon the TRT recommendations if sufficient projects are not available to meet HCP specific goals and objectives, the TRT will consider other projects that provide similar benefits to coho salmon and recommend adjustments in the program as necessary. The TRT may also make recommendations to adjust the program if other projects or actions that provide greater benefits to coho salmon are identified over the permit term as long as the projects adhere to the biological goals and objectives identified in the HCP. All adjustments considered as a result of adaptive management must remain within the funding limits of the CEF and associated matching NFWF contributions. NMFS and PacifiCorp will be the final authorities on whether adaptive management changes are necessary and prudent to make to achieve the conservation benefit for coho salmon in the Klamath basin expected from HCP implementation. Chapter VIII of the HCP has more detail on the adaptive management process and procedures.

2.4 Changed and Unforeseen Circumstances

The HCP includes a description of what would constitute changed and unforeseen circumstances for the ITP, as provided in NMFS' implementing regulations for ITPs at 50 CFR 222.307(g). Changed circumstances are those changes in circumstances affecting a species or geographic area covered by an HCP that can reasonably be anticipated by NMFS and plan developers and that can be planned for (e.g., the listing of new species, or a fire or other natural catastrophic event in areas prone to such events). Unforeseen circumstances are changes in circumstances affecting a species or geographic area covered by an HCP that could not reasonably have been anticipated by plan developers and NMFS at the time of plan development, and that result in a substantial and adverse change in the status of the species covered in the HCP. Should such unforeseen events occur, modifications to an HCP would only be made in accordance with procedures set forth in an Implementing Agreement. Typically, this means only changes to a conservation plan that the permittee is willing and able to do.

The PacifiCorp HCP identifies three types of changes as potential “changed circumstances.” They are:

1. Drought with a recurrence probability of 100 years as measured at IGD;
2. Flood with a recurrence probability of 100 years as measured at IGD;
3. Coho salmon disease incidence above 90% in the mainstem Klamath River.

As stated in the HCP if a changed circumstance occurs, then the following measures will be implemented:

1. If a drought or flood occurs rising to the level of a changed circumstance, NMFS may, in consultation with CDFG and PacifiCorp, adjust habitat enhancement priorities under the CEF to address these changed circumstances;
2. If a disease outbreak occurs rising to the level of a changed circumstance, NMFS may, in consultation with PacifiCorp, adjust research priorities under the Fish Disease Research Fund and CEF to address changed circumstance; and
3. If a drought occurs rising to the level of a changed circumstance, PacifiCorp will meet with Reclamation and NMFS to discuss changes to flow releases at IGD to address the changed circumstances.

Also, if a species is listed under the federal ESA subsequent to the effective date of the ITP, and that species (i) is not a Covered Species, and (ii) is affected by the Covered Activities, such listing will constitute a changed circumstance. As highlighted in the Implementing Agreement (Section 9.3) between NMFS and PacifiCorp, if a new species is listed PacifiCorp shall not have incidental take authority with respect to such newly-listed species unless and until the ITP is amended to include such species or other authorization is provided pursuant to the ESA. Upon receipt of notice of the potential listing of a species that is not a Covered Species, PacifiCorp may request the technical assistance of NMFS to (i) identify possible measures to avoid take and avoid causing jeopardy to such species; (ii) identify any modifications to the Plan that may be necessary to provide coverage for the new species; and (iii) determine whether to amend the Plan and the ITP. If these conditions occur, it is of reasonable certainty that reinitiation of intra-Service formal consultation would take place to analyze effects of the Project on the newly listed species and address any amendments to the ITP and HCP to address the newly listed species (see 50 CFR 402.16). These changes may have effects on SONCC ESU coho salmon or the newly listed species, or designated critical habitat in a manner or an extent that was not considered in this Opinion. NMFS will not be considering the listing of a new species or designation of new critical habitat further in this Opinion, as the effects of such an action are not determinable at this point and would likely require a new consultation.

Additionally, the Implementing Agreement (Section 9.4) further addresses changes in anadromous fish passage assumptions as a changed circumstance. It is reasonably certain to expect that anadromous fish passage will occur for the Project by the end of 2020 under one of two alternative processes: (1) facilities removal as provided under the KHSA; or (2) mandatory fishway prescriptions required under any new FERC license for the Project if facilities removal is not achieved under the KHSA. In the event that NMFS determines that (1) circumstances have changed and it is no longer reasonably certain that anadromous fish passage will occur for the Project by the end of 2020 as described above, and (2) the potential extension of the ITP under section 6.2.a of the Implementing Agreement would not apply to these changed circumstances, then NMFS may notify PacifiCorp that the ITP shall terminate 180 days from such notice if NMFS and PacifiCorp do not agree on specific conservation and mitigation measures that are necessary to respond to these changed circumstances. If NMFS and PacifiCorp do not agree on specific conservation and mitigation measures that are necessary to respond to these changed circumstances within 180 days from such notice, the ITP shall terminate at the end of that period. If NMFS and PacifiCorp agree on specific conservation and mitigation measures that are necessary to respond to these changed circumstances within 180 days from such notice, the ITP shall not terminate at the end of that period, and the HCP shall be modified or amended as appropriate. Should this event occur, it is of reasonable certainty that reinitiation of intra-Service formal consultation would occur as NMFS would likely be modifying the ITP in a manner that causes an effect to SONCC ESU coho salmon or critical habitat not considered in this Opinion. NMFS will not be considering the effects of such a modification and extension of the ITP further in this Opinion, as the effects of such an action are not determinable at this point and would likely require a new consultation.

All other changes in circumstances affecting a Covered Species or its habitat in the Permit Area that are not designated changed circumstances are considered not reasonably foreseeable in the context of this Plan. For purposes of this Plan such changes are Unforeseen Circumstances.

2.5 Permit and Action Area

The permit area for the ITP includes PacifiCorp's existing Project facilities and the adjacent water and land areas potentially influenced by Project maintenance and operations, including the mainstem Klamath River and reservoirs from Link River dam at the outlet of Upper Klamath Lake down to the Klamath River estuary, inclusive. The permit area encompasses PacifiCorp Project facilities that either directly or indirectly may contribute to incidental take of coho salmon downstream of IGD (current limit of anadromy). The permit area is not the same as the action area in this Opinion.

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." In this proposed action the action area is the mainstem Klamath River and tributaries downstream from IGD (RM 190.1) to the Klamath River estuary, inclusive. The action area includes the Shasta River and Scott River watersheds, as they are included in conservation measures under the Proposed Action. The action area does not include the Salmon and Trinity River tributaries to the Klamath River as the Project does not affect these watersheds, nor is it likely that conservation measures identified in the HCP's *Coho Salmon Conservation Strategy* will occur in these watersheds as the conservation strategy focuses on minimization and mitigation activities for Project effects on coho populations in the upper portion of the watershed.

The action area does not include areas above IGD as coho salmon exposure from Project related stressors, and exposure from the effects of conservation measures identified in the HCP's *Coho Salmon Conservation Strategy* will occur downstream of IGD throughout the permit term.

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. Below, NMFS outlines the conceptual framework and key steps and assumptions utilized in the jeopardy and critical habitat destruction or adverse modification analyses.

3.1 Overview of NMFS' Assessment Framework

NMFS uses a series of sequential analyses to assess the effects of federal actions, including our own, on endangered and threatened species and designated critical habitat. The first analysis identifies those physical, chemical, or biotic aspects of proposed actions that are likely to have individual, interactive, or additive direct and indirect effect on the environment (we use the term "potential stressors" for these aspects of an action).

The second step of our analyses starts by determining whether endangered species, threatened species, or designated critical habitat are likely to occur in the same space and at the same time as these potential stressors. If we conclude that such co-occurrence is likely, we then try to estimate the nature of that co-occurrence (these represent our *exposure analyses*). As part of this step, we identify the spatial extent of any potential stressors as listed species may be exposed to these stressors, and recognize that the spatial extent of those stressors may change with time (the spatial extent of these stressors where they occur and have the potential to result in exposure to listed species is the "action area" for a consultation). In this step of our analyses, if reasonably quantifiable, we try to identify the number and age (or life stage) of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent. If exposure to numbers and ages (life stage) is not reasonably quantifiable, we often conduct an exposure analysis on the habitat affected by the proposed action as a surrogate for number of individuals and age structure.

Once we identify which listed resources (endangered and threatened species and designated critical habitat) are likely to be exposed to potential stressors associated with an action and the nature of that exposure, in the third step of our analyses we examine the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure (these represent our *response analyses*). Responses to stressors and exposure can be adverse, or in the long term, beneficial. In the final steps of our analyses we establish the risks those responses pose to ESA listed species and designated critical habitat (these represent our *risk analyses*).

3.1.1 Risk Analyses for Endangered and Threatened Species

Our jeopardy determinations must be based on an action's effects on the continued existence of threatened or endangered species as those "species" have been listed, which can include true biological species, subspecies, or distinct population segments of vertebrate species. Because the continued existence of listed species depends on the fate of the populations that comprise them, the viability (that is, the probability of extinction or probability of persistence) of listed species depends on the viability of the populations that comprise the species. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them; populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so).

Our risk analyses reflect these relationships between listed species and the populations that comprise them, and the individuals that comprise those populations. Our risk analyses begin by identifying the probable responses of listed individuals that are likely to be exposed to an action's effects. We then integrate those individuals' responses to identify consequences to the populations those individuals represent. Our analyses conclude by determining the consequences of those population-level response to the extinction risk of the species those populations comprise.

We measure risks to listed individuals using the individual's current or expected future reproductive success which integrates survival and longevity with current and future reproductive success. In particular, we examine the scientific and commercial data available to determine if an individual's probable response to stressors produced by an action would reasonably be expected to reduce the individual's current or expected future reproductive success by increasing the individual's likelihood of dying prematurely, having reduced longevity, increasing the age at which individuals become reproductively mature, reducing the age at which individuals stop reproducing, reducing the number of live births individuals produce during any reproductive bout, reducing the number of times an individual is likely to reproduce over its reproductive lifespan (in animals that reproduce multiple times), or causing an individual's progeny to experience any of these phenomena (Brommer 2000, Brommer *et al.*1998, 2002, Clutton-Brock 1998, Coulson et al. 2006, Kotiaho et al. 2005, McGraw and Caswell 1996, Newton and Rothery 1997, Oli and Dobson 2003, Roff 2002, Stearns 1992, Turchin 2003).

When individual, listed animals are expected to experience reductions in their current or expected future reproductive success or experience reductions in the rates at which they grow, mature, or become reproductively active, we would expect those reductions to also reduce the abundance, reproduction rates, and growth rates (or increase variance in one or more of these rates) of the populations those individuals represent (see Stearns 1992). Reductions in one or more of these variables (or one of the variables we derive from them) is a *necessary* condition for reductions in a population's viability, which is itself a *necessary* condition for reductions in a species' viability. On the other hand, when listed animals exposed to an action's effects are *not* expected to experience reductions in fitness, we would not expect the Action to have adverse consequences on the viability of the populations those individuals represent or the species those populations comprise (Anderson 2000, Mills and Beatty 1979, Stearns 1992). If we conclude that listed animals are *not* likely to experience reductions in their fitness, we would conclude our assessment.

If, however, we conclude that listed animals are likely to experience reductions in their current or expected future reproductive success, our assessment tries to determine if those reductions are likely to be sufficient to reduce the viability of the populations those individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, or variance in these measures to make inferences about the population's extinction risks). In this step of our analyses, we use the population's base condition (established in the *Environmental Baseline* and *Status of the Species* sections of this Opinion) as our point of reference. Finally, our assessment tries to determine if changes in population viability are likely to be sufficient to reduce the viability of the diversity groups and species those populations comprise. In this step of our analyses, we use the species' status (established in the *Status of the Species* section of this Opinion) as our point of reference. The primary advantage of this approach is that it considers the consequences of the response of endangered and threatened species in terms of fitness costs, which allows us to assess how particular behavioral decisions are likely to influence individual reproductive success (Bejder et al. 2009). Individual-level effects can then be translated into changes in demographic parameters of populations, thus allowing for an assessment of the biological significance of particular human disturbances.

Biological opinions, then, distinguish among different kinds of adverse or beneficial effects. First, we focus on potential physical, chemical, or biotic stressors that are important in the sense of being distinct from ambient or background stressors (e.g., natural predation). We then ask if exposing individuals to additional potential stressors is likely to (1) represent adverse responses in the life of individuals that have been exposed; (2) exposing individuals to those potential stressors is likely to cause the individuals to experience physical, chemical, or biotic responses that can impact growth and survival of various life stages; and (3) any physical, chemical, or biotic responses are likely to have adverse or beneficial consequences for the overall fitness of the individual animal leading to chronic or acute mortality, or in the reverse, result in improved fitness of individuals.

For populations (or sub-populations, demes, etc.), we are concerned about whether the number of individuals that experience reductions in fitness and the nature of any fitness reductions are likely to have clinical or biological consequences for the viability (i.e. probability of demographic, ecological, or genetic extinction) of the population(s) those individuals represent.

Our considerations of whether populations of endangered or threatened species are likely to experience reductions in viability as a result of reductions in the fitness of individuals that are members of those populations considers the process by which species decline, collapse, become extinct, or recover from endangerment. That process consists of several phases – instability, decline, collapse, small dynamics, terminal, and recovery phases – and populations exhibit different dynamics, tendencies, and patterns of behavior in these phases. Those dynamics, tendencies, and patterns of behavior influence, in whole or in part, whether reductions in the fitness of a small number of individuals would or would not be expected to reduce the viability of the population(s) and diversity groups those individuals represent or of the species those populations comprise. Nevertheless, the decline, collapse, and extinction of existing populations is symptomatic of a species that is incrementally approaching extinction; therefore, if we conclude that one or more populations of an endangered or threatened species are likely to experience increased extinction risk as a result of a proposed action, and that such a decline in populations is likely to compromise the viability of a diversity group, as in the case of salmon ESU's, we can assume that the action agency has failed to insure that a proposed action is not likely to jeopardize the continued existence of the species those populations comprise.

3.1.1.1 Viable Salmonid Populations Framework for Coho Salmon

In order to assess the survival and recovery of any species, a guiding framework that includes the most appropriate biological and demographic parameters is required. For Pacific salmon, McElhany et al. (2000) defines a *Viable Salmonid Population* (VSP) as an independent population that has a negligible probability of extinction over a 100-year time frame. The VSP concept provides specific guidance for estimating the viability of populations and larger-scale groupings of Pacific salmonids such as Evolutionarily Significant Unit (ESU) or Distinct Population Segment (DPS). Four VSP parameters form the key to evaluating population and ESU/DPS viability: (1) abundance; (2) productivity (*i.e.*, population growth rate); (3) population spatial structure; and (4) diversity (McElhany et al. 2000). Therefore, these four VSP parameters were used to evaluate the extinction risk of the SONCC coho salmon ESU.

A viable population (or species) is not necessarily one that has recovered as defined under the ESA. To meet recovery standards, the species may need to achieve higher levels of resiliency to allow for activities such as commercial harvest and the existing threat regime would need to be abated or ameliorated as detailed in a recovery plan. As a result, we evaluate the current status of the species to diagnose how near, or far, the species is from this viable state because it is an important metric indicative of a self-sustaining species in the wild, but we also consider the ability of the species to recover in light of its current condition and the status of the existing and future threat regime. Generally, NMFS folds this consideration of current condition and ability to recover into a conclusion regarding the "risk of extinction" of the population or species.

We equate the risk of extinction of the species with the "likelihood of both the survival and recovery of the species in the wild" for purposes of conducting jeopardy analyses under section 7(a)(2) of the ESA because survival and recovery are conditions on a continuum with no bright dividing lines. Similar to a species with a low likelihood of both survival and recovery, a species with a high risk of extinction does not equate to a species that lacks the potential to become viable. Instead, a high risk of extinction indicates that the species faces significant risks from internal and external processes and threats that can drive a species to extinction. Our jeopardy assessment, therefore, focuses on whether a proposed action appreciably increases extinction risk, which is a surrogate for appreciable reductions in the likelihood of survival and recovery. NMFS uses the general life cycle approach outlined by the VSP report (McElhany et al. 2000) in this Opinion. NMFS uses the concepts of VSP as an organizing framework in this Opinion to systematically examine the complex linkages between project effects and VSP parameters while also considering and incorporating natural risk factors such as climate change and ocean conditions. These VSP 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 coho salmon (McElhany et al. 2000). These four parameters are consistent with the "reproduction, numbers, or distribution" criteria found within the regulatory definition of jeopardy (50 CFR 402.02) and are used as surrogates for numbers, reproduction, and distribution. The fourth VSP parameter, diversity, relates to all three jeopardy criteria. For example, numbers, reproduction, and distribution are all affected when genetic or life history variability is lost or constrained, resulting in reduced population resilience to environmental variation at local or landscape-level scales.

Along with the VSP concept, NMFS uses a conceptual model of the species to evaluate the potential effect of a proposed action. For the SONCC coho salmon ESU, the conceptual model is based on a bottom-up hierarchical organization of individual fish at the life stage scale, population, diversity stratum, and ESU (Figure 8). The guiding principle behind this conceptual model is that the viability of a species (*e.g.*, ESU) is dependent on the viability of the diversity groups that compose that species and the spatial distribution of those groups; the viability of a diversity group is dependent on the viability of the populations that compose that group and the spatial distribution of those populations; and the viability of the population is dependent on the four VSP parameters, and on the fitness and survival of individuals at the life stage scale. SONCC ESU coho salmon life cycle includes the following life stages and behaviors, which will be evaluated for potential effects resulting from the proposed action: adult migration, spawning, embryo incubation, juvenile rearing, and smolt outmigration.

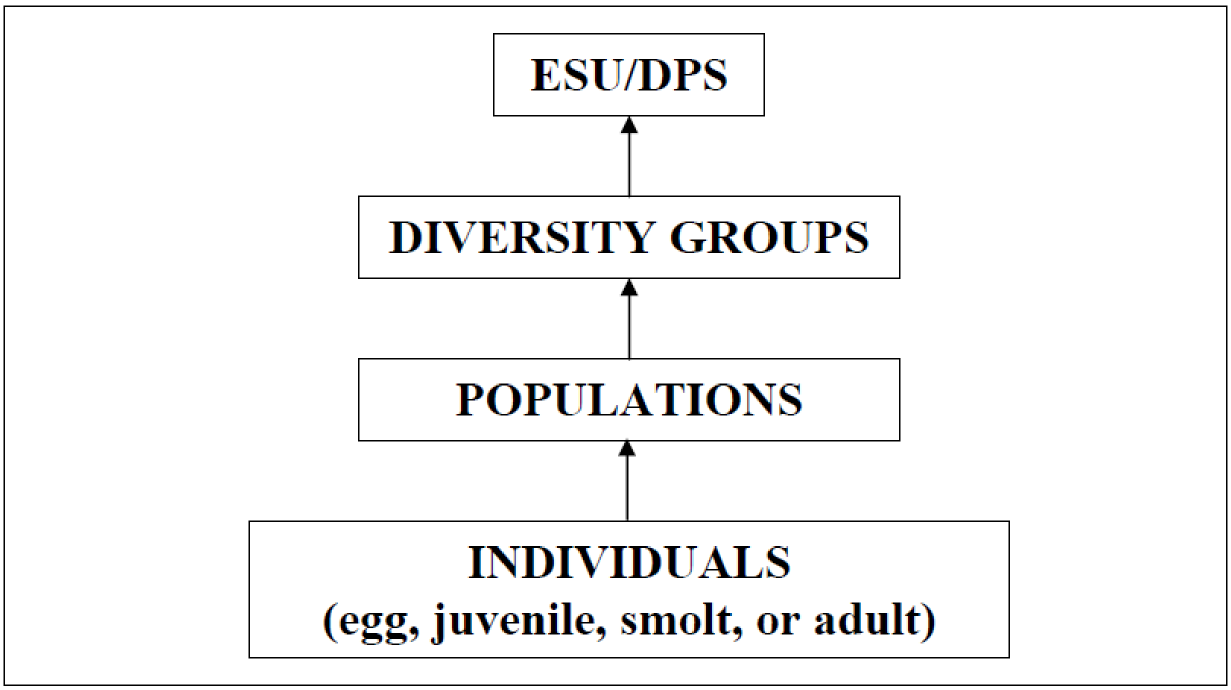

Figure 8. Conceptual model of the hierarchical structure that is used to organize the jeopardy risk assessment for SONCC ESU coho salmon.

3.1.2 Risk Analyses for Designated Critical Habitat

Our "destruction or adverse modification" determinations are based on an action's effects on the conservation value of habitat that has been designated as critical to threatened or endangered species[4]. If an area encompassed in a critical habitat designation is likely to be exposed to the

[4] We are aware that several courts have ruled that the definition of destruction or adverse modification that appears in the ESA section 7 implementing regulations at 50 CFR 402.02 is invalid and we do not rely on that definition for the determinations we make in this Opinion. Instead, as we explain in the text, we use the "conservation value" of critical habitat for our determinations which focuses on the designated area's ability to contribute to the conservation of the species for which the area was designated.

direct or indirect consequences of the proposed action on the natural environment, we ask if primary constituent elements or essential features included in the designation or physical, chemical, or biotic phenomena that give the designated area value for the conservation are likely to respond to that exposure.

In this step of our assessment, we must identify (a) the spatial distribution of stressors produced by an action; (b) the temporal distribution of stressors produced by an action; (c) changes in the spatial distribution of the stressors with time; (d) the intensity of stressors in space and time; (e) the spatial distribution of constituent elements of designated critical habitat; and (f) the temporal distribution of constituent elements of designated critical habitat.

If primary constituent elements (PCE's) of designated critical habitat (or physical, chemical, or biotic phenomena that give the designated area value for the conservation of listed species) are likely to respond given exposure to the *direct or indirect consequences of the proposed action*, we ask if those responses are likely to be sufficient to reduce the quantity, quality, or availability of those constituent elements within the action area. The basis of the analysis is to evaluate the function and role of the critical habitat in the conservation of the species.

In this step of our assessment, we must identify or make assumptions about: (a) the habitat's probable condition before any exposure as our point of reference (that is the current conservation value of critical habitat as described in the *Environmental Baseline* section of this opinion) on the conservation value of the designated critical habitat; (b) the ecology of the habitat at the time of proposed action exposure; (c) where the exposure is likely to occur; (d) when the exposure is likely to occur; (e) the intensity of exposure; (f) the duration of exposure; and (g) the frequency of exposure. We recognize that the conservation value of critical habitat, like the baseline condition of individuals and populations, is a dynamic property that changes over time in response to changes in land use patterns, climate (at several spatial scales), ecological processes, changes in the dynamics of biotic components of the habitat, etc.. For these reasons, some areas of critical habitat might respond to an exposure when others do not. We also consider how designated critical habitat is likely to respond to any interactions and synergisms between or cumulative effects of pre-existing stressors and proposed stressors.

As with the outline of our summary approach to how we analyze the effects from the proposed action on individuals, we perform the following steps in determining effects from the proposed action on designated critical habitat:

- Determine the critical habitat potentially exposed to project related stressors,
- Determine the area or features of critical habitat that could be affected by the proposed project,
- Determine which primary constituent elements could be affected by project related stressors,
- Estimate the stressor(s) frequency, intensity, and duration of exposure to critical habitat,
- Identify if there is an existing stress regime to which critical habitat in the action area is already exposed,
- Determine if there will be interactions between existing stressors and project stressors on critical habitat,

- Determine short-term responses of critical habitat to stressors including project related stressors,
- Determine long-term responses of critical habitat to stressors including project related stressors,
- Determine if the stressor and exposure scenarios anticipated are expected to result in a probable reduction in the quantity, quality, or function of critical habitat in the action area

If the quantity, quality, or availability of the primary constituent elements of the area of designated critical habitat is reduced, we ask if those reductions are likely to be sufficient to reduce the conservation value of the designated critical habitat for listed species in the action area. In this step of our assessment, we combine information about the contribution of constituent elements of critical habitat (or of the physical, chemical, or biotic phenomena that give the designated area value for the conservation of listed species) to the conservation value of those areas of critical habitat that occur in the action area. We use the *conservation value* of those areas of designated critical habitat that occur in the action area as our point of reference for this comparison. For example, if the critical habitat in the action area has limited current value or potential value for the conservation of listed species that limited value is our point of reference for our assessment.

If the conservation value of designated critical habitat in an action area is reduced, the final step of our analysis asks if those reductions are likely to be sufficient to reduce the conservation value of the entire species critical habitat designation. In this step of our assessment, we combine information about the constituent elements of critical habitat that are likely to experience changes in quantity, quality, and availability given exposure to a proposed action. We use the conservation value of the entire designated critical habitat as our point of reference for this comparison. For example, if the designated critical habitat affected by a proposed action has limited current value or potential value for the conservation of listed species that limited value is our point of reference for our assessment of how the conservation value for all designated critical habitat is going to be affected. In other words, the higher the value of critical habitat, the more adverse effects to this habitat will result in adverse effects to the conservation value of all designated critical habitat.

Where the critical habitat designation is particularly large and supports multiple populations that comprise the species, then our assessment tries to determine if the reduction in the conservation value of the action area is sufficient to reduce the conservation value of a subarea of the entire area designated as critical habitat (e.g., a hydrological unit area [HUC] or watershed). Finally, our assessment tries to determine if reductions in the conservation value of the subarea of critical habitat (e.g., watershed) is sufficient to reduce the conservation value of the entire area designated as critical habitat.

If the proposed action results in reductions in the quantity, quality, or availability of one or more essential features that reduces the value of the PCE, which in turn reduces the function of the designated areas, which in turn reduces the function of the overall critical habitat designation in its relation to conservation of the species, then we will conclude that the proposed action is likely to produce an adverse modification or destruction of critical habitat. In the strictest interpretation, reductions to any one essential feature or PCE would equate to a reduction in the value of the whole. However, there are other considerations. We look to various factors to determine if the reduction in the value of an essential feature or PCE would affect the ability of critical habitat to provide for the conservation of the species.

3.1.3 Approach of the Assessment Used for the Proposed Action (Issuance of an Incidental Take Permit for the Implementation of the PacifiCorp Habitat Conservation Plan)

To assess the effects of the proposed action (issuance of an ITP to PacifiCorp and Implementation of the HCP), we ask the following series of questions:

1) What are the physical and biological processes that are likely to be directly or indirectly affected by the covered activities associated with the proposed action over the 10-year duration of the ITP?
2) How are those processes likely to respond to the activities considered in the HCP?
3) How are the responses of those physical and biological processes likely to affect the quality, quantity, and availability of the habitat conditions for listed species in the action area?
4) What threatened or endangered species are likely to be exposed to those changes in the quality, quantity, and availability of their habitat conditions?
5) How are the different life stages of those listed species exposed to habitat changes likely to respond, expressed in terms of individual fitness (specifically, the growth, survival, and lifetime reproductive success)?
6) If individual species fitness is expected to be affected by changes in habitat conditions, what are the probable consequences of any changes in the viability of the populations affected and;
7) What are the probable consequences of any changes in the viability of populations on the viability of the species as a whole?

To answer these questions, we used information provided by PacifiCorp as well as information gained from numerous literature and data searches and professional judgment. The following discussion briefly summarizes the approach we took to answer each question and the assumptions or assessments we made to complete the analysis.

1) What are the physical and biological processes that are likely to be directly or indirectly affected by the covered activities associated with the proposed action over the 10-year duration of the ITP?

Our assessment is structured around the physical and biologic processes that dictate habitat conditions in the action area. We use the best scientific and commercial data available to determine whether the proposed activity affects the processes discussed in the *Environmental Baseline* section including:

A. Barriers and Limited Habitat Access (physical process)
B. Current Hydrology (physical process)
C. Water Quality (physical process)
D. Aquatic Diseases (biological process)

E. Gravel Recruitment (physical process)
F. Large Woody Debris Recruitment (physical process)

2) How are those processes likely to respond to the activities considered in the HCP?

The interactions of the various processes described in #1 above with stream reaches in the action area will be influenced by many of the activities proposed in the HCP. In our analysis of effects of the proposed action we examine how the proposed action is likely to influence habitat blockages, instream flows, water quality, sediment transport and spawning gravel recruitment, disease processes in the mainstem Klamath River, recruitment of large woody debris to the action area, juvenile rearing and overwintering habitat, and hatchery influences on populations of the SONCC ESU of coho salmon.

For example, many of the proposed activities in the HCP will influence the quality and quantity of juvenile SONCC ESU coho rearing and overwintering habitat. Thus, we look at the various HCP covered activities that have the potential to influence the suitability of juvenile habitat. We then consider these activities collectively to qualitatively estimate an overall effect on juvenile habitat within the action area. A key factor in this assessment is an estimation of the location and suitability of habitat potentially affected by the proposed covered activities in the HCP. In essence, the larger and more expansive the covered activities, the greater the potential for these activities to have influence on listed species and their habitat, either adverse or beneficial.

3) How are the responses of those physical and biologic processes likely to affect the quality, quantity, and availability of the habitat conditions for listed species in the action area?

The conditions of the various physical and biologic processes dictate the condition of habitat in the action area. For example, gravel recruitment and transport in mainstem rivers is recognized as a significant influence on the form and function of stream channels (e.g., Nelson 1998, Tripp and Poulin *op cit.* Nelson 1998). The channel form, in turn, dictates the quantity and quality of various habitat types that aquatic species depend on for various life history stages. Thus, understanding changes in gravel recruitment and transport in stream systems from the activities proposed in the HCP is critical to understanding the response of various in-stream habitat types to the proposed action.

The *Effects of the Action* section describes anticipated responses for individual watershed processes from the proposed action and the *Integration and Synthesis* section considers these responses in tandem with other factors affecting the covered species and their habitats. A key component in this assessment is the quality, quantity and availability of existing habitat as described in the *Environmental Baseline* section. This forms a reference point to which the responses of the various physical and biologic processes expected from the proposed action are added. This reference point enables us to estimate the magnitude and direction of habitat changes, if any, as a result of the proposed action. For example, if existing baseline conditions are good and provide functional habitat, and the proposed action resulted in habitat improvements, then we would assume that conditions would remain functional under the proposed action. If, on the other hand, baseline habitat conditions are poor and limiting one or more salmonid life stages, any improvements in habitat would have to be further examined to determine whether the response of a given process under the proposed action results in poor habitat conditions or if the response is sufficient to lead towards the promotion of functional habitat.

4) What threatened or endangered species are likely to be exposed to those changes in the quality, quantity, and availability of their habitat conditions?

Although the action area in this consultation is large, proposed action effects will be discrete in space and time, and may or may not adversely affect the fitness of individual federally listed threatened or endangered species, or their habitat, either living in or reliant upon biologic or physical processes of the Klamath River watershed. Exposure to proposed action stressors, whether adverse or beneficial, will depend on the expected geographic extent of stressor exposure, and whether listed species, either individually or via habitat effects, are likely to have a response to the stressor (s). Another consideration in this analysis is whether the listed species is known to be adversely affected by exposure to the stressor(s) at levels predicted from the proposed action. In this consultation NMFS has determined that the proposed action *is likely to adversely affect* SONCC coho salmon, and its designated critical habitat. NMFS makes this determination due to a wide body of evidence that demonstrates that PacifiCorp's operation and maintenance of the Klamath Hydroelectric Project adversely affects the quality, quantity, and availability of SONCC ESU coho salmon habitat, including PCEs for designated critical habitat, resulting in direct adverse affects to the fitness of individual coho. Further explanation of these effects is presented in Section 6, *Effects of the Action*, of this Opinion.

In this consultation, NMFS has concluded that the proposed action is not likely to result in exposure to stressors that results in measurable adverse changes to the following species habitat quality, quantity, and availability, nor is the proposed action likely to result in adverse effects to individuals, of the following species which occur in the action area:

Green Sturgeon (Southern DPS) and Critical Habitat

Green sturgeon enter the Klamath River to spawn from March through July (NRC 2004). Although the population of green sturgeon in the Klamath River is within northern distinct population segment (DPS) of green sturgeon, which is not listed under the ESA, there is some possibility that sturgeon from the listed southern DPS (the most northern population of the southern DPS occurs in the Eel River in Humboldt County), could enter the Klamath River during the permit term as sturgeon are known to stray into non-natal systems. For sturgeon in the Klamath River most spawning occurs from the middle of April to the middle of June. Spawning takes place in the lower mainstems of the Klamath and Trinity rivers in deep pools with strong bottom currents. Green sturgeon have been observed migrating into the Salmon River, but they are not thought to ascend the Klamath River beyond Ishi Pishi Falls (RM 66) (Moyle 2002, NMFS 2005). After egg emergence, juveniles stay in the river until they are 1 to 3 years old, when they move into the estuary and then to the ocean. Outmigrant juveniles are captured each year in screw traps at Big Bar (RM 49.7) on the Klamath River and at Willow Creek (RM 21.1) on the Trinity River (Scheiff et al. 2001). After leaving the river, green sturgeon spend 3 to 13 years at sea before returning to spawn, and they often move long distances along the coast (NRC 2004).

Southern DPS Green sturgeon occur in the Klamath River mainstem primarily in the estuary, which is far downstream of the proposed action covered activities and are not known to be adversely affected by the Klamath Hydroelectric Project. NMFS expects that most of the coho conservation measures proposed in the HCP are likely to occur upstream of Portuguese Creek (RM 128) in the Middle Klamath River reach as this is the area of most adverse Project effects to coho. Green sturgeon are not known to migrate further than RM 66, making exposure to stressors from the Project unlikely. There is some possibility that over the term of the ITP that some HCP conservation projects could be implemented in the Lower Klamath River section if suitable projects are not available in the Middle and Upper Klamath reaches. If this occurs, the projects implemented in the Lower Klamath reach could provide benefits to the Upper, Middle, Lower, Scott and Shasta populations (e.g. improvement to estuarine rearing habitat). Habitat improvement projects for coho in the Lower Klamath River may provide some level of benefits for Green Sturgeon occupying the estuary. Therefore, NMFS has determined that the green sturgeon southern DPS is not likely to be exposed to stressors from the proposed action that would result in a response from individual green sturgeon or their habitat, and therefore is not likely to be adversely affected by the proposed action. Critical habitat for the southern DPS is not designated in the Klamath River, and NMFS does not anticipate that the proposed action will have an effect on waters offshore from the Klamath River estuary, where critical habitat does occur. Therefore, NMFS concludes the proposed action *is not likely to adversely affect* the green sturgeon southern DPS or its designated critical habitat.

Southern DPS Pacific Eulachon and Critical Habitat

The eulachon (*Thaleichthys pacificus*) or candlefish is a smelt that reaches the southern extent of its range in the Mad River, Redwood Creek, and the Klamath River (Moyle 2002). Eulachon are anadromous spending most of their lives in the ocean environment, and enter freshwater habitats only to spawn. Eulachon are semelparous, meaning that they spawn once and then die. In many rivers known to support eulachon, spawning typically occurs in the portion of river influenced by tides (Lewis et al.2002). In the Kemano River, Canada, water velocity greater than 0.4 meters/second begins to limit the upstream movements of eulachon (Lewis et al.2002). Spawning appears to be related to river water temperature and the occurrence of high tides (Ricker *et al.*1954, Smith and Saalfeld 1955, Spangler 2002), generally occurring in January, February, and March in the Columbia River, the Klamath River, and the coastal rivers of Washington and Oregon, and April and May in the Fraser River (Gustafson *et al.*2010). Although spawning generally occurs at temperatures from 4 to 7 °C (39 to 45 °F) in the Cowlitz River (Smith and Saalfeld 1955), and at a mean temperature of 3.1 °C (37.6 °F) in the Kemano and Wahoo Rivers, peak eulachon runs occur at noticeably colder temperatures (between 0 and 2 °C [32 and 36 °F]) in the Nass River.

Historically, large numbers of eulachon entered the Klamath River to spawn in March and April, but they rarely moved more than 8 miles inland (NRC 2004). The Klamath River is believed to support the largest population of eulachon in California. Larson and Belchik (1998) noted that adults generally migrate up to Pecwan Creek or near Weitchpec, however specific spawning areas are not well known. Eulachon adults do not feed during spawning (McHugh 1939, Hart and McHugh 1944). Adults choose river substrate (e.g. sand and small gravels) to deposit their eggs and eulachon eggs hatch in 20 to 40 days with incubation time dependent on water temperature (Smith and Saalfeld 1955, Langer et al. 1977). Shortly after hatching, the larvae are carried downstream and dispersed by estuarine, tidal, and ocean currents. Larval eulachon may remain in low salinity surface waters of estuaries for several weeks or longer (Hay and McCarter

2000) before entering the ocean. Moyle (2002) states that eulachon have been scarce in the Klamath River since the 1970s, with the exception of 3 years; they were plentiful in 1988 and moderately abundant again in 1989 and 1999. Similar declines have been noted elsewhere within the species range. Commercial landings in the Columbia River and its tributaries averaged between 1 and 3 million pounds prior to 1993, but declined ten-fold starting in 1994. A similar decline has occurred in the Fraser River, where landings decreased from about 100 metric tons (110 tons) prior to 1966 to about 20 metric tons (22 tons) in the early 1990s, leading to closure of the fishery in 1998, 1999, and 2000. In March 2010 NMFS listed the Southern DPS, which includes the Klamath River population, of eulachon as threatened (75 FR 13012; March 18, 2010). Primary factors cited as threatening the species include climate change, commercial fisheries, and altered freshwater habitat. NMFS is unsure as to the viability of eulachon in the Klamath River as we are uncertain that abundance is large enough to support a self-sustaining population.

In October, 2011, NMFS designated final critical habitat for the southern distinct population segment (DPS) of Pacific eulachon; the designation took effect on December 19, 2011 (76 FR 65324; October 20, 2011). In the Klamath River, critical habitat is designated from the mouth of the Klamath River upstream to the confluence with Omogaar Creek at approximately river mile (RM) 10.5 from the mouth, which overlaps with the Lower Klamath population unit. The physical or biological features that constitute critical habitat includes: (1) freshwater spawning and incubation sites with water flow, quality and temperature conditions and substrate supporting spawning and incubation, (2) freshwater and estuarine migration corridors free of obstruction and with water flow, quality and temperature conditions supporting larval and adult mobility, and with abundant prey items supporting larval feeding after the yolk sac is depleted, and (3) nearshore and offshore marine foraging habitat with water quality and available prey, supporting juveniles and adult survival. In the Klamath River basin, critical habitat does not include lands within the Yurok Indian Reservation, or the Resighini Rancheria located in the Lower Klamath River. NMFS does not believe that the physical or biological features of designated critical habitat will be adversely affected by the proposed action covered activities as NMFS believes that adverse effects from the Project will be mostly limited to the Middle and Upper Klamath reaches. There is some possibility that over the term of the ITP that some HCP conservation projects could be implemented in the Lower Klamath River section if suitable projects are not available in the Middle and Upper Klamath reaches. If this occurs, the projects implemented in the Lower Klamath reach could provide benefits to the Upper, Middle, Lower, Scott and Shasta populations, as well as benefiting eulachon occupying the estuary and Lower Klamath River reach. Continued persistence and strength of eulachon runs in the Klamath River may be strongly influenced by climate change effects and/or commercial fisheries as suitable spawning habitat in the Lower Klamath River does not seem to be limited.

NMFS does not believe the covered activities in the proposed action will affect the fitness of individual eulachon as the effects (i.e., stressor exposure) of those activities are generally limited to reaches upstream of Portuguese Creek in the Middle Klamath reach, which is well above where eulachon have been observed, and well above designated critical habitat. In addition, eulachon adults and juveniles are believed to occur in the lower Klamath River during early spring to early summer limiting their potential exposure to disease conditions, low DO, and high water temperature. Conservation actions implemented in the Lower Klamath reach have the potential to provide beneficial effects to eulachon occupying critical habitat in the Lower Klamath reach. We do not anticipate that the conservation measures proposed in the HCP will affect eulachon as our expectation is that effects from coho conservation measures are likely to occur much higher in the watershed where Project effects on coho salmon populations are most pronounced. Therefore, NMFS concludes the proposed action *is not likely to adversely affect* the eulachon southern DPS or its designated critical habitat.

Southern Resident Killer Whales

The Southern Resident killer whale (Southern Residents) Distinct Population Segment (DPS) was listed as endangered under the ESA on November 18, 2005 (70 FR 69903). Critical habitat for the Southern Resident killer whale DPS was designated on November 29, 2006 (71 FR 69054). Critical habitat includes approximately 2,560 square miles of inland waters in three specific areas: 1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; 2) Puget Sound; and 3) the Strait of Juan de Fuca. Designated critical habitat is located outside of the action area and NMFS has determined Pacificorp's actions will have no effect on Southern Residents critical habitat.

Southern Residents consume a variety of fish species (22 species) such as herring, rockfish, and various flatfish sp., and one species of squid (Scheffer and Slipp 1948, Ford et al. 1998, 2000, Ford and Ellis 2006, Saulitis et al. 2000, Hanson et al. 2010a). However, salmon are identified as their primary prey (*i.e.,* a high percent of prey consumed during spring, summer and fall, from long-term studies of resident killer whale diet; see Ford and Ellis 2006, Ford et al. 2010, Hanson et al. 2010b). The Southern Resident population consists of three pods, referred to as J, K, and L pods. The current population estimate is 88 whales as of July, 2011[5]: 26 in J pod, 20 in K pod, and 42 in L pod. All three pods reside for part of the year in the inland waterways of Washington State and British Columbia (Strait of Georgia, Strait of Juan de Fuca, and Puget Sound), principally during the late spring, summer, and fall. There is much less information available about their range and distributions during the winter and early spring. Southern Residents were formerly thought to range southward along the coast to about Grays Harbor (Bigg et al. 1990) or the mouth of the Columbia River (Ford et al. 2000), in addition to the coastal waters and inland waters surrounding Vancouver Island. However, recent sightings and documentation of members of K and L pods off Oregon and California have considerably extended the southern limit of their known range during the winter (NMFS 2009 and NWR 2011).

Research indicates that Southern Residents have a strong preference for Chinook salmon in the Puget Sound and inland waters during the summer and fall, likely because they are the largest salmon species and contain the highest lipid content. They also appear to target large individual fish, for probably the same reasons (Hanson et al. 2010b, Ford et al. 2010). However, there is very limited information available on their diet and prey selection during foraging in coastal waters. Although less is known about the diet of Southern Residents in Pacific coastal waters, the available information suggests that salmon, and Chinook in particular, are also important during this time. To date, there are direct observations of two different predation events where

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5 Annual census: http://www.whaleresearch.com/research.html

the prey was identified to species and stock from genetic analysis of prey remains when the whales were in coastal waters. Both were identified as Columbia River Chinook stocks (Hanson et al. 2010a). Chemical analyses also support the importance of salmon in the year round diet of Southern Residents (Krahn et al. 2002, 2007, and 2009). Based on the available information, it is reasonable to assume that their preference for Chinook remains strong anytime Chinook are available. However, it has been documented that Southern Residents will switch to other prey species such as chum when those prey are available in higher densities in inland waters during the late fall (Hanson et al. 2010c).

PacifiCorp's proposed interim operations of the Project and conservation measures are expected to affect Chinook salmon in the Klamath River, and may reduce the available salmon prey in the ocean for Southern Residents. Interim Project operations will result in (1) continued loss of historical habitat upstream of Iron Gate Dam, and (2) effects to water quality and water quantity that may adversely affect the fitness of Chinook salmon individuals through increased risks to disease and impeding improvements of habitat form and function as a result of the continued existence and operation of Project facilities.

To mitigate for these potential adverse effects of Interim Operations, PacifiCorp proposes to continue to fund the operation of Iron Gate Hatchery, resulting in the continued annual release of 5.1 million Chinook salmon smolts and 0 .9 million Chinook salmon yearlings. Additionally, NMFS expects PacifiCorp's proposed conservation measures to further mitigate for the adverse effects of ongoing operations on Chinook salmon and their habitat.

Genetic Stock Identification results have indicated that the Klamath River stock can comprise at least about 37% of the adult Chinook salmon off of Fort Bragg and about 45% off of the southern Oregon coast during late spring and early summer months in any one given year. It must be noted that these stock composition percentages estimated from GSI data on such a relatively fine scale can be highly variable on an annual or even monthly basis. For example, in July 2010, the Klamath Chinook salmon composition off Florence, Oregon was only 2.6%, compared to 45% in July 2007 (Project CROOS 2010). This calculation assumes that the preference for Chinook remains high during the winter and that Klamath-origin fish constitute a relatively large component of the Chinook population in these areas during that that time. Both assumptions are speculative, but reasonably supported by the available information.

NMFS has considered the effects of the Proposed Action based on the current condition and state of knowledge regarding Southern Residents and salmon populations. We then assess the effects of ongoing operations downstream of Iron Gate Dam and continued loss of habitat upstream of Iron Gate Dam, combined with ongoing IGH production and proposed conservation measures to evaluate the effects on available prey resources for individual Southern Residents and the pods they comprise.

Given an expected 1% smolt to adult survival ratio, NMFS expects continued IGH operations to result in approximately 60,000 adult Chinook salmon, annually, that may be available as prey resources for Southern Residents. NMFS also expects ongoing operations to reduce the survival and fitness of natural Chinook salmon, however NMFS also expects hatchery production and proposed conservation measures to offset those adverse effects to Southern Resident prey to a negligible level such that we anticipate Southern Residents will not experience measurable effects to prey availability due to PacifiCorp's continued Project operations.

Based on the information available and the current state of Southern Residents, Chinook populations, and the ecosystem as a whole, NMFS concludes the proposed is not likely to adversely affect the Southern Resident killer whale DPS.

5) How are the different life stages of those listed species exposed to habitat changes likely to respond to those changes in habitat conditions, expressed in terms of individual fitness (specifically, the growth, survival, and lifetime reproductive success)?

Given the expected habitat conditions resulting from the proposed action and the distribution of listed species in the action area, we compare these expected habitat conditions with life-stage specific requirements for listed species. In conducting our assessment of habitat responses, we use the best scientific and commercial data available to determine what constitutes functional habitat for various life stages of the species. We determine whether the habitat conditions resulting from the proposed action would reduce or improve growth, survival, or reproductive success of the exposed individuals. If the resulting habitat conditions fall short of life-stage specific requirements over the duration of the action, we assume that the growth, survival or reproductive success of individuals would be negatively impacted by the proposed action. The habitat assessment focuses on the following life history stages in the case of listed salmonids: egg incubation and emergence, juvenile rearing and out-migration, and adult migration and spawning. Most importantly, we consider the effects on life history stages that may be limited by one or more habitat elements. For example, the *Environmental Baseline* section describes many areas where excessive water withdrawals have resulted in limited habitat access conditions and instances of juvenile coho stranding. Under these conditions, juvenile abundance is currently limited for species that depend on adequate flow regimes for successful rearing and migration, such as juvenile SONCC ESU coho salmon.

6) If individual species fitness is expected to be affected by changes in habitat conditions, what are the probable consequences of any changes in the viability of the populations affected?

This analytical approach assumes that these species, in general, will experience demographic changes (that is, changes in population size, and distribution) commensurate with the changes in the habitat-related variables described above. We note that localized impacts to habitat will not always have a measurable effect on numbers, reproduction or distribution for species that are limited in abundance or distribution in a given area. The affected individuals may be able to locate to nearby suitable unoccupied habitat. However, many listed species in the action area are highly mobile and may rely on key refuge habitat as conditions seasonally deteriorate in some areas of the action area. In particular, poor water quality conditions in the mainstem Klamath River highlight the importance of tributary reaches for seasonal rearing. Thus, we expect that effects to individuals of a species are likely to have an effect at the population scale. As a result, these habitat-related variables are used as surrogates or indices of potential population trends for the purposes of this assessment.

If the proposed action impairs the survival of an individual to its next life history stage, and depending upon the number of individuals affected, these effects may result in an adverse population response (e.g. reduction in adult spawners). These effects are taken into consideration along with existing limiting factors across the action area. These effects may negatively influence the viability of populations in the action area, depending on the magnitude of habitat responses described in question #3 and the current conditions as described in both the *Status of the Species* and *Environmental Baseline* sections. Conversely, if the proposed action does not impair survival rates to the next life history stage, or if the impairment occurs for a life history stage that is not currently limited, we assume that although individuals of the listed species may be taken, the overall viability of populations in the action area may not be significantly reduced by the proposed action.

Integrating the Effects

Once we have established what the effects of the proposed action are on the listed species at issue, we must examine those expected effects in context to the baseline conditions the species exists within, and the expected cumulative effects on the listed species from non-federal future actions within the action area. We integrate and synthesize these past, present, and future effects (including effects from the proposed action) on the various life stages of the species analyzed to determine how the proposed action will influence the viability of the species. Through our integration and synthesis of the stressors affecting covered species and the habitats upon which they depend, we must determine whether the proposed action is likely to appreciably reduce the likelihood of both the survival and recovery of the species and whether it is likely to result in the destruction or adverse modification of critical habitat. In summary, the combined effects analysis and biological jeopardy determination is made in the following manner:

> *The effects of the proposed Federal action, in this case issuance of an ITP with resulting implementation of the HCP, are evaluated in the context of the aggregate effects of all factors that have contributed to the covered species' current status and, for non-Federal activities in the action area, those future actions likely to affect the listed species under analysis, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the species in the wild. Inherent in this analysis is an understanding of how actions in the past within the action area have affected the listed species, how future actions are anticipated to affect the species, and finally, how the proposed action can add to further effects on the species (either adversely or beneficially).*

An important tool we use in this step of the assessment is a consideration of the life cycle of the species. The consequences on a population's probability of extinction as a result of impacts to different life stages are assessed within the framework of this life cycle and our current knowledge of the transition rates (essentially, survival and reproductive output rates) between stages, the sensitivity of population growth to changes in those rates, and the uncertainty in the available estimates or information.

7) What are the probable consequences of any changes in the viability of populations on the viability of the species as a whole?

In this final step, we consider the role of the populations in the action area to the overall survival and recovery of the affected species (e.g., SONCC coho salmon ESU). If the viability of one or more of these populations is impacted by the proposed action, and these populations play an influential role in the survival and recovery of the ESU as a whole, we conclude that the proposed action would have impacts on the viability of the entire ESU.

To determine if the proposed permitted activities are likely to result in the destruction or adverse modification of designated critical habitat, once a determination has been made that the proposed action is likely to adversely affect a species or its designated habitat, NMFS will analyze the effects of the proposed action on the PCE's of critical habitat identified as essential to the conservation of the species. This analysis starts the same as the species jeopardy analysis described above. That is, using the best scientific and commercial data available, we estimate the responses of watershed processes as they may influence substrate condition, water quality conditions, flow, stream temperatures, physical habitat elements, channel condition, chemicals and nutrients, riparian vegetation, habitat accessibility, and the general condition of watersheds that support the biological and ecological requirements of the species. If the effects of the proposed action, when combined with the cumulative effects and environmental baseline, do not destroy or adversely modify the value of PCE's essential to the conservation of the species in the action area, then the adverse modification or destruction threshold is not reached. Conversely, if the conservation value of the affected primary constituent elements in the action area is destroyed or adversely modified, NMFS must then determine whether the impacts result in an appreciable diminishment of the value of the overall critical habitat designation 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 reached when the proposed action will diminish the constituent elements in a manner likely to appreciably diminish or preclude the role of those habitat elements in the conservation of the species.

3.2 Concept of the Natural Flow Regime

A universal feature of the hydrographs of the Klamath River and its tributaries is a spring pulse inflow followed by recession to a baseflow condition by late summer (NRC 2004). This main feature of the hydrographs has influenced the adaptations of native organisms, as reflected in the timing of their key life-history features (NRC 2004). The natural flow regime of a river is the characteristic pattern of flow quantity, timing, rate of change of hydrologic conditions, and variability across time scales (hours to multiple years), all without the influence of human activities (Poff et al. 1997).

Variability of the natural flow regime is inherently critical to ecosystem function and native biodiversity (Poff et al. 1997, Puckridge et al. 1998, Bunn and Arthington 2002, Beechie et al. 2006). Life history diversity of Pacific salmonids (*Oncorhynchus spp.*) substantially contributes to their persistence, and conservation of such diversity is a critical element of recovery efforts (Beechie et al. 2006). The findings of Waples et al. (2001) support the conclusion of Beechie et al. (2006), which found that life history and genetic diversity showed a strong, positive correlation with the extent of ecological diversity experienced by a species. For example, the analysis by Williams et al. (2006) suggests that substantial environmental variability (e.g., wet coastal areas and arid inland regions) within the Klamath River basin resulted in nine separate populations of coho salmon (see Section 5 of this Opinion, *Status of the Species and Critical*

Habitat). Because aquatic species have evolved life history strategies in direct response to natural flow regimes (Taylor 1991, Waples et al. 2001, Beechie et al 2006), maintenance of natural flow regime patterns is essential to the viability of populations of many riverine species such as anadromous salmonids (Poff et al. 1997,Bunn and Arthington 2002).

Understanding the link between the adaptation of aquatic and riparian species to the flow regime of a river is crucial for the effective management and restoration of running water ecosystems (Beechie et al 2006), because humans have now altered the flow regimes of most rivers (Poff et al. 1997, Bunn and Arthington 2002). Additionally, ongoing climatological conditions have and will continue to alter streamflow patterns, primarily by making the timing of peak runoff earlier in the year (Stewart et al. 2004). When flow regimes are altered and/or simplified, the diversity of life history strategies for some species such as coho salmon can be reduced, because life history and genetic diversity have a strong, positive correlation with the extent of ecological diversity experienced by a species (Waples et al. 2001). Any reductions in species life history diversity can have implications for their persistence (Beechie et al. 2006).

The historic flows of the Klamath River were the hydrologic condition under which aquatic species evolved prior to anthropogenic factors that have altered the hydrological regime. The annual historic hydrological regime of the Upper Klamath River was relatively smooth, with high flows in winter and spring that declined gradually during summer and then recovered in fall (Hecht and Kamman 1996). This pattern reflected the seasonal cycle of fall and winter precipitation and spring rainfall and snowmelt in the basin (Risley and Laenen 1999).

Average daily flows for the 1905-1912 period of record at Keno illustrate the natural flow variation that likely existed prior to the implementation of Reclamation's Klamath Project (Figure 9). Although data for entire years exists for the period 1906-1911, four years that represent a variety of precipitation levels are shown to limit clutter of the graph. This period of record, although thought to be wetter than normal, is useful for illustrating hydrograph shape and features under historical conditions. For example, baseflows generally incrementally increased through the fall and winter as rainfall events raised the water table and added variability to the hydrograph. In April and May, river discharge typically increased as snowmelt from mountainous areas caused the river to swell. Baseflows through the spring and summer gradually decreased until reaching minimum flows in the beginning of September.

Farther downstream in the coastal zone of the Lower Klamath basin, the hydrologic pattern of the Klamath River is primarily dominated by rainfall events in the fall and winter which affect discharge. Although there are no empirical river discharge data downstream of Keno, Oregon prior to implementation of Reclamation's Klamath Project, modeling results of flows near IGD that assume absence of Reclamation's Klamath Project show similar patterns to discharge at Keno, Oregon (Figure 10). Spring peaks from snowmelt in tributary basins provided a predictable increase in discharge, typically near the end of April (NRC 2004), with baseflows reaching a minimum in the beginning of September. In the middle and lower portions of the Klamath River, discharge responded rapidly to rainfall events due to the relatively short length of lower tributary sub-basins (e.g., Salmon River). Historic Klamath River hydrology was diverse, with a range of hydraulic conditions and habitats which in turn supported a variety of salmonid life history stages throughout the year. As an example of this natural phenomenon, interior population units of coho salmon (e.g., Upper Klamath, Shasta, Scott) that persisted within spring-fed hydrologic systems experienced instream conditions that differed from those populations located in the coastal zones (e.g., Lower Klamath Population unit).

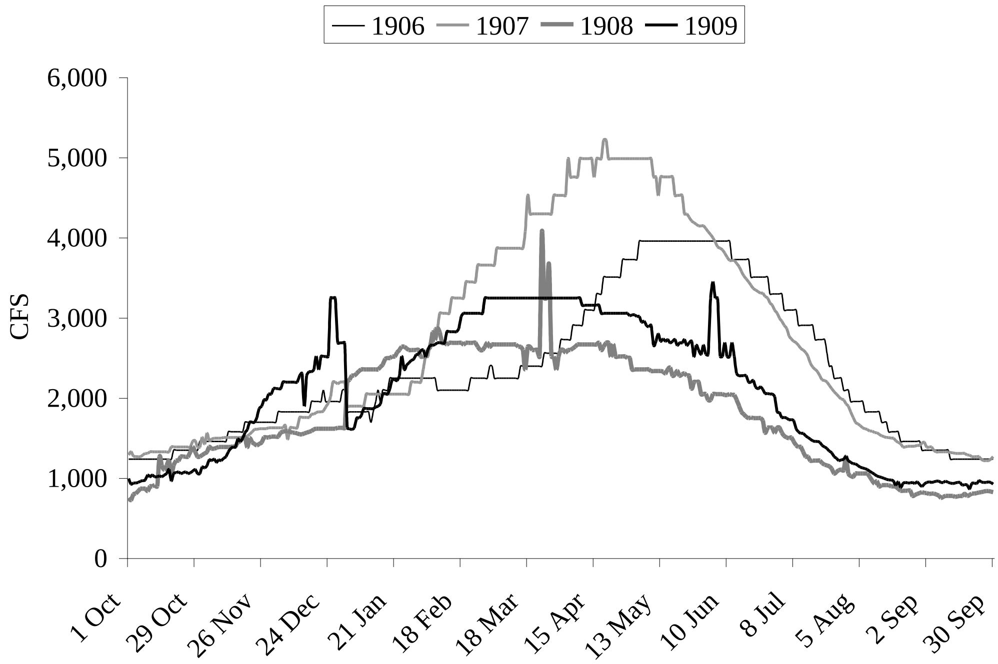

Figure 9. Klamath River discharge at Keno, Oregon during 1906 to 1909 (USGS gage data).

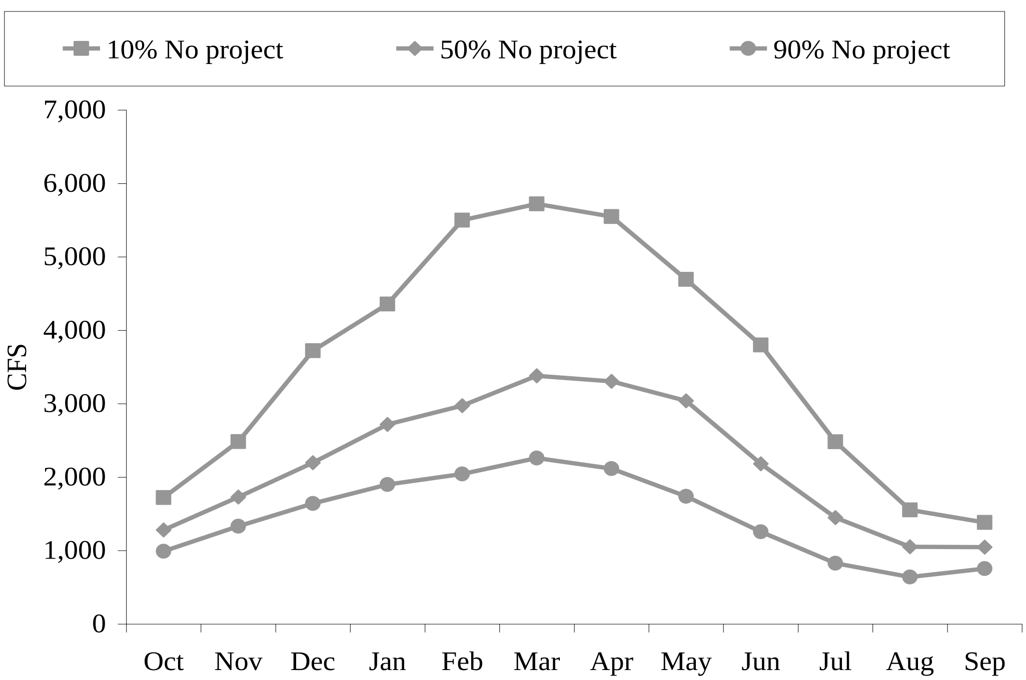

Figure 10. Estimated monthly flow exceedence at Iron Gate Dam that assumes absence of Reclamation's Klamath Project (based on modeling data provided by Reclamation).

IV. STATUS OF THE SPECIES AND CRITICAL HABITAT

As explained in Section III of this Opinion, NMFS has determined that the following species and its designated critical habitat may be adversely affected by the Proposed Action:

Evolutionarily Significant Unit (ESU)	Scientific Name	Listing Status	Federal Register Notice	Geographic Distribution	Critical Habitat Designation
SONCC coho salmon	*Oncorhynchus kisutch*	Threatened	June 28, 2005 (70 FR 37160)	From Cape Blanco Oregon, to Punta Gorda, California	May 5, 1999 (64 FR 24049)

4.1 SONCC Coho Salmon Evolutionarily Significant Unit

NMFS listed the SONCC coho salmon ESU, which includes populations spawning from the Elk River (Oregon) in the north to the Mattole River (California) in the south, as a threatened species in 1997 (62 FR 24588; May 6, 1996). In 2005, NMFS reaffirmed its status as a threatened species and also listed three hatchery stocks as part of the ESU (70 FR 37160; June 28, 2005). Analysis of recent genetic data from coho salmon in this and adjacent ESUs (Oregon Coast ESU to the north and Central California Coast ESU to the south) supports the existing boundaries of the SONCC coho salmon ESU boundary (Stout et al. 2010, Williams et al. 2011).

Adult coho salmon reach sexual maturity at 3 years, and die after spawning. Precocious 2 year olds, especially males, also make up a small percentage of the spawning population. Coho salmon adults migrate and spawn in small streams that flow directly into the ocean, or tributaries and headwater creeks of larger rivers (Sandercock 1991, Moyle 2002). Adults migrate upstream to spawning grounds from September through late December, peaking in October and November. Adult coho salmon migrate at water temperatures of 45 to 59º F, a minimum water depth of approximately 7 inches, and streamflow velocities less than 8 ft/s (Bjornn and Reiser 1991). Coho salmon are known to stage at the confluences of tributaries, holding until flows and temperatures are suitable for migration into upper tributary spawning habitat. Spawning occurs mainly in November and December, with fry emerging from the gravel in the spring, approximately 3 to 4 months after spawning. The favorable range for coho salmon egg incubation is 10-13.5º C (Bell 1991). 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 1 to 2 meters wide. They may spend 1 to 2 years rearing in freshwater (Bell and Duffy 2007), or emigrate to an estuary shortly after emerging from spawning gravels (Tschaplinski 1988). Coho salmon juveniles are also known to "redistribute" into non-natal rearing streams, lakes, or ponds, often following rainstorms, where they continue to rear (Peterson 1982). At a length of 38 to 45 mm, fry may migrate upstream a considerable distance to reach lakes or other rearing areas (Godfrey 1965 *op. cit.* Sandercock

1991, Nickelson et al. 1992). Emigration from streams to the estuary and ocean generally takes place from March through May.

The Southern Oregon/Northern California Technical Recovery Team (SONCC TRT) evaluated the population structure of the SONCC coho salmon ESU (Williams et al. 2006). In general, the historical population structure of this ESU was characterized by small-to-moderate-sized coastal basins where high quality habitat is in the lower portions of the basin and by three large basins where high quality habitat was located in the lower portions, middle portions of the basins provided little habitat, and the largest amount of habitat was located in the upper portions of the sub-basins. Based on its review, the SONCC TRT concluded the ESU was historically comprised of: 1) 19 functionally independent populations, 2) 12 potentially independent populations, 3) 17 small dependent populations of coho salmon, and 4) 2 ephemeral populations. In addition to categorizing individual populations, the TRT's analysis defined seven diversity strata (Figure 11) within the ESU which comprised groups of populations that likely exhibit genotypic and phenotypic similarity due to exposure to similar environmental conditions or common evolutionary history (Williams et al. 2006). NMFS recently completed a status review of the SONCC coho salmon ESU (NMFS 2011) and determined that the ESU, although trending in declining abundance, should remain listed as threatened.

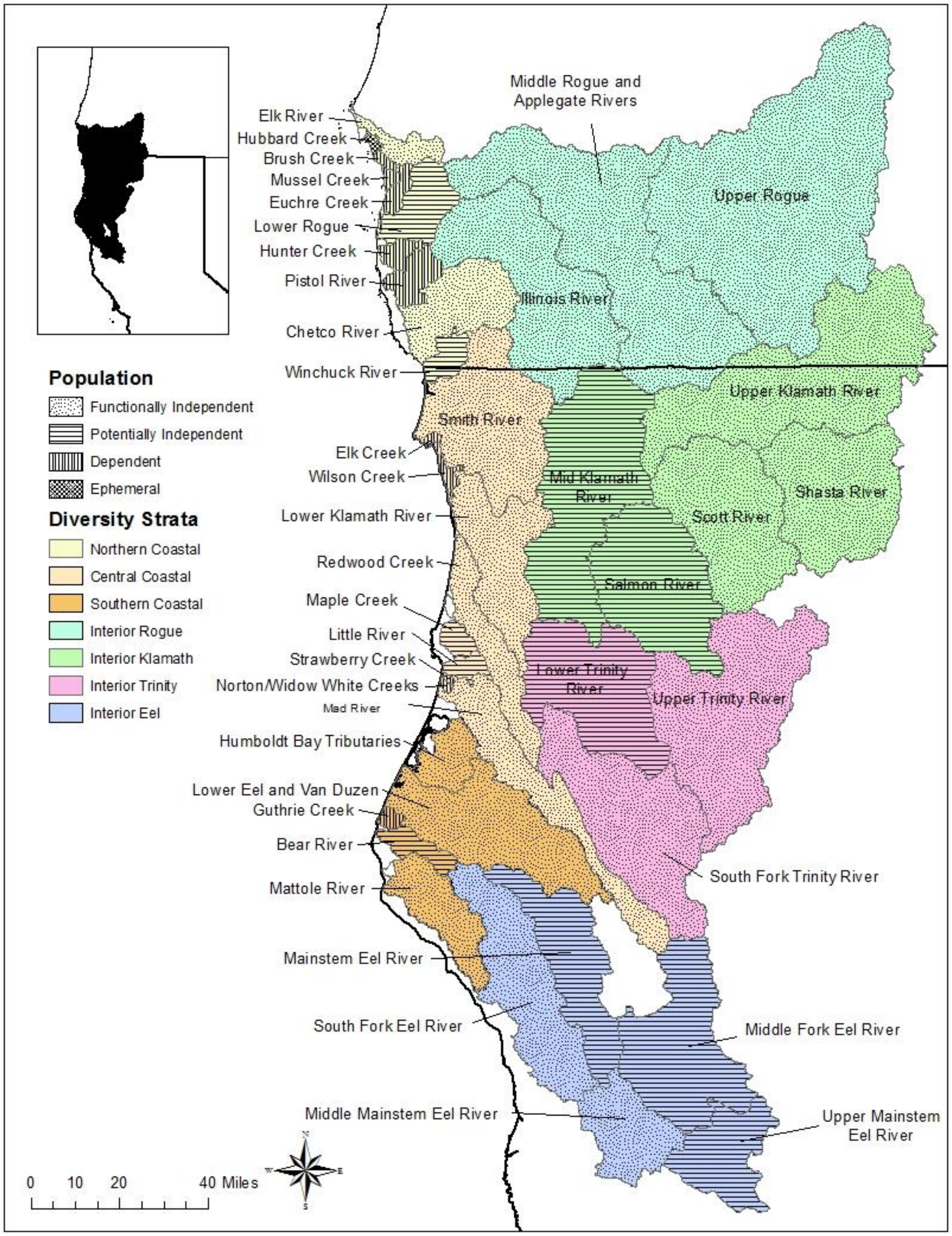

Figure 11. Historic population structure of the SONCC coho salmon ESU (modified from Williams et al.2006).

a. *Abundance and Productivity*

NMFS (2001) concluded that population trend data for SONCC coho salmon from 1989 to 2000 show a continued downward trend throughout most of the California portion of the SONCC coho salmon ESU. The main populations in the ESU (Rogue, Klamath, and Trinity Rivers) remain heavily influenced by hatcheries and have little natural production in mainstem rivers (Weitkamp et al. 1995, Good et al. 2005). Trinity River Hatchery maintains high production rates, with straying of hatchery reared SONCC coho salmon into non-natal streams occurring regularly (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, Good et al. 2005). Combining 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. Brown and Moyle (1991) suggested that naturally-spawned adult coho salmon runs in California streams were less than one 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 1940s, 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 have already been eliminated.

Table 4 provides the specific viability criteria for independent coho populations in the ESU (Williams et al. 2008). A majority of independent populations identified in Table 4 are well below low-risk abundance targets, and many may also be below the high-risk depensation thresholds (1 spawner/IPkm) identified in Williams et al. (2008). Using spawner-recruit relationships from 14 populations of coho salmon, Barrowman et al. (2003) found evidence of depensatory effects when spawner densities are less than 1 female per km (2 spawners/km). Small-population demographic risks are very likely to be significant when spawner density is below 0.6 spawner per km (Wainwright et al. 2008), which Williams et al. (2008) estimates is approximately 1 spawner/IP-km and used this density for setting the depensation threshold. Because the depensation threshold for SONCC coho salmon populations is set at such a low density, populations that do not meet their depensation threshold are definitely at a high risk of extinction.

Population Unit	Historical IP km	Depensation threshold (fish)	Spawner density (fish/IP km)	Spawner threshold low risk
Elk River (1)	62.64	63	38	2,400
Lower Rogue River (7a)	80.88	81	37	3,000
Illinois River (7b)	589.69	590	20	11,800
Mid. Rogue/Applegate Rivers (7c)	758.58	759	20	15,200
Upper Rogue River (7d)	915.43	915	20	18,300
Chetco River (10)	135.19	135	33	4,500
Winchuck River (11)	56.5	57	39	2,200
Smith River (12)	385.71	386	20	7,700
Lower Klamath River (15a)	204.69	205	29	5,900
Middle Klamath River (15b)	113.49	113	34	3,900
Upper Klamath River (15c)	424.71	425	20	8,500
Salmon River (15d)	114.8	115	35	4,000
Scott River (15e)	440.87	441	20	8,800
Shasta River (15f)	531.01	531	20	10,600
South Fork Trinity River (15g)	241.83	242	26	6,400
Lower Trinity River (15h)	112.01	112	35	3,900
Upper Trinity River (15i)_	64.33	64	37	2,400
Redwood Creek (16)	151.02	151	32	4,900
Maple Creek/Big Lagoon (18)	41.3	41	39	1,600
Little River (19)	34.2	34	41	1,400
Mad River (22)	152.87	153	32	4,900
Humboldt Bay tributaries (23)	190.91	191	30	5,700
Lower Eel/ Van Duzen Rivers (24a)	393.52	394	20	7,900
South Fork Eel River (24b)	476.1	476	20	9,500
Mainstem Eel River (24c)	143.9	144	33	4,700
North Fork Eel River (24d)	53.97	54	39	2,100
Middle Fork Eel River (24e)	77.7	78	37	2,900
Middle Mainstem Eel River (24f)	255.5	256	25	6,500
Upper Mainstem Eel River (24g)	54.11	54	39	2,100
Bear River (26)	47.84	48	40	1,900
Mattole River (28)	249.79	250	26	6,500

Table 4. Specific viability criteria for independent populations of coho salmon in the SONCC ESU (from Williams et al.2008).

Available data indicates that many populations have declined, which reflects a declining productivity. Concern remains about these recent declines in abundance of coho salmon across the ESU, regardless of what the contributing factor(s) are or may have been (e.g., marine survival conditions and drought). The negative short-term trends observed in the limited number of time series are not unexpected given the apparent low marine survival in recent years (<1% for the 2004 to 2006 year classes). However, as population sizes have decreased other factors (e.g., small population dynamics) may be adversely affecting coho salmon populations in spite of the improved ocean conditions that occurred from 2007 to 2009. The declining abundance trends and low spawner abundance for most populations in the ESU underscore the importance of addressing freshwater habitat conditions across the ESU so that all populations are sufficiently resilient to withstand fluctuations in marine survival.

NMFS recently concluded a periodic status review for the SONCC ESU (NMFS 2011). In this review we concluded that quantitative population-level estimates of adult spawner abundance spanning more than 9 –12 years are scarce for independent or dependent populations of the SONCC ESU (NMFS 2011). New data since the last status review (Good et al. 2005) consist of the continuation of a limited number of adult abundance time series (some of which had only a few years of data at the time of the last status review), expansion of sampling efforts in coastal basins of Oregon to collect data on SONCC ESU coho salmon populations, and the continuation and addition of several "population unit" scale monitoring efforts in California (NMFS 2011). Other than the Shasta River and Scott River adult counts, reliable time series of naturally produced adult migrant or spawners are not available for the California portion of the SONCC ESU at the "population unit" scale (NMFS 2011). Although long-term data on coho abundance in this ESU are scarce, the available evidence from shorter-term research and monitoring efforts indicate that populations in this ESU have declined since the last formal status review. For all available time series (except the counts from the West Branch and East Fork of Mill Creek), recent population trends have been downward.

b. Spatial Structure and Diversity

For a summary of historical and current distributions of SONCC ESU coho salmon in northern California, refer to CDFG's (2002) coho salmon status review, historical population structure by Williams et al. (2006), as well as the presence and absence update for the northern California portion of the SONCC coho salmon ESU (Brownell et al. 1999). The most recent NMFS status review in 2011 reported that many independent populations do not have, or are not known to currently have, $\geq$ 50% occupancy of intrinsic potential (IP) habitat (NMFS 2011) meaning spatial distribution is likely highly confined as compared to historical conditions. NMFS has used the concept of a stream's "intrinsic potential" to mean a stream exhibits suitable habitat for a particular species or life stage which emanates from a hierarchical perspective of fish-habitat relationships (Agrawal et al. 2005). Essentially, NMFS has modeled IP habitat for streams with coho presence using three primary physical indicators, channel gradient, valley width, and mean annual stream discharge in an assumption that habitat conditions should be favorable to a particular salmonid species at some stage of its life. Additionally, not all dependent populations are currently known to have habitat to support all life stages, though many do.

None of the seven diversity strata comprising the ESU appears to support a single viable population; however, all of the diversity strata are occupied by coho salmon. Recent data shows a negative trend in occupancy as compared to historic spatial structure throughout the ESU. Good et al. (2005) noted that they had strong indications that California breeding groups have been lost from a significant percentage of streams within their historical range. Figure 12 demonstrates relatively low levels of observed presence in historically occupied coho salmon streams (32 to 56 percent from 1986 to 2000) and indicates continued low abundance in the California portion of the SONCC coho salmon ESU. The relatively high occupancy rate of historical streams observed in brood year 2001 suggests that much habitat remains accessible to coho salmon (70 FR 37160, June 28, 2005). 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 lacking coho salmon runs were all tributaries of the Klamath River and Eel River basins. CDFG (2002) reported a decline in SONCC coho salmon occupancy, with the percent reduction dependent on the data sets used.

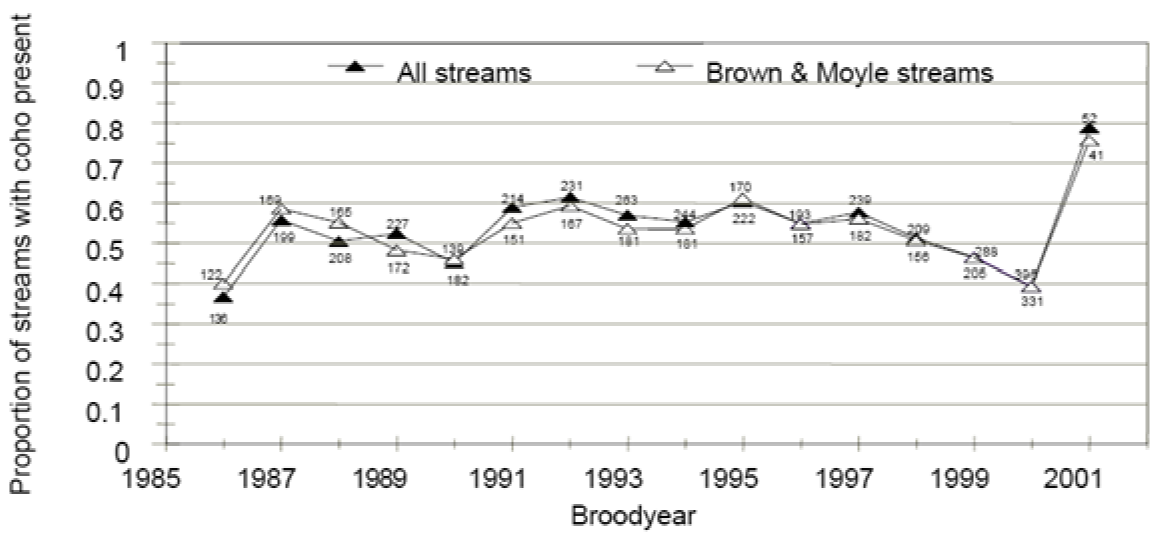

Figure 12. Proportion of surveyed streams with coho salmon present (from Good et al.2005). The number of streams surveyed noted with each data point.

The primary factors affecting the diversity of SONCC coho ESU salmon appear to be low population abundance and the influence of hatcheries and out-of-basin introductions. Although the operation of a hatchery tends to increase the abundance of returning adults (70 FR 37160; June 28, 2005), the reproductive success of hatchery-born salmonids spawning in the wild can be less than that of naturally produced fish (Araki et al. 2007). The most recent status review shows that a majority of hatcheries in ESU do not have an approved HGMP, and spawner abundance is extremely low for most core populations, where data is available. Because the main populations in the SONCC coho salmon ESU (i.e., Rogue River, Klamath River, and Trinity River) remain heavily influenced by hatcheries and have little natural production in mainstem rivers (Weitkamp et al. 1995, Good et al. 2005), without improvements to hatchery practices, many of these populations are at high risk of extinction relative to the genetic diversity parameter.

c. *Summary*

NMFS recently completed a status review for SONCC coho and determined that although short-term research and monitoring indicates that abundance of coho salmon has decreased for many populations in the SONCC ESU since the last status review in 2005, the biological status of this ESU and the threats facing this ESU indicate that it continues to remain threatened and has not declined to a point where it is considered endangered (NMFS 2011). Threats discussed in the five factor status review analysis (NMFS 2011) are largely unchanged since the 2005 status review with the exception of those associated with the listing criterion of other natural or manmade factors affecting the continued existence of the species. In particular, threats from poor ocean conditions, drought, climate change, and small population size (depensation and stochastic processes) have or are likely to have increased and may be responsible for the observed declines in abundance (NMFS 2011). NMFS concludes that recent available times series of population trends have been downward, notably the Shasta River population which exhibited a significant negative trend, as has the Rogue River Basin population in Oregon. NMFS concluded that these negative trends are cause for concern and resulted in a recommendation by NMFS that the ESU and relevant environmental conditions be carefully monitored and that the status of the ESU be reassessed in 2-3 years if it does not respond positively to improvements in environmental conditions and management actions (NMFS 2011).

4.2 Factors Responsible for the Current Status of the SONCC Coho Salmon Evolutionarily Significant Unit

When it listed the SONCC coho salmon ESU, NMFS identified the major activities responsible for the decline of coho salmon in Oregon and California and/or degradation of 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). The lack, or inadequacy, of protective measures in existing regulatory mechanisms, including land management plans (e.g., State Forest Practice Rules), Clean Water Act section 404 regulatory activities, urban growth management, and harvest and hatchery management contributed by varying degrees to the decline of coho salmon. Below, some of these major activities are covered in more detail.

a. Water Diversions and Habitat Blockages

Stream-flow diversions are common throughout the species' ranges. Unscreened diversions for agricultural, domestic and industrial uses are a significant factor for salmonid declines in many basins. Reduced stream-flows due to diversions reduce the amount of habitat available to salmonids and can degrade water quality, such as causing water temperatures to elevate more easily. Reductions in the water quantity will reduce the carrying capacity of the affected stream reach. Where warm return flows enter the stream, fish may seek reaches with cooler water, thus increasing competitive pressures in other areas.

Habitat blockages have occurred in relation to road construction. However, hydropower, flood control, and water supply dams of different municipal and private entities, particularly in the Klamath basin, have permanently blocked or hindered salmonid access to historical spawning and rearing grounds. Since 1918, the completion of Copco 1 Dam (RM 198.6) has blocked coho salmon access into upstream reaches of Klamath River and tributaries. In addition, the construction of IGD further blocked coho salmon access upstream of river mile (RM) 190. On the Eel River, the construction of the Potter Valley Project dams in 1908 has blocked access to a majority of the historic salmonid habitat within the mainstem Eel River watershed. As a result of migration barriers, salmon and steelhead populations have been generally confined to lower elevation mainstems that historically only were used for migration and rearing. Population abundances have declined in many streams due to decreased quantity, quality, and spatial distribution of spawning and rearing habitat (Lindley et al. 2007). Higher temperatures at these lower elevations during late-summer and fall are also a major stressor to adult and juvenile salmonids.

b. Commercial and Recreational Fisheries

Tribal Fishery

Tribal harvest was not considered to be a major threat to the SONCC coho salmon ESU when the ESU was listed under the ESA (60 FR 38011; July 25, 2011). Klamath basin tribes (Yurok, Hoopa, and Karuk) harvest a relatively small number of coho salmon for subsistence and ceremonial purposes (CDFG 2002). Coho salmon harvested by Native American tribes is primarily incidental to larger Chinook salmon subsistence fisheries in the Klamath and Trinity Rivers. Fishing for coho salmon within the Yurok tribe's reservation on the Lower Klamath River, which extends from about 2 miles upstream of Weitchpec, California, to the Pacific Ocean, has been monitored since 1992. The median Yurok harvest from the entire area from 1992 to 2009 was 418 coho salmon (Williams 2010), which approximates an average annual harvest of four percent of the total run (Williams 2010). Harvest rate estimates for the other two tribal fisheries are not available.

<u>Non-tribal Commercial Fishery</u>

Commercial fisheries have been identified as a major factor in the decline of the SONCC coho salmon ESU (60 FR 38011; July 25, 1995 and 69 FR 33102; June 14, 2004). However, coho salmon-directed fisheries and coho salmon retention from other fisheries have been prohibited off the coast of California since 1996. Therefore, the SONCC coho salmon ESU ocean exploitation rate is low and attributable to non-retention impacts in California and Oregon Chinook-directed fisheries and in Oregon's mark-selective coho fisheries. The Rogue/Klamath Rivers coho salmon ocean exploitation rate forecast time series from 2000 to 2010 (Figure 13) is the best available measure of ocean exploitation rate for the SONCC coho salmon ESU. This rate had been stable and averaged 6% over 2000–2007 prior to falling to 1% and 3% in 2008 and 2009, respectively, due to closure of nearly all salmon fisheries south of Cape Falcon, Oregon. For 2010, the forecast rate was 10% (Pacific Fisheries Management Council [PFMC] 2011) due primarily to the resumption of recreational fishing in 2010 off California and Oregon. However, preliminary post-season estimates show a 2.2% marine exploitation rate for 2010 (PFMC 2011). Because of the limited fishery since 2005, NMFS believes commercial fisheries have been a small threat to the SONCC coho salmon ESU in recent years.

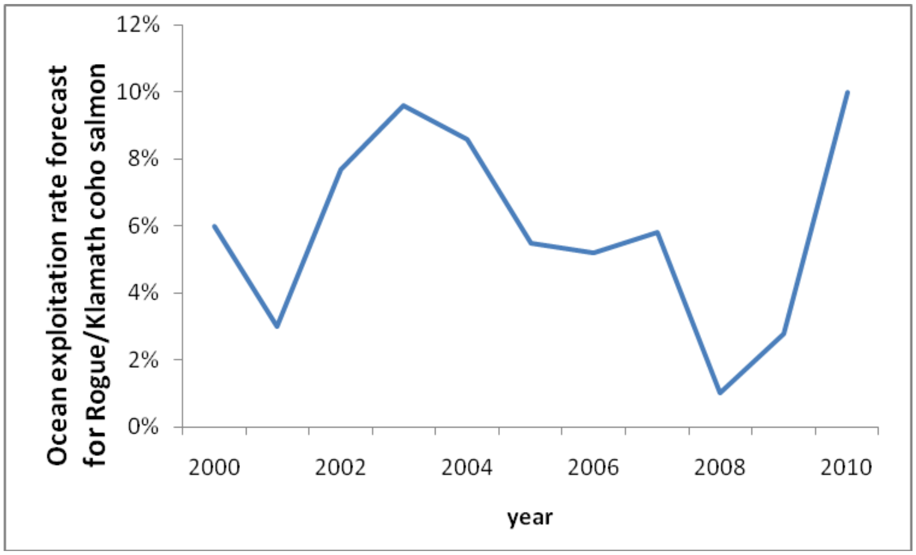

Figure 13. Rogue/Klamath coho salmon ocean exploitation rate forecast for years 2000-2010 (PFMC 2010).

c. Ocean Conditions

Variability in ocean productivity has been shown to affect fisheries production both positively and negatively (Chavez et al. 2003). Beamish and Bouillion (1993) showed a strong correlation between North Pacific salmon production and marine environmental factors from 1925 to 1989.

Coho salmon marine survival corresponds with periods of alternating cold and warm ocean conditions. Cold conditions are generally good for coho salmon, while warm conditions are not (Peterson et al. 2010). Unusually warm ocean surface temperatures and associated changes in coastal currents and upwelling, known as El Niño conditions, result in ecosystem alterations such as reductions in primary and secondary productivity and changes in prey and predator species distributions. Coho salmon along the Oregon and California coast may be especially sensitive to upwelling patterns because these regions lack extensive bays, straits, and estuaries, which could buffer adverse oceanographic effects. The paucity of high quality near-shore habitat, coupled with variable ocean conditions, makes freshwater rearing habitat essential for the survival and persistence of many coho salmon populations.

Data from hatchery fish at Cole Rivers Hatchery (Figure 14) indicate extremely low marine survival for the 2005 and 2006 broodyears (i.e., 0.05 and 0.07 %, respectively) compared with an average of approximately 2.2% between 2000 and 2004 (Williams et al. 2011). Strong upwelling in the spring of 2007 resulted in better ocean conditions (MacFarlane et al 2008, Peterson et al. 2010) for the 2005 coho salmon broodyear. Marine conditions in 2008 and 2009 have also been favorable (Figure 15), with 2008 being the best in the last 13 years (Northwest Fisheries Science Center 2011). Because salmon productivity and survival are correlated with ocean conditions (Peterson et al. 2010, Pearcy 1992 in Zabel et al. 2006, Beamish & Bouillon 1993), favorable marine conditions usually corresponds with increased marine survival. However, despite favorable marine conditions in 2007 and 2008, data on hatchery fish returns at Cole Rivers Hatchery show extremely poor marine survival for those respective year classes (i.e., 2005 and 2006 broodyears; Williams et al. 2011). While poor ocean conditions are likely to result in poor marine survival, recent improved ocean conditions generally have not resulted in improved marine survival and higher adult returns for SONCC ESU coho salmon. In 2008, adult spawner populations (2005 broodyear) within the Oregon Coast coho salmon ESU rebounded from recent declines (Lewis et al. 2009), while many SONCC ESU coho salmon populations, including Rogue River populations declined to near record low numbers. On average, coastal coho salmon populations are unable to replace themselves when marine survival falls below about 3% (Bradford et al. 2000). NMFS is concerned that the ocean conditions in 2010 do not indicate marine survival would be much different than recent lows of 0.05 and 0.07%, which are significantly below the 3% identified by Bradford et al. (2000) as generally unsustainable for populations. Therefore, poor marine survival poses a significant threat to the SONCC coho salmon ESU.

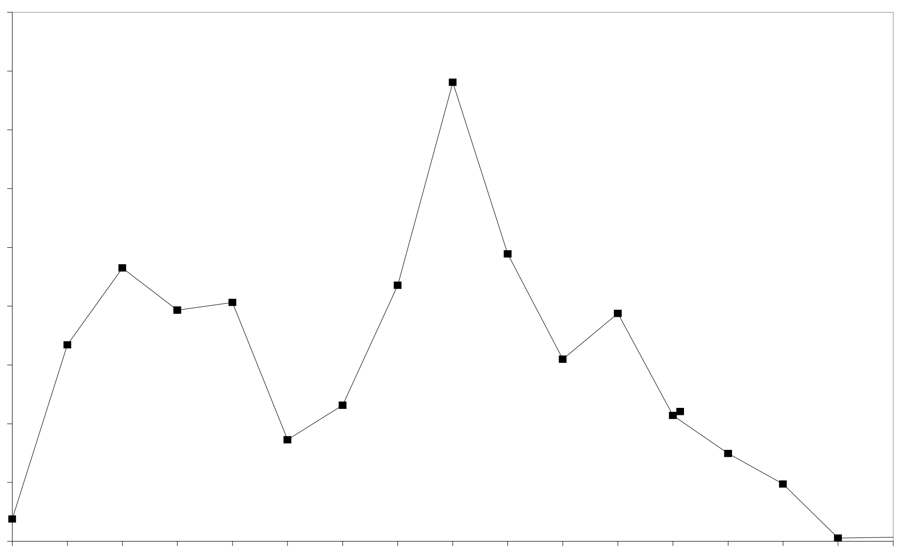

Figure 14. Survival of hatchery fish returning to Cole Rivers Hatchery (Rogue River) based on coded-wire-tag returns, broodyears 1990 – 2006 (data from ODFW).

	Year of Samples												
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Pacific Decadal Oscillation													
Dec–Mar	12	4	2	8	5	13	7	11	9	6	3	1	10
May–Sep	10	2	4	5	7	12	11	13	9	8	1	6	3
Multivariate El Niño Southern Oscillation Index													
MEI Annual	13	1	3	6	12	11	9	10	7	5	2	8	4
MEI Jan–Jun	13	2	3	4	9	10	7	11	5	8	1	6	12
Mean sea surface temperature (°C)													
Buoy 46050 (May–Sep)	11	8	3	4	1	7	13	10	5	12	2	9	6
NH 05 (May–Sep)	8	4	1	6	2	5	13	10	7	12	3	11	9
Winter prior to ocean entry (Nov–Mar)	13	10	3	5	6	9	11	8	7	2	1	4	12
Coastal upwelling													
Physical transition (upwelling index)	3	6	12	11	4	8	10	13	8	1	5	2	7
Anomalies (April–May)	7	1	12	3	6	10	9	13	7	2	4	5	11
Season length (upwelling index)	6	2	12	9	1	10	8	13	5	3	7	3	11
Deep water at NH 05 (May–Sep)													
Temperature (°C)	13	4	6	3	1	9	10	11	12	5	2	8	7
Salinity	13	3	6	2	5	11	12	8	7	1	4	9	10
Copepod indicators													
Biodiversity (species richness)	13	2	1	5	3	9	8	12	10	6	4	7	11
Anomalies	13	10	3	7	2	11	8	12	9	6	1	5	4
Community structure	13	3	4	6	1	9	10	12	11	7	2	5	8
Biological transition	13	7	5	3	6	11	9	12	10	4	1	2	8
Trawl survey catch													
Winter ichthyoplankton	13	6	2	4	5	9	12	8	11	10	1	7	3
Spring Chinook (June)	12	2	3	10	7	9	11	13	8	6	1	4	5
Coho (Sep)	9	2	1	4	3	5	10	12	7	8	6	13	11
Overall Ranking													
Mean rank	10.9	4.2	4.5	5.5	4.5	9.4	9.9	11.2	8.1	5.9	2.7	6.1	8.0
Rank of mean ranks	12	2	3	5	3	10	11	13	9	6	1	7	8

Figure 15. Rank scores of ocean ecosystem indicators. Lower numbers indicate better ocean ecosystem conditions, or "green lights" for salmon growth and survival. Figure from NMFS 2011.

d. Timber Harvest

Timber harvest and associated activities occur over a large portion of the range of the ESU. Timber harvest has caused widespread increases in sediment delivery to channels through both increased landsliding and surface erosion from harvest units, roads, and log decks. Significant amounts of old-growth and late-seral second-growth riparian vegetation along spawning streams has been removed, reducing future sources of large woody debris (LWD) needed to form and maintain stream habitat that salmonids depend on during various life stages.

The potential for delivering sediment to streams increases as hillslope gradients increase (Murphy 1995). The soils in virgin forests generally resist surface erosion because their coarse texture and thick layer of organic material and moss prevent overland flow (Murphy 1995). Activities associated with timber management decrease the ability of forest soils to resist erosion and contribute to fine sediment in the stream. Yarding activities that cause extensive soil disturbance and compaction can increase splash erosion and channelize overland flow. Site preparation and other actions which result in the loss of the protective humic layer can increase the potential for surface erosion (Hicks et al. 1991). Controlled fires can also consume downed wood that had been acting as sediment dams on hillslopes. After harvesting, root strength declines, often leading to slumps, landslides, and surface erosion (FEMAT 1993, Thomas et al. 1993).

Riparian tree roots provide bank stability and streambank sloughing. Erosion often increases if these trees are removed, leading to increases in sediment and loss of overhanging banks, which are important habitat for rearing Pacific salmonids (Murphy 1995). Where rates of timber harvest are high, the effects of individual harvest units on watercourses are cumulative. Therefore, in sub-watersheds where timber harvest is concentrated in a relatively short period of time, we expect that fine sediment impacts will be similarly concentrated. In smaller watercourses, wood that has fallen and recruited to the watercourse generally remains stable, so logs remain in place and act as check-dams that store sediment eroded from hillsides (Reid 1998). Sediment storage in smaller streams can persist for decades (Nakamura and Swanson 1993). In assessing the characteristics of ephemeral watercourses including within the Mad River watershed, Simpson Resource Company (2002) found that coniferous woody debris was the predominant channel bed grade control. Furthermore, where channels are prone to sediment debris flows, woody debris and adjacent riparian stands can provide roughness that limit the distance debris flows may travel down into channels (Ketcheson and Froehlich 1978, Pacific Watershed Associates (PWA) 1998). For example, in Bear Creek, a tributary to the Eel River, PWA (1998) noted that debris flows now travel farther downstream and channel aggradation extends farther downstream because of inadequate large wood from landslide source areas and streamside vegetation.

On larger channels, wood again stores sediment, and also provides a critical element in the habitat of aquatic life forms (Spence et al. 1996, Reid 1998). Sullivan et al. (1987) found that woody debris forms abundant storage sites for sediment in forest streams as large as fourth-order (20 to 50 km^2 drainage area), where storage is otherwise limited by steep gradients and confinement of channels between valley walls. Studies of this storage function in Idaho by Megahan and Nowlin (1976) and in Oregon by Swanson and Lienkamper (1978) indicated that annual sediment yields from small forested watersheds are commonly less than 10 percent of the sediment stored in channels.

In fish-bearing streams, woody debris is important for storing sediment, halting debris flows, and decreasing downstream flood peaks, and its role as a habitat element becomes directly relevant for Pacific salmon species (Reid 1998). LWD alters the longitudinal profile and reduces the local gradient of the channel, especially when log dams create slack pools above or plunge pools below them, or when they are sites of sediment accumulation (Swanston 1991).

Cumulatively, the increased sediment delivery and reduced woody debris supply from timber practices have led to widespread impacts to stream habitats and salmonids. These impacts include reduced spawning habitat quality, loss of pool habitat for adult holding and juvenile rearing, loss of velocity refugia, and increases in the levels and duration of turbidity which reduce the ability of juvenile fish to feed and, in some cases, may cause physical harm by abrading the gills of individual fish. These changes in habitat have led to widespread decreases in the carrying capacity of streams that support salmonids.

e. Road Construction

Road construction, whether associated with timber harvest or other activities, has caused widespread impacts to salmonids (Furniss et al. 1991). Where roads cross salmonid-bearing streams, improperly placed culverts have blocked access to many stream reaches. Land sliding and chronic surface erosion from road surfaces are large sources of sediment across the affected species' ranges. Roads also have the potential to increase peak flows and reduce summer baseflows with consequent effects on the stability of stream substrates and banks. Roads have led to widespread impacts on salmonids by increasing the sediment loads. The consequent impacts on habitat include reductions in spawning, rearing and holding habitat, and increases in turbidity. The delivery of sediment to streams can be generally considered as either chronically delivered, or more episodic in nature. Chronic delivery refers to surface erosion that occurs from rain splash and overland flow. More episodic delivery, on the order of every few years, occurs in the form of mass wasting events, or landslides, that deliver large volumes of sediment during large storm events. Road construction, use, and maintenance, tree-felling, log hauling, slash disposal, site preparation for replanting, and soil compaction by logging equipment are all potential sources of fine sediment that could ultimately be delivered to streams (Hicks et al. 1991, Murphy 1995).

Construction of road networks can also greatly accelerate erosion rates within a watershed (Haupt 1959, Swanson and Dyrness 1975, Swanston and Swanson 1976, Reid and Dunne 1984, Hagans and Weaver 1987). Once constructed, existing road networks are a chronic source of sediment to streams (Swanston 1991) and are generally considered the main cause of accelerated surface erosion in forests across the western United States (Harr and Nichols 1993). Processes initiated or affected by roads include landslides, surface erosion, secondary surface erosion (landslide scars exposed to rainsplash), and gullying. Roads and related ditch networks are often connected to streams via surface flow paths, providing a direct conduit for sediment. Where roads and ditches are maintained periodically by blading, the amount of sediment delivered continuously to streams may temporarily increase as bare soil is exposed and ditch roughness features which store and route sediment and also armor the ditch are removed. Hagans and Weaver (1987) found that fluvial hillslope erosion associated with roads in the lower portions of the Redwood Creek watershed produced about as much sediment as landslide erosion between 1954 and 1980. In the Mattole River watershed, which is south of the project area, the Mattole Salmon Group (1997) found that roads, including logging haul roads and skid trails, were the source of 76% of all erosion problems mapped in the watershed. This does suggest that overall, roads are a primary source of sediment in managed watersheds. Road surface erosion is particularly affected by traffic, which increases sediment yields substantially (Reid and Dunne 1984). Other important factors that affect road surface erosion include condition of the road surface, timing of when the roads are used in relation to rainfall, road prism moisture content, location of the road relative to watercourses, methods used to construct the road, and steepness on which the road is located.

f. Artificial Propagation (Hatcheries)

We acknowledge that issues relating to hatchery operations, such as the role of hatchery fish in the recovery of the SONCC coho salmon ESU, effects of hatchery releases on the overall productivity and abundance of the SONCC coho salmon ESU and the goals of hatchery programs can be confusing. Hatchery operations have the potential to conflict with the wider goal of SONCC coho salmon ESU recovery. It appears that there may be inconsistencies within certain policy documents, hatchery operations, and peer reviewed literature relating to the effects of hatchery fish on mixed populations of hatchery and naturally produced fish.

Three artificial propagation programs are considered to be part of the ESU: the Cole Rivers Hatchery (Rogue River), Trinity River Hatchery, and IGH (Klamath River) coho programs. These hatcheries produce not only coho salmon but also Chinook salmon and steelhead for release into the wild. Iron Gate (IGH), Trinity River, and Cole Rivers hatcheries release roughly 14,215,000 hatchery salmonids into SONCC coho salmon ESU rivers annually. Annual coho salmon production goals at these hatcheries are 75,000, 500,000, and 200,000, respectively. In addition to the three hatcheries, the Mad River and Rowdy Creek hatcheries in California and the Elk River Hatchery in Oregon produce steelhead and Chinook salmon that can prey on or compete with wild SONCC coho ESU salmon.

Natural populations in these basins are heavily influenced by hatcheries (Weitkamp et al. 1995, Good et al. 2005) through genetic and ecological interactions. Genetic risks associated with out-of-basin and out-of-ESU stock transfers have largely been eliminated. However, two significant genetic concerns remain: 1) the potential for domestication selection in hatchery populations such as the Trinity River, where there is little or no infusion of wild genes, and 2) out-of-basin straying by large numbers of hatchery coho salmon. Spawning by hatchery salmonids in rivers and streams is often not controlled (ISAB 2002) and hatchery fish can stray into rivers and streams, transferring genes from hatchery populations into naturally spawning populations (Pearse et al. 2007). CDFG (2002a) found that 29 percent of coho salmon carcasses recovered at the Shasta River Fish Counting Facility (SRFCF) had left maxillary clips in 2001, indicating that they were progeny from IGH. The average percentage of hatchery coho salmon carcasses recovered at the SRFCF from 2001, 2003, and 2004 was 16 percent (Ackerman et al. 2006). Although the actual percentages of hatchery fish in the river changes from year to year and depends largely on natural returns, these data indicate that substantial straying of IGH fish may be occurring in important tributaries of the Klamath River, and this straying has the potential to reduce the reproductive success of the natural population (Mclean et al. 2003,Chilcote 2003, Araki et al. 2007) and negatively affect the diversity of the interior Klamath populations via out breeding depression (Reisenbichler and Rubin 1999, HSRG 2004). More information is needed to determine the stray rate and its impact on natural populations. This can be problematic because hatchery programs have the potential to significantly alter the genetic composition (Reisenbichler and Rubin 1999,Ford 2002), phenotypic traits (Hard et al. 2000, Kostow 2004), and behavior (Berejikian et al. 1996, Jonsson 1997) of reared fish.

Genetic interactions between hatchery and naturally produced stocks can decrease the amount of genetic and phenotypic diversity of a species by homogenizing once disparate traits of hatchery and natural fish. The result can be progeny with lower survival (McGinnity et al. 2003, Kostow 2004) and ultimately, a reduction in the reproductive success of the natural stock (Reisenbichler and McIntyre 1977, Chilcote 2003, Araki et al. 2007), potentially compromising the viability of natural stocks via out breeding depression (Reisenbichler and Rubin 1999, HSRG 2004). Williams et al. (2008) considers a population to be at least at moderate risk of extinction if the proportion of naturally spawning fish that are of hatchery origin exceeds 5 percent. Flagg et al (2000) found that, depending on the carrying capacity of the system, increasing release numbers of hatchery fish often negatively impacts naturally-produced fish because these fish can get displaced from portions of their habitat. Competition between hatchery and naturally-produced salmonids can also lead to reduced growth of naturally produced fish (McMichael et al. 1997). Kostow et al. (2003) and Kostow and Zhou (2006) found that over the duration of the steelhead hatchery program on the Clackamas River, Oregon, the number of hatchery steelhead in the upper basin regularly caused the total number of steelhead to exceed carrying capacity, triggering density-dependent mechanisms that impacted the natural population. Competition between hatchery and natural salmonids in the ocean can also lead to density-dependent mechanisms that affect natural salmonid populations, especially during periods of poor ocean conditions (Beamish et al. 1997, Levin et al. 2001, Sweeting et al. 2003).

g. Climate Change

New information since the SONCC coho salmon ESU was listed suggests that the earth's climate is warming, and that this change could significantly impact ocean and freshwater habitat conditions, which affects survival of coho salmon. In the coming years, climate change will influence the ability to recover some salmon species in most or all of their watersheds. Of all the Pacific salmon species, coho salmon are likely one of the most sensitive to climate change due to their extended freshwater rearing. Additionally, SONCC coho salmon ESU are near the southern end of the species' distribution and many populations reside in degraded streams that have water temperatures near the upper limits of thermal tolerance for coho salmon. For these reasons, climate change poses a new threat to the viability of the SONCC coho salmon ESU. Across the entire range of the SONCC coho salmon ESU, there may be dramatic changes in the spatial structure, diversity, abundance, and productivity. Together these changes may influence the future viability of individual populations, as well as the overall viability of the ESU. Specific factors of a population or its habitat that could influence its vulnerability to climate change include its reliance on snowpack, its current temperature regime (how close is it to lethal temperatures already), the extent of barriers that may block access to critical habitat and refugia areas, the range of ecological processes that are still intact, and the current life history and genetic diversity.

Water temperature is likely to increase overall, with higher high temperatures along with higher low temperatures in streams. The increase in winter temperatures will be especially dramatic. A recent study in of the Rogue River basin determined that annual average temperatures are likely to increase from 1 to 3° F (0.5 to 1.6° C) by around 2040, and 4 to 8° F (2.2 to 4.4° C) by around 2080. Summer temperatures may increase dramatically reaching 7 to 15° F (3.8 to 8.3° C) above baseline by 2080, while winter temperatures may increase 3 to 8°F (1.6 to 3.3° C) (Doppelt et al. 2008). Changes in temperature throughout the range of the SONCC coho salmon ESU are likely to be similar. The individual increases in temperature that we are likely to see within a specific stream or stream reach will depend on factors such as riparian condition, groundwater and spring influence, the presence of upstream impoundments, and stream flow (Bartholow 2005). Increases in winter and spring temperature regimes may cause eggs to develop more quickly, leading to early emergence. Early fry may be disoriented or displaced downstream during high spring flows, which increases their exposure to predators or the ocean prematurely. Higher spring temperatures will increase the growth rates of fry; however, increases in summer temperatures will lead to thermal stress and decreased growth and mortality of juveniles. The increase in winter water temperatures will be especially dramatic since flows in many streams are expected to continue decreasing as a result of decreasing snowpack (Crozier et al 2008, Doppelt et al. 2008, Luers et al. 2006).

Recent projections indicate that snowpack in northern California and southern Oregon will decrease by 60-75% by 2040 and will disappear almost completely by 2080. Levels will be less than 10 inches SWE (snow water equivalent) in the few areas where snowpack remains (Doppelt et al. 2008, Luers et al. 2006). This loss of snowpack will continue to create lower spring and summertime flows while additional warming will cause earlier onset of runoff in streams. Changes in the timing of runoff will shift downstream migration timing to be earlier and may ultimately influence the survival of smolts depending on the timing of upwelling and favorable ocean conditions. Annual precipitation could increase by up to 20% over northern California. Most precipitation will occur during the mid-winter months as intense rain and rain-on-snow events that will be linked to higher numbers of landslides and greater and more severe floods (Doppelt et al. 2008, Luers et al. 2006). Overall, there will be earlier and lower low-flows and earlier and higher high-flows. Increased flooding may cause eggs to be scoured from their nests; displace overwintering juveniles; and contribute to higher summer water temperatures. In coastal and estuarine ecosystems, where coho salmon reside as juveniles, the threats from climate change largely come in the form of sea level rise and the loss of coastal wetlands. Sea level will likely rise exponentially over the next 100 years, with possibly a 50-80 cm rise by the end of the 21st century (USGCRP 2002). This rise in sea level will alter the habitat in estuaries and either provide increased opportunity for feeding and growth of coho salmon or in some cases will lead to the loss of estuarine habitat and a decreased potential for estuarine rearing. Marine ecosystems face an entirely unique set of stressors related to global climate change, all of which may have deleterious impacts on coho salmon growth and survival while at sea. In general, the effects of changing climate on marine ecosystems are not well understood given the high degree of complexity and the overlapping climatic shifts that are already in place (e.g. El Niño, La Niña, Pacific Decadal Oscillation) and will interact with global climate changes in unknown and unpredictable ways.

Current and projected changes in the North Pacific include rising sea surface temperatures that increase the stratification of the upper ocean; changes in surface wind patterns that impact the timing and intensity of upwelling of nutrient-rich subsurface water; and increasing ocean acidification which will change plankton community compositions with bottom-up impacts on marine food webs (ISAB 2007). Ocean acidification also has the potential to dramatically change the phytoplankton community due to the likely loss of most calcareous shell-forming species such as pteropods. Recent surveys show that ocean acidification is increasing in surface waters off the west coast, and particularly off northern California, even more rapidly than previously estimated (Feely et al. 2008). For coho salmon, shifts in prey abundance, composition, and distribution are the indirect effects of these changes. Direct effects are decreased growth rates due to ocean acidification and increased metabolic costs due to the rise in sea surface temperature (Portner and Knust 2007). Another consequence is that salmon must travel further from their home streams to find satisfactory marine habitat, which will increase energy demands, slow growth and delay maturity (ISAB 2007). Coho salmon typically do well when ocean conditions are cool and upwelling occurs. Because conditions may be warmer and upwelling may be delayed, salmon may encounter less food or may have to travel further from their home ranges to find satisfactory habitat, increasing energy demands, slowing growth and delaying maturity.

Global average surface temperature has increased by approximately 0.7°C during the 20th Century (IPCC 2007) and appears to be accelerating, and the global trend over the past 50 years is nearly twice that rate. Regional trends in temperature show even greater warming tendencies. In general, conditions in the climate and within the ecosystems on which coho salmon rely will change dramatically and at an ever-increasing rate. In the near future, climate change will likely surpass habitat loss as the primary threat to the conservation of most species (Thomas et al. 2004). Climate change is having, and will continue to have, an impact on salmonids throughout the Pacific Northwest and California (Battin et al. 2007). Overall, climate change is believed to represent a growing threat for the SONCC ESU, and will challenge the resilience of coho salmon.

h. Stochastic Pressure

SONCC ESU coho salmon populations have declined significantly (e.g., Shasta River population;) and are facing an additional threat from stochasticity. Stochasticity is defined as random fluctuations that have no systematic direction, and can effect populations through genetic, demographic, or environmental changes (NMFS 2012). These forces have been shown to reduce population size and when populations are reduced to very low densities, they can experience reduced rates of survival and reproduction (Allee 1938, Wood 1987). Over the long term, a series of unlucky generations in which there are successive declines in population size can lead to extinction even if the population is growing, on average (NMFS 2012). Many populations, such as the Shasta River population, are at a high risk of extinction because of their small population size (e.g., only 30, 9 adults [all males], and 46 spawners returned to the Shasta River in the 2008, 2009 and 2010 spawning seasons, respectively). With a majority of SONCC ESU coho salmon populations at low abundance, stochastic pressures become an increased and significant factor in the extinction process. Small populations have a significantly increased risk of extinction (Schaffer 1981, McElhany et al 2000, Fagan and Holmes 2006). In fact, time-to-extinction decreases logarithmically with population size (Lande 1993, Fagan and Holmes 2006). Population declines are likely to beget further declines, especially for small populations because stochastic factors exert more influence (Fagan and Holmes 2006). Small populations can be affected by multiple forms of stochasticity, not all of which affect large populations (Lande 1993). The fact that small populations can be affected by multiple forms of stochasticity results in extinction probabilities substantially greater than the extinction probabilities that would occur from of a single form of stochasticity (Melbourne and Hastings 2008). Random events in small populations may have a large impact on population dynamics and population persistence. Small populations face both deterministic (the result of systematic forces that cause population decline (e.g., overexploitation, development, deforestation, loss of pollinators, inability to find mates, inability to defend against predators)) and stochastic (the result of random fluctuations that have no systematic direction). If the rate of population growth varies from one generation to the next, a series of generations in which there are successive declines in population size can lead to extinction even if the population is growing, on average, over a longer period. Many SONCC ESU coho salmon populations have declined to such a low point that they may be influenced by natural stochastic processes (e.g., Shasta River, Middle Mainstem Eel River, Mainstem Eel River, Upper Mainstem Eel River, and Mattole River populations), in addition to deterministic threats, that make recovery of the SONCC coho salmon ESU difficult. As populations get smaller, the number of interacting stochastic processes increases. These stochastic processes can create alterations in genetics, breeding structure, and population dynamics that may interfere with persistence of the species. This stochastic pressure can express itself in four ways: genetic, demographic, environmental, and catastrophic events (Schaffer 1981, Lande 1993, McElhany et al. 2000, Reed et al. 2007).

Genetic stochasticity refers to changes in the genetic composition of a population unrelated to systematic forces (selection, inbreeding, or migration), i.e., genetic drift. Genetic stochasticity can have a large impact on the genetic structure of populations, both by reducing the amount of diversity retained within populations and by increasing the chance that deleterious recessive alleles may be expressed. The loss of diversity could limit a population's ability to respond adaptively to future environmental changes. In addition, the increased frequency with which deleterious recessive alleles are expressed (because of increased homozygosity) could reduce the viability and reproductive capacity of individuals. Demographic stochasticity refers to the variability in population growth rates arising from random differences among individuals in survival and reproduction within a season. This variability will occur even if all individuals have the same expected ability to survive and reproduce and if the expected rates of survival and reproduction don't change from one generation to the next. Even though it will occur in all populations, demographic stochasticity is generally important only in populations that are already small (Lande 1993, McElhany et al. 2000). In very small populations, demographic stochasticity can lead to extinction. Environmental stochasticity is the type of variability in population growth rates that refers to variation in birth and death rates from one season to the next in response to weather, disease, competition, predation, or other factors external to the population (Melbourne and Hastings 2008). Catastrophic events are sudden, rare occurrences that severely reduce or eliminate an entire population in a relatively short period of time (McElhany et al. 2000). For example, the 1964 flood in northern California significantly degraded many watersheds and reduced the abundance of many SONCC ESU coho salmon populations. These stochastic processes always occur, but they don't always significantly influence population dynamics until populations are small. Due to the low abundance of most SONCC ESU coho salmon populations, stochastic pressure may be one of the most significant threats to their persistence. Stochastic events have likely contributed to population instability and decline for many SONCC ESU coho populations, which may explain why recent adult returns remain low despite improved ocean conditions since 2007 and significant reductions in bycatch mortality from recent fishery closures.

i. Watershed Restoration

There are various restoration and recovery actions underway across the ESU aimed at improving habitat and water quality conditions for anadromous salmonids. Watershed restoration activities have improved freshwater habitat conditions in some areas, and are helping to reduce the stressors to SONCC ESU coho salmon. The California Department of Fish and Game created both a multi-stakeholder Coho Recovery Team to address rangewide recovery issues, and a sub-working group [Shasta –Scott Recovery Team (SSRT)] to develop coho salmon recovery strategies associated specifically with agricultural management within the Scott and Shasta Rivers to return coho salmon to a level of viability so that they can be delisted. The California Department of Fish and Game has been prioritizing restoration proposals that are consistent with the coho salmon recovery strategies for funding under the Fisheries Restoration Grant Program. Since 2005, several significant fish passage improvements have occurred throughout the ESU. In the Rogue River, three dams have been recently removed (i.e. Savage Rapids Dam in 2009, Gold Hill Dam in 2008, and Gold Ray Dam in 2010) and one notched (i.e. Elk Creek Dam in 2008) to restore natural flow and fish passage. The Rogue River now flows unimpeded for 157 miles from the Cascade foothills to the ocean, increasing salmon returns by an estimated 22% (ODFW 2011). In addition, 75 barriers in California portion of the SONCC ESU have been remediated since 2005, through the CDFG Fisheries Restoration Grant Program (Carpio 2010). Overall, coho salmon passage has improved, but barriers remain a major threat because many are still unaddressed and continue to block passage. In addition, the five northern California counties affected by the Federal listing of coho salmon (which includes Humboldt County) have created a 5 County Conservation Plan that will establish continuity among the counties for managing anadromous fish stocks (Voight and Waldvogel 2002). The plan identifies priorities for monitoring, assessment, and habitat restoration projects. The Bear Creek Watershed Council (Rogue River tributary) is developing restorative, enhancement, and rehabilitative actions targeted at limiting factors. Similarly, several assessments have been completed for the Oregon coast in coordination with the Oregon Watershed Enhancement Board. These plans and assessments are helping to reduce, or stabilize, sediment inputs into streams throughout the ESU. Additionally, in areas where riparian vegetation has been replanted or enhanced, stream temperatures and cover for salmonids has been positively affected.

j. Disease

Coho salmon are exposed to numerous bacterial, protozoan, and parasitic pathogens throughout their lives, and have evolved with exposure to these and other organisms (Stocking and Bartholomew 2004). Susceptibility to disease changes according to fitness level, environmental condition, and overall health. When water quality deteriorates, diminished flows cause crowding and stress, or when parasite spore loads are extremely high, then lethal disease outbreaks can occur (Spence et al., 1996, Guillen, 2003, CDFG 2003, YTEP 2004, Foott 1995, Nichols and Foott 2005). Disease issues arise when the interaction between host and pathogen is altered and when natural resistance levels become impaired by stressful environmental conditions or decreased fitness levels. Within the last few decades, the prevalence of diseases in wild stocks has become of increasing concern, and has begun to be a factor in the continuing survival and viability of wild stocks of coho salmon (CDFG 2002a).

C. shasta and *P. minibicornis* are myxosporean parasites found in a number of Pacific Northwest watersheds (Hoffmaster et al. 1988, Bartholomew et al. 1989, Jones et al. 2004, Bartholomew et al. 2006). These both have parasite life cycles which include the polychaete, *Manayunkia speciosa*, as an alternate host (Hoffmaster *et al.* 1988, Jones *et al.* 2004, Bartholomew et al. 2006). The actinospore, a stage that is infectious to salmon, is released from infected polychaetes into the water column, and infections by *C. shasta* can occur from spring through fall at water temperatures > 7°C (Ching and Munday 1984, Henderickson et al. 1989). Myxospores develop within infected salmonids (particularly migratory adults infected during declining water temperature periods), and it is this stage that, once shed from fish, can infect polychaetes to complete the life cycle (Bartholomew et al. 1997). Studies conducted in 2004 and 2005 suggest that *P. minibicornis* has seasonality similar to that of *C. shasta*, while its actinospore concentration and infectivity appears greater than *C. shasta* (Foott et al. 2006, Nichols and Foott 2005).

4.3 SONCC Coho Salmon Evolutionarily Significant Unit Critical Habitat

4.3.1 Summary of Designated Critical Habitat

Critical habitat for the SONCC coho salmon ESU includes all accessible waterways, substrate, and adjacent riparian zones between Cape Blanco, Oregon and Punta Gorda, California (64 FR 24049; May 5, 1999). Excluded are: (1) areas above specific dams identified in the FR notice; (2) areas above longstanding natural impassible barriers (*i.e.*, natural waterfalls); and (3) tribal lands. 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 (essential features) 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. Within the range of the SONCC coho salmon ESU, the life cycle of the species 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. Areas 1 and 5 are often located in small headwater streams and side channels, while areas 2 and 4 include these tributaries as well as mainstem reaches and estuarine zones. Growth and development to adulthood (area 3) occurs primarily in near-and off-shore marine waters, although final maturation takes place in freshwater tributaries when the adults return to spawn. Within these areas, essential features of coho salmon critical habitat 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 (64 FR 24049; May 5, 1999).

4.3.2 Factors Affecting Critical Habitat

Except for ocean conditions, commercial fisheries, and stochasticity, the factors responsible for the current status of the SONCC coho salmon ESU (section 4.2 above) also affect critical habitat of the SONCC coho salmon ESU.

4.3.3 Current Condition of Critical Habitat at the Evolutionarily Significant Unit Scale

Because the diversity of life history strategies of coho salmon include spending one and sometimes up two years rearing in freshwater (Bell and Duffy 2007), they are especially susceptible to changes within the freshwater environment, more so than fall-run Chinook salmon for example, which migrate to the ocean shortly after emerging from spawning gravels. The condition of habitat throughout the range of the SONCC coho salmon ESU is degraded, relative to historical conditions. While some relatively unimpaired streams exist within the ESU, decades of intensive timber harvesting, mining, agriculture, channelization, and urbanization have altered coho salmon critical habitat, sometimes to the extent that it is no longer able to support one or more of the life stages of coho salmon. Below, we provide a summary of the condition of the essential habitat types necessary to support the life cycle of the species (64 FR 24049; May 5, 1999).

a. Juvenile Summer and Winter Rearing Areas

Juvenile summer and winter rearing areas should contain adequate substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, and space. These essential features are necessary to provide sufficient growth and reasonable likelihood of survival to smoltification. In the SONCC coho salmon ESU, juvenile summer rearing areas have been compromised by low flow conditions, high water temperatures, insufficient dissolved oxygen concentration levels, excessive nutrient loads, invasive species, habitat loss, disease effects, pH fluctuations, sedimentation, removal or non-recruitment of large woody debris, stream habitat simplification, and loss of riparian vegetation. Winter rearing areas suffer from high water velocities due to excessive surface runoff during storm events, suspended, removal or non-recruitment of large woody debris and stream habitat simplification. Changes to streambeds and substrate, as well as removal of riparian vegetation have limited the amount of invertebrate production in streams, which has in turn limited the amount of food available to rearing juveniles. Some streams in the ESU remain somewhat intact relative to their historical condition, but the majority of the waterways in the ESU fail to provide sufficient juvenile summer and winter rearing areas.

b. Juvenile Migration Corridors

Juvenile migration corridors need to have sufficient water quality, water quantity, water temperature, water velocity, and safe passage conditions in order for coho salmon juveniles and smolts to emigrate to estuaries and the ocean, or to redistribute into non-natal rearing zones. Adequate juvenile migration corridors need to be maintained throughout the year because smolts emigrate to estuaries and the ocean from the early spring through the late summer, while juveniles may redistribute themselves at any time in response to fall freshets or while seeking better habitat and rearing conditions. In the ESU, juvenile migration corridors suffer from low flow conditions, disease effects, high water temperatures and low water velocities that slow and hinder emigration or upstream and downstream redistribution. Low DO levels, excessive nutrient loads, insufficient pH levels and other water quality factors also afflict juvenile migration corridors.

c. Adult Migration Corridors

Adult migration corridors should provide satisfactory water quality, water quantity, water temperature, water velocity, cover/shelter and safe passage conditions in order for adults to reach spawning areas. Adults generally migrate in the fall or winter months to spawning areas. During this time of year, suspended sediment makes respiration for adults difficult. Removal or non-recruitment of woody debris and stream habitat simplification limits the amount of cover and shelter needed for adults to rest during high flow events. Low flows in streams can physically hinder adult migration, especially if fall rain storms are late or insufficient to raise water levels enough to ensure adequate passage. Poorly designed culverts and other road crossings have truncated adult migration corridors and cut off hundreds of miles of stream habitat throughout the SONCC coho salmon ESU. While adult migration corridors are a necessary step in the lifecycle for the species, the condition of this particular essential habitat type in the ESU is probably not as limiting, in terms of recovery of the species, as other essential habitat types, such as juvenile summer and winter rearing areas.

d. Spawning Areas

Spawning areas for the SONCC coho salmon ESU must include adequate substrate, water quality, water quantity, water temperature, and water velocity to ensure successful redd building, egg deposition and egg to fry survival. Coho salmon spawn in smaller tributary streams from November through January in the ESU. A widespread problem throughout the ESU is sedimentation and embedding of spawning gravels, which makes redd building for adults difficult and decreases egg-to-fry survival. Excessive runoff from storms, which causes redd scouring, is another issue that plagues adult spawning areas. Low or non-recruitment of spawning gravels is common throughout the ESU, limiting the amount of spawning habitat.

e. SONCC Coho Salmon ESU Critical Habitat Summary

The current function of critical habitat in the SONCC coho salmon ESU has been degraded relative to its unimpaired state. Although there are exceptions, the majority of streams and rivers in the ESU have impaired habitat. Additionally, critical habitat in the ESU often lacks the ability to establish essential features due to ongoing human activities. For example, large dams, such as IGD on the Klamath River, California, impede the recruitment of spawning gravels, which impacts both an essential habitat type (spawning areas) as well as an essential feature of spawning areas (substrate). Water utilization in many regions throughout the ESU reduces summer baseflows, which limits the establishment of several essential features such as water quality and water quantity.

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 the proposed action, as required by regulation ("effects of the action" definition in 50 CFR 402.02). The evaluation in the *Environmental Baseline* of the current extinction risk for each coho salmon population within the action area, and the condition of critical habitat for each population provides a reference condition at the population scale to which NMFS will later add the effects of the proposed action in the *Integration and Synthesis* section of the Opinion to determine if the action is expected to affect the population's risk of extinction. These assessments of effects are described in the *Effects of the Action* section (Section VI of this Opinion), the *Cumulative Effects* section (Section VIII of this Opinion), and the *Integration and Synthesis* section (Section IX of this Opinion).

5.1 SONCC Evolutionarily Significant Unit Coho Salmon

5.1.1 Periodicity of Coho Salmon in the Action Area

The periodicity of a population, or multiple populations of fish, refers to the quality or state of being periodic, or recurrence at regular intervals.   Coho salmon were once numerous and widespread within the Klamath River basin (Snyder 1931), but now the small populations that remain occupy limited habitat within tributary watersheds and the mainstem Klamath River below IGD (CDFG 2002, NRC 2004). This section outlines the life history traits and seasonal periodicities of coho salmon inhabiting the Klamath River, specifically within the action area.

Adult migration and spawning

Adult coho salmon typically begin entering the lower Klamath River in late September (but as early as late August in some years), with peak migration occurring in mid-October (Ackerman et al. 2006). They move into the portion of the mainstem from IGD to Seiad Valley from the late fall through the end of December (USFWS 1998). Many returning adults seek out spawning habitat in sub-basins, such as the Scott, Shasta and Trinity rivers, as well as smaller mainstem tributaries throughout the basin with unimpeded access, functional riparian corridors and clean spawning gravel. Coho salmon have been known to migrate at water temperatures up to 19ºC in the Klamath River (Strange 2008). Coho salmon spawning within the Klamath River basin usually commences within a few weeks after arrival at the spawning grounds (NRC 2004) between November and January (Leidy and Leidy 1984).

Coho salmon spawning has been documented in low numbers as early as November 15 within the mainstem Klamath River. From 2001 to 2005, Magneson and Gough (2006) documented a total of 38 coho salmon redds (egg “nests” within streambed gravels) between IGD (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 IGH.

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 redds for another 4 to 10 weeks, further developing while subsisting off their yolk sac. Once most of the yolk sac is absorbed, the 30 to 50 millimeter fish (then termed “fry”) begin emerging from the gravel in search of shallow stream margins for foraging and safety (NRC 2004). Within the Klamath River, fry begin emerging in mid-February and continue through mid-May (Leidy and Leidy 1984).

Juvenile Rearing

Fry

After emergence from spawning gravels within the mainstem Klamath River, or as they move from their natal streams into the river, coho salmon fry distribute themselves upstream and downstream while seeking favorable rearing habitat (Sandercock 1991). Further redistribution occurs following the first fall rain freshets as fish seek stream areas conducive to surviving high winter flows (Ackerman et al. 2006, YTFP unpublished data). Coho salmon fry have been found occupying habitats with water velocities of 0.0-1.07 m/s, with the most heavily utilized habitats having water velocities of 0.1 to 0.5 m/s (Hardy et al. 2006). They use areas with water depths of 0.06 to 0.88 m, with the most utilized habitats having water depths of 0.21 to 0.4 m (Hardy et al. 2006). Coho salmon fry are thought to grow best at water temperatures of 12 to 14ºC (Moyle 2002). They do not persist for long periods of time at water temperatures from 22ºC to 25ºC (Moyle 2002), unless they have access to thermal refugia. Temperatures greater than 26ºC are invariably lethal (Moyle 2002). Large woody debris and other instream cover are heavily utilized by coho salmon fry (Nielsen 1992, Hardy et al. 2006), indicating the importance for access to cover in coho salmon rearing.

Parr

As coho salmon fry grow larger (50-60 mm) they transform physically (developing vertical dark bands or “parr marks”), and behaviorally begin partitioning available instream habitat through aggressive agonistic interactions with other juvenile fish (Quinn 2005). These 50 to 60 mm fish are commonly referred to as “parr,” and will remain at this stage until they migrate to the ocean. Typical parr rearing habitat consists of slow moving, complex pool habitat commonly found within small, heavily forested tributary streams (Moyle 2002, Quinn 2005). When rootwads, large woody debris, or other types of cover are present, growth is bolstered (Nielsen 1992), which increases survival. Water temperature requirements of parr are similar to that of fry.

Some coho salmon parr redistribute following the first fall rain freshets, when fish seek stream areas conducive to surviving high winter flows (Ackerman et al. 2006, Soto et al 2009, Hillemeier et al. 2009). The Yurok Tribal Fisheries Program (YTFP) and the Karuk Tribal Fisheries Program (KTFP) have been monitoring juvenile coho salmon movement in the Klamath River using passive integrated transponder (PIT) tags. Some coho salmon parr, tagged by KTFP, have been recaptured in ponds and sloughs over 90 river miles away in the lower 6-7 miles of Klamath River. The PIT tagged fish appear to leave the locations where they were tagged in the fall or winter following initial fall freshets before migrating downstream in the Klamath River to off-channel ponds near the estuary where they are thought to remain and grow before emigrating as smolts the following spring (Voight 2008). Several of the parr (~65 mm) that were tagged at locations like Independence Creek (rm 95), were recaptured at the Big Bar trap (rm 51), which showed pulses of emigrating coho salmon during the months of November and December following rainstorms (Soto 2008). Some PIT-tagged parr traveled from one stream and swam up another, making use of the mainstem Klamath during late summer cooling events. Summer cold fronts and thunderstorms can lower mainstem temperatures, making it possible for juvenile salmonids to move out of thermal refugia during cooling periods in the summer (Sutton et al. 2004)

Juvenile coho salmon (parr and smolts) have been observed residing within the mainstem Klamath River downstream of IGD within the Upper Klamath Population Unit throughout the summer and early fall in thermal refugia during periods of high ambient water temperatures (>22ºC). Mainstem refugia areas are often located near tributary confluences, where water temperatures are 2 to 6°C lower than the surrounding river environment (NRC 2004, Sutton et al. 2004). Habitat conditions of refugia zones are not always conducive for coho salmon because several thousand fish can be crowded into small areas, leading to predator aggregation, increasing competition, and thereby triggering density dependent mechanisms. Robust numbers 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 refugia areas within the Middle and Lower Klamath Population Units (Sutton *et al.*2004). No coho salmon were observed within extensive cold-water refugia habitat adjacent to lower river tributaries such as Elk Creek (rm 107), Red Cap Creek (rm 53), and Blue Creek (rm 16) during past refugia studies (Sutton *et al.*2004). However, Naman and Bowers (2007) captured 15 wild coho salmon ranging in size from 66 mm to 85 mm in the Klamath River between Pecwan and Blue creeks near cold water seeps and thermal refugia during June and July of 2007.

Juvenile outmigration

Migrating smolts are usually present within the mainstem Klamath River between February and the beginning of July, with April and May representing the peak migration months Migration rate tends to increase as fish move downstream (Stutzer et al. 2006). Yet, some coho salmon smolts may stop migrating entirely for short periods of time if factors such as water temperature inhibit migration. 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). Salmonid smolts may further delay their downstream migration by residing in the lower river and/or estuary (Voight 2008). Sampling indicates coho salmon smolts are largely absent from the Klamath River estuary by July (NRC 2004). Peak emigration timing varies throughout the basin from April until July, depending on the system and the age class of fish moving (BOR 2008, Pinnix et al. 2007). Many coho salmon parr migrate downstream from the Shasta River and into the mainstem Klamath River during the spring months after emergence and a brief (<3 month) rearing period in the Shasta River (Chesney et al. 2007). In several different years, personnel from CDFG noticed a distinct emigration of 0+ (sub yearling, ≤1 year of age) smolts around the week of May 21 on the Shasta River. Analysis of scales samples indicates that most of these fish are less than one year old (Chesney et al. 2007). Unlike the 0+ coho parr in the canyon that are leaving the Shasta River due to loss of habitat, these fish appear to be smolting.

The variability of early life history behavior of coho salmon recently observed by Chesney et al. (2007) and by the Yurok and Karuk tribes mentioned in the sections above is not unprecedented; coho salmon have been shown to spend up to two years in freshwater (Bell and Duffy 2007), migrate to estuaries within a week of emerging from the gravels (Tschaplinski 1988), enter the ocean at less than one year of age at a length of 60 to 70 mm (Godfrey et al. 1975), and redistribute into riverine ponds following fall rains (Peterson 1982, Soto et al 2009, Hillemeier et al 2009). Taken together, the research by the Yurok and Karuk tribes, plus the research from outside the Klamath basin, indicate that coho salmon in the Klamath River exhibit a diversity of early life history strategies, utilizing the mainstem Klamath River throughout various parts of the year as both a migration corridor and a rearing zone.

5.2 Current Conditions within the Action Area

The following section will discuss the current conditions of habitat within the five population units within the action area. The five population units within the action area are the Upper Klamath, Middle Klamath, Shasta River, Scott River, and Lower Klamath River population units.

5.2.1 Barriers and Limited Habitat Access

Upper Klamath

The Upper Klamath population unit boundaries (Figure 16) are from Portuguese Creek (non-inclusive), upstream to Spencer Creek (inclusive), including Seiad and Grider Creeks (Williams et al. 2006).

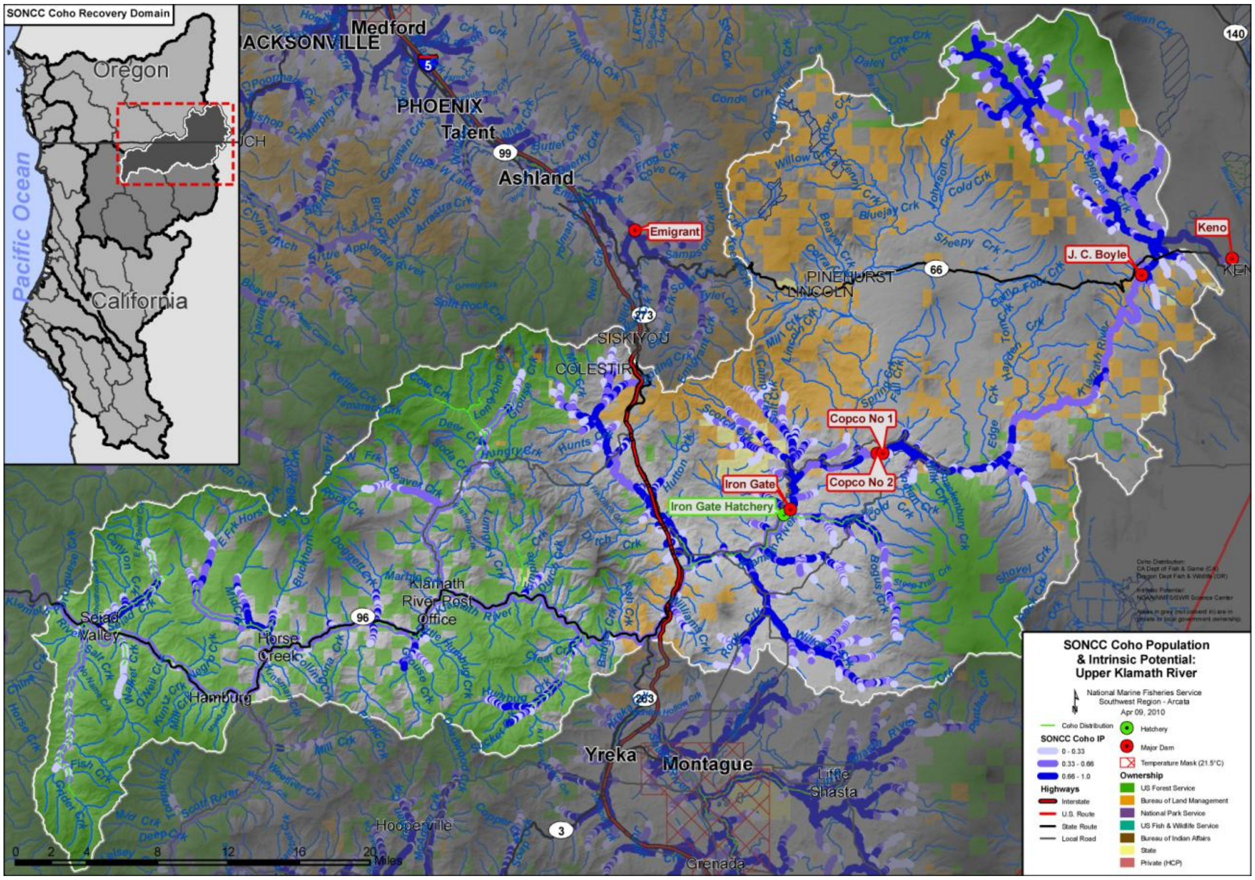

Figure 16. Boundary of the Upper Klamath River coho salmon population. Figure shows Intrinsic Potential of habitat, ownership, coho salmon distribution, and location within the Southern Oregon/Northern California Coast Coho Salmon ESU and the Interior Klamath diversity stratum (Williams et al. 2006).

IGD blocks coho salmon access to upstream river and tributary reaches (up to and including, Spencer Creek) that are believed to have been historically inhabited by coho salmon from the Upper Klamath coho population (NMFS 2007). Approximately 58 miles of this habitat is believed to have been historically suitable for coho salmon including 21.6 miles of tributary habitat (NMFS 2007, Hamilton et al. 2005). Hydropower, flood control, and water supply dams of different municipal and private entities, block or hinder salmonid access to historical spawning and rearing grounds in the Upper Klamath basin. This blocked habitat constitutes 40 percent of the historic habitat of the Upper Klamath coho population (Williams et al. 2006). This habitat once consisted of high quality, cold-water spawning and rearing habitat with high intrinsic potential for coho salmon spawning and rearing. Intrinsic potential (IP) is determined from modeling which assesses a stream's capacity to provide high-quality habitat for coho based on pre-defined geomorphic characteristics (e.g. gradient and temperature). At least 10 miles of perennial stream reaches that are blocked by Project facilities have gradients below 4 percent including Jenny Creek, Fall Creek, Shovel Creek, and Spencer Creek. As a result of many decades of anthropogenic-caused disturbances to historical, quality habitat, coho salmon within the Upper Klamath River population now spawn and rear downstream of IGD primarily within several of the larger tributaries between Portuguese Creek and IGD, namely Bogus, Horse, Beaver, and Seiad creeks. A small proportion of the population spawns within the mainstem channel, primarily within the section of the river several miles below IGD (PacifiCorp 2012).

Diversion dams, alluvial barriers, low flow conditions, and poorly functioning road/stream crossings also block passage by juvenile and/or adult fish in several mainstem tributaries within the watershed. Records indicate that there are approximately 57 unscreened diversions and 43 total or partial road crossing barriers in the Upper Klamath population area (CalFish 2011). The most notable road-stream crossing barriers on Highway 96 at Tom Martin Creek and on Seiad Creek Road at Canyon Creek. Many "push up" dams (dams created by pushing gravel and substrate material to form a blockage of the stream) and diversions seasonally block access to high Intrinsic Potential (IP) habitat and vital cold-water rearing habitat. A push-up dam on Horse Creek acts as a barrier when combined with low flow conditions in the stream, preventing both upstream and downstream access to high quality rearing habitat and refugia. Habitat blockages have resulted in significant risk to the Upper Klamath population unit.

Mid-Klamath

The Middle Klamath population unit boundaries (Figure 17) are from the confluence of the Trinity River upstream to Portuguese Creek (inclusive) (Williams et al. 2006).

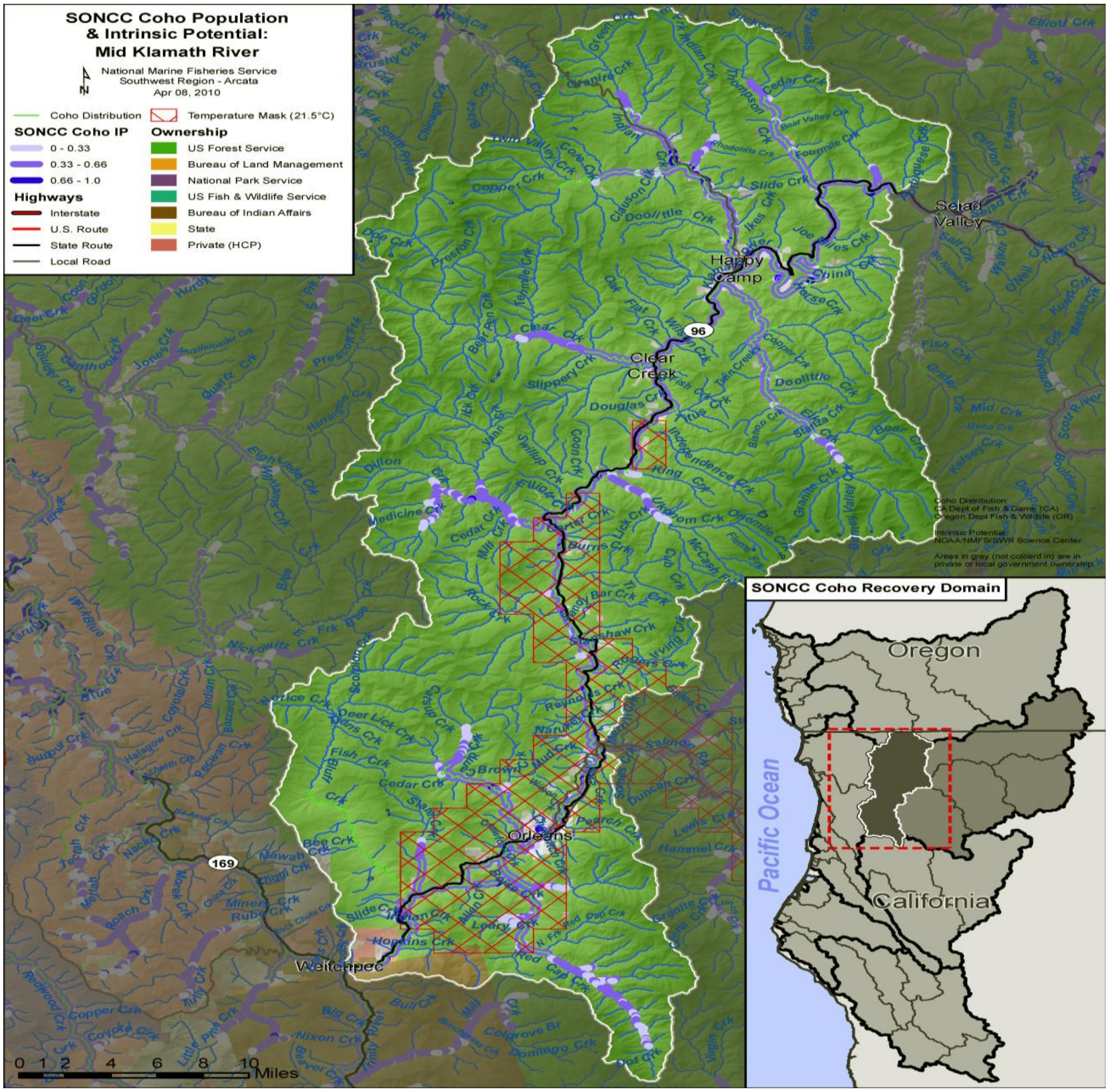

Figure 17. Boundary of the Middle Klamath River coho salmon population. Figure shows Intrinsic Potential of habitat, ownership, coho salmon distribution, and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Interior Klamath diversity stratum (Williams et al. 2006).

In total, there are almost 50 known seasonal or permanent barriers in the Mid-Klamath unit blocking or impairing access to many miles of coho salmon habitat (MKRP 2010). For example, low flow conditions in Empire, Willow, Cottonwood, Lumgrey, Barkhouse, and Humbug Creeks create seasonal flow barriers (MKRP 2010). Flushing flows, which are stream discharges with sufficient power to remove silt and sand from a gravel/cobble substrate but not enough power to dislodge and transport gravels, have become functionally non-existent in the upper reach of the Klamath basin. The loss of “flushing flows” in the mainstem Klamath causes higher than normal formation of alluvial barriers to seasonally form at the mouths of mainstem tributaries (e.g., Walker, O’Neil, and Grider Creeks) where the buildup of sediment at the tributary/mainstem interface acts as barriers to fish migration, further decreasing spatial structure and habitat availability (MKRP 2010). Additionally, Hwy 96 has several poorly designed culverts that block upstream and downstream migration in key watersheds (Portuguese, Fort Goff, and Cade Creeks) and unscreened diversions in streams that can result in stranding of juveniles and/or temporary barriers are likely an issue. Refugia and off-channel rearing habitat are often cut off from mainstem and tributary streams from low flow conditions in the summer. Known summer water diversions contribute to degraded habitat and/or fish passage issues in Stanshaw, Red Cap, Boise, Camp, Elk Creek, and Fort Goff Creeks during low water years. Many of these areas lack the summer baseflows needed to maintain connectivity to summer rearing habitat and refugia after diversions have been removed from streams. Overall, barriers and diversions pose a high stress for juveniles, smolts, and adults in the Middle Klamath population unit.

Shasta River

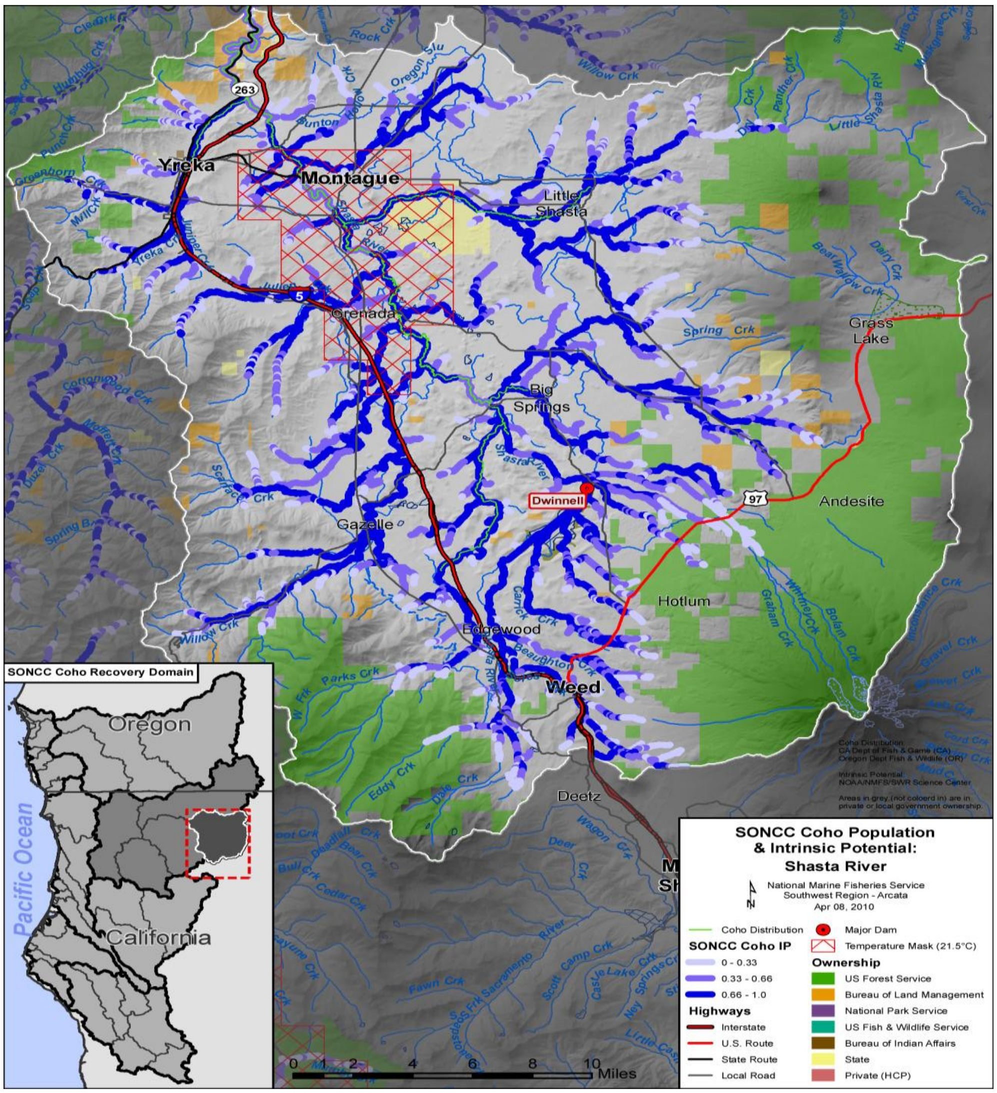

Figure 18. Boundary of the Shasta River coho salmon population. Figure shows Intrinsic Potential of habitat, ownership, coho salmon distribution, and location within the Southern-

Oregon/Northern California Coast Coho Salmon ESU and the Interior Klamath diversity stratum. (Williams et al. 2006).

Figure 18 shows the area of the Shasta River population unit. There are two permanent dams that act as fish barriers in the Shasta River, Dwinnell and Greenhorn dams. In 1926 the Shasta River was dammed at River Mile 37 to form Dwinnell Reservoir (Lake Shastina), blocking about 22 percent of historic salmon habitat in the Shasta River basin (NAS 2003). In 1955, the capacity of the dam was increased, bringing the total storage capacity to 50,000 acre-feet (NAS 2003). Dwinnell dam diverts flow from the upper Shasta River, Parks Creek, and Carrick Creek for irrigation and local municipal water supply. As a result, Dwinnell dam changes channel morphology and has altered the hydrologic function of the mainstem Shasta River (see discussion on natural flow regime). Greenhorn Dam, built on Greenhorn Creek in the 1950s, is used for municipal and industrial water storage and blocks access to upstream areas in Greenhorn Creek. Additionally, two seasonal flashboard irrigation diversion dams are thought to exist on the mainstem Shasta River, and create additional passage problems for juvenile and smolt coho salmon. Additional barriers associated with small water diversion have been observed, particularly in lower Parks Creek, an area with several small, cold water springs that are critically important for the survival of juvenile coho salmon. The current distribution of coho spawners is limited to the mainstem Shasta River from river mile 17 to river mile 23, Big Spring Creek, Lower Parks Creek, lower Yreka Creek, the upper Little Shasta River, and the Shasta River Canyon. Juvenile rearing is also currently confined to these same areas (PacifiCorp 2012).

The onset of the irrigation season in the Shasta River watershed has a dramatic impact on discharge when large numbers of irrigators begin taking water simultaneously. This results in a rapid decrease in flows below the diversions, stranding coho salmon as channel margin and side channel habitat disappears (CDFG 1997) and in some extreme cases channels can become entirely de-watered (Klamath River Basin Fisheries Task Force 1991). Low stream flows limit access to spawning areas and can decrease rearing habitat availability for juvenile coho salmon. Annually, persistent low flow conditions through October 1st, the end of the irrigation season, can also constrain the migration and distribution of spawning adult salmon. Diversion dams can reduce instream flows to such an extent that isolated ponds are created creating poor conditions for stranded juvenile coho as the summer progresses, subjecting juveniles to lethal environments.

Scott River

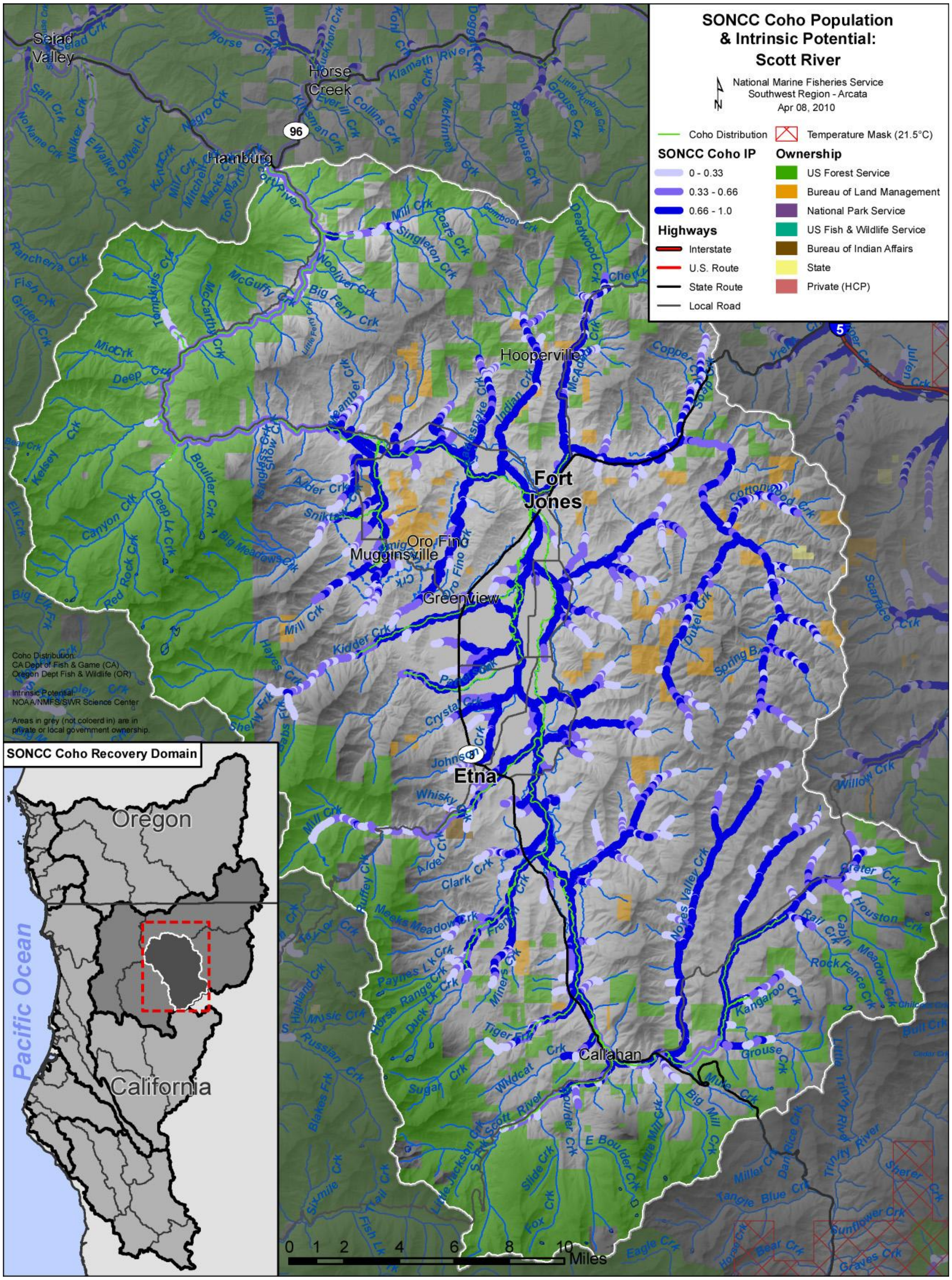

Figure 19. Boundary of the Scott River coho salmon population. Figure shows Intrinsic Potential of habitat, ownership, coho salmon distribution, and location within the Southern-Oregon/Northern California Coast Coho Salmon ESU and the Interior Klamath diversity stratum (Williams et al. 2006).

Figure 19 shows the area of the Scott River population unit. Two physical fish barriers exist in the basin. Big Mill Creek, a tributary to the East Fork Scott River, has a complete fish passage barrier caused by down cutting at a road culvert outfall (CalFish 2011). For many years, the City of Etna's municipal water diversion dam on Etna Creek effectively blocked fish passage into upper Etna Creek, however this dam was retrofitted with a volitional fishway in 2010. Water diversions for agricultural practices, including cattle grazing, and domestic water use, have diminished surface flows and greatly reduced or eliminated access to and use of historical coho salmon habitat in the Scott River Valley. Where low flows have not restricted juvenile movements, there are thermal refugial pools and tributaries available where water temperatures are suitable for growth and survival, providing a limited amount of rearing habitat in the basin.

Currently, valley-wide agricultural water withdrawals and diversions, groundwater extraction, and natural cycles of drought have all combined to cause premature surface flow disconnection along the mainstem Scott River. These conditions can consistently result in restrictions or exclusions to suitable rearing habitat, contribute to elevated water temperatures, and contribute to conditions which cause juvenile fish stranding and mortality. Although rearing habitat still exists in some tributaries, access to and from these areas is hindered by dams and diversions, the existence of alluvial sills, and the formation of thermal barriers at the confluence of tributaries and stagnant, disconnected pools.

Lower Klamath

The Lower Klamath population unit boundaries (Figure 20) are from the mouth of the Klamath River upstream to the confluence of the Trinity River (Williams et al. 2006).

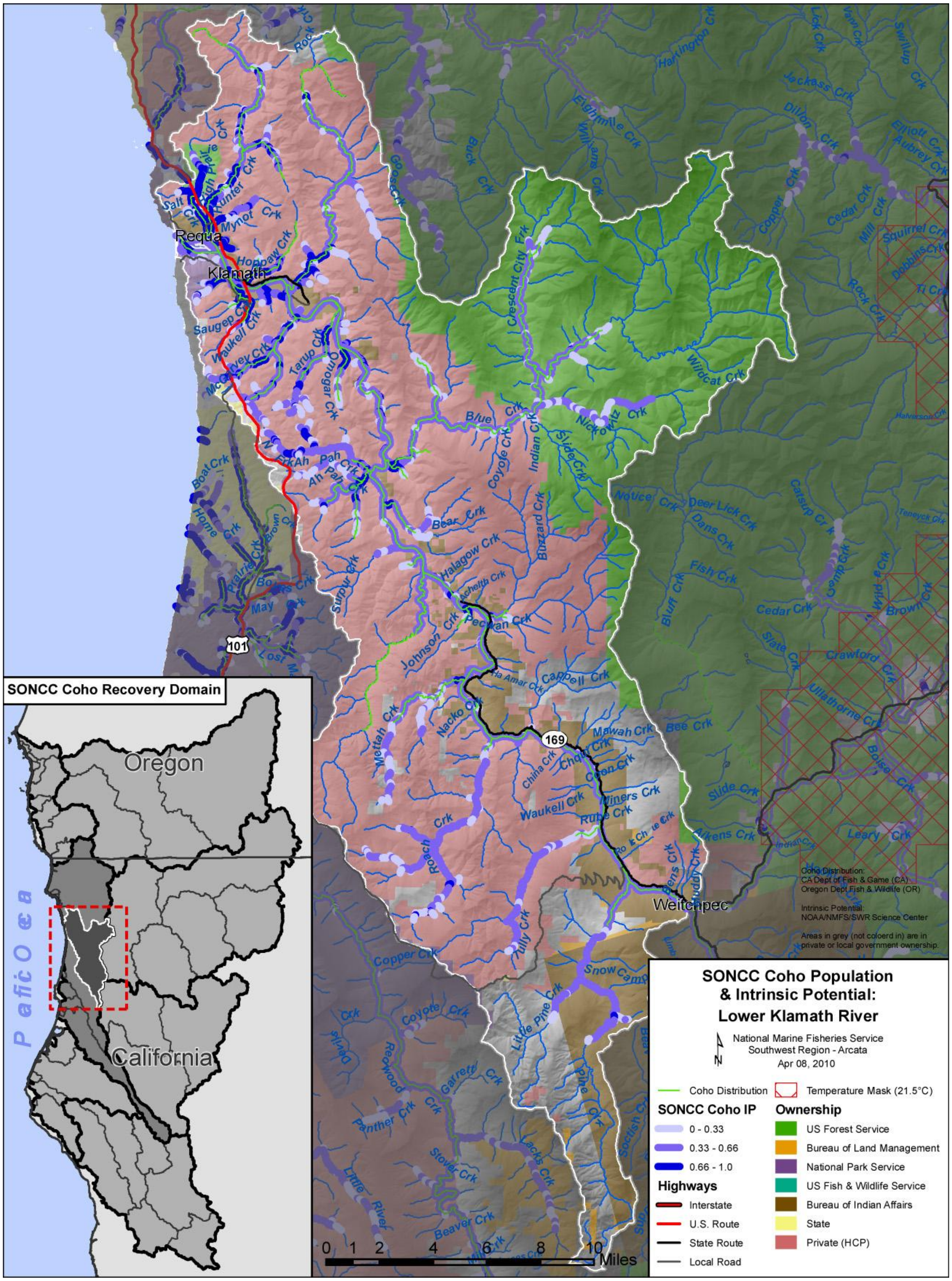

Figure 20. Boundary of the Lower Klamath River (LKR) coho salmon population. Figure shows Intrinsic Potential of habitat, ownership, coho salmon distribution, and the population's location

within the Southern Oregon/Northern California Coast Coho Salmon ESU and the Central Coastal diversity stratum (Williams et al. 2006).

Historical land management practices in the Lower Klamath basin, such as timber harvest and road building, have created high rates of sediment delivery to important coho tributaries. As a result, access to rearing and holding habitat in the Lower Klamath basin can be impeded by seasonal low and subsurface flows as sediment accretion limits the development of well-defined thalwegs in the lower reaches of tributaries. These conditions limit access to vital habitat needed by juveniles throughout the basin. Lower Klamath tributaries such as Terwer and Hunter creeks begin drying upstream of the tributary confluence and flows go subsurface both upstream and downstream as the dry season progresses, creating passage and access problems. Lower Klamath tributaries such as Hunter, Mynot, Hoppaw, Tarup, Omagaar, Bear, Terwer, Ah Pah, Tectah and Johnsons creeks are usually the first to begin drying in the spring, and typically experience periods of subsurface flow during winter and early spring months in the absence of continued, frequent rain events (YTFP 1999), further exacerbating passage and access problems. Recent data show that all of these creeks experience a disruption or complete cessation of flow during critical juvenile emigration periods (Gale and Randolph 2000, Beesley and Fiori 2007). Important road-related fish passage and water conveyance issues have been identified on McGarvey, Waukell, Blue, Terwer, and Richardson creeks. A grade control structure on West Fork McGarvey Creek blocks access to high IP reaches. Three undersized culverts (one on Saugep, one Waukell, and one on Junior creeks), a grade control structure on Waukell Creek (Klamath Beach Road and Hwy 101), and an impassible culvert (except at higher Klamath River flows of around 20,000 cfs or higher when backwatering occurs) on Richardson Creek (Klamath Beach Road) block access to important tributary habitat (Taylor 2007). Several road crossings in the vicinity of the estuary (e.g., Saugep, Junior, and Spruce creeks) have limited passage for coho salmon (Taylor 2007). Several other total barriers exist in the sub-basin, but are on streams where coho salmon have not been documented and no IP habitat exists (e.g., Burrill, Rube, Mareep, Knulthkarn).

Most tributaries in the Lower Klamath basin have formed large, persistent gravel deltas at their mouths and these seasonal barriers interrupt successful juvenile emigration in the spring, block adult immigration in the fall, and inhibit immigration of non-natal juvenile salmonids. (Payne and Associates 1989, Beesley and Fiori 2007). These large gravel bars and deltas require either high tributary or mainstem flows to allow fish passage. Because of alterations in the hydrology of tributaries, the timing and magnitude of rains in autumn is crucial for salmonid spawners attempting to gain access to spawning grounds (Voight and Gale 1998), and for juvenile fish seeking refuge in tributary habitats to overwinter (Soto et al. 2008, Hillemeier et al. 2009).

Decreases in the availability of habitat and continued fish passage problems in the Lower Klamath basin effect all the Klamath River populations. Coho salmon juveniles and smolts from upstream populations use the lower basin during the summer and winter for rearing and acclimation for ocean entry, and adults use thermal refugia for holding prior to migrating upstream (Voight and Gale 1998, YTFP 1999, Soto et al. 2008, YTFP 2009a, Hillemeier et al. 2009, Silloway 2010, Belchik and Turo 2002).

5.2.2 Current Hydrology

The historic (pre-dam building) flows of the Klamath River were the hydrologic condition under which coho salmon evolved. As previously reviewed in this Opinion, the annual historic hydrological regime of the Upper Klamath River was relatively smooth, with high flows in winter and spring that declined gradually during summer and then recovered in fall (Hecht and Kamman 1996). As noted by the U.S. Geological Survey (USGS, Fort Collins, Colorado, unpublished material 1995) in its review of the hydrology of the Klamath River, the changes in flow below IGD are attributable to water management practices in the Upper and Lower Klamath basin. The shift toward an earlier peak in annual runoff appears to be associated with increased flows in the Klamath River from the Lost River diversions and the loss of seasonal hydrologic buffering that originally was associated with overflow into Lower Klamath Lake and Tule Lake (NRC 2004). The persistent low-flow conditions that occur in summer below IGD reflect irrigation demand in Reclamation's Klamath Project and other parts of the upper Klamath basin and irrigation diversions on the Scott and Shasta rivers and other tributaries (NRC 2004).

Upper Klamath

Significant hydrologic alteration of the Upper Klamath River basin has been occurring for over 100 years. Both the timing and volume of flows is manipulated by diversion and dam activities. Current facilities for irrigation and hydropower in the Upper Klamath basin include 5 dams and hundreds of miles of canals and pumps which support significant water withdrawals, transfers, and diversions upstream and downstream of IGD (Hecht and Kamman 1996). For example, the Bureau of Reclamation's operation of the Rogue River basin project annually removes an average of 26,973 acre-feet of water from the Klamath River basin (Jenny Creek) as flows are diverted to the Rogue River basin (La Marche 2001). Conditions of altered hydrology in the Upper Klamath basin is also observed through the shift in the timing and duration of the spring peak-flow event, which causes spring flows to peak approximately a month earlier and subside to summer baseflow approximately two months earlier during most years as compared to an unaltered system. Generally, the flow regime has been rated as fair in Cottonwood Creek, Seiad Creek, and Walker Creek and poor in Beaver Creek, Humbug Creek, Horse Creek, and Bogus Creek.

Hecht and Kamman (1996) analyzed the hydrologic records for similar water years (pre- and post-Project (Reclamation's project)) at several locations throughout the Klamath River basin and concluded that the timing of peak and baseflows changed significantly after construction of Reclamation's Klamath Project. The study also found that, water diversions in areas outside of Reclamation's Project are further influencing changes in basin hydrology. Altered flows may interfere with environmental cues that initiate the redistribution of juvenile coho salmon in the river and potentially other important ecological functions leaving them exposed to poor over-wintering habitat in the upper Klamath River which may result in lower overwinter survival (Hecht and Kamman 1996). Altered flows might also reduce the amount of short-term (i.e., transitory and refugial) rearing habitat that would become available during higher flow events.

In an unaltered hydrologic regime, fall and winter freshets help distribute salmon carcasses downstream into lower sections of the watershed, effectively dispersing nutrients, as well as infective spores that enter the aquatic environment as the carcass decomposes. The current flow regime does not effectively redistribute carcasses within the reach between IGD and the Shasta

River, resulting in high densities of decomposing fish downstream of important spawning areas. NMFS concluded that these factors related to altered flow likely influence the fitness and overwintering survival of juvenile coho salmon in the mainstem Klamath River, particularly in the reach from IGD to the Shasta River (NMFS 2010).

Middle Klamath

The timing, magnitude and extent of flows in the mainstem middle Klamath River have been altered compared to historic conditions. Alteration of the natural hydrograph is due to diversions and water withdrawals in the Upper Basin and in upstream tributaries, and the managed flow from IGD. Current conditions include a transformed hydrology in the mainstem, characterized by poor hydrologic function, disconnection and diminishment of thermal refugia, and poor water quality. In addition to the diversions and alterations which occur in the Upper Klamath basin, within the Middle Klamath basin, there are many undocumented diversions, and approximately 170 documented diversions (CalFish 2011), all of which play a part in changing the hydrology in the sub-basin. These diversions decrease surface water availability and cause an earlier onset of baseflow conditions. Many tributary streams experience flow impairments from the diversion of water for private use. Diversions cause some tributaries to go subsurface intermittently during the summer and eliminate or reduce thermal refugia in tributaries or tributary outlets at other times of the year. Low flow conditions in Empire, Willow, Cottonwood, Lumgrey, Barkhouse, and Seiad, have been shown to create flow barriers and impaired summer rearing conditions (MKRP 2010). Although the hydrologic impacts of the major hydropower and agricultural projects decrease with distance downstream from IGD, significant impacts from these sources remain in the Middle Klamath mainstem hydrograph. Generally, spring and summer flows are reduced compared to historically unimpaired flows, and tend to peak approximately a month earlier, subsiding to summer baseflow approximately two months earlier during most years. The earlier onset of low baseflows also likely contributes to poor water quality conditions that now coincide with a greater proportion of the smolt outmigration through the mainstem reach.

Shasta River

The hydrology in the Shasta River is dominated by a large spring complex that provides the majority of the water for the Shasta River, particularly during the summer. The water that emerges from springs is very cold, high in nutrients, and provides for exceptionally high primary and secondary productivity. The flow of the Shasta River is enhanced by snowmelt from Mt. Shasta that historically maintained a consistent cold water flow of at least 103 cubic feet per second (cfs) to the Klamath River during the summer (Mack 1958). This spring-fed system was noted for producing large runs of spring and fall Chinook salmon, coho salmon, and steelhead (Snyder 1931). Flows are generally unaltered in the southern portion of the Shasta Valley including upper Parks Creek, the upper Shasta River, and tributaries originating from the flanks of Mt. Shasta: Dale, Boles, Broughton and Carrick creeks, but poor in other key areas from over-allocated water diversions and Dwinnell Dam. Currently, there are no instream flow release requirements from Dwinnell Dam, which further diminishes Shasta River flows during the summer irrigation season. During the winter, Lake Shastina's (formed by Dwinnell dam) capture of peak winter flows significantly reduces the ability of the Shasta River to flush fine sediment from spawning gravels and changes downstream hydrology.

Historically, Mack (1960) reported that one small tributary, Big Springs, supplied a consistent 103 cfs to the Shasta River before its waters were captured and diverted. Flow from the springs and numerous small accretions in the reach above them would have supplied flows close to or exceeding today's bankfull condition, even during summer months (NRC 2004). Flows of that magnitude would have had very short transit times (less than 1 day to the Klamath River), thus maintaining cool water throughout the summer for the entire river (NRC 2004). Consistency of flows and cool summer water were the principal reasons that the Shasta River was historically highly productive of salmonids. During summer, the Shasta River may also have cooled the mainstem Klamath near the confluence of the Shasta and the mainstem (NRC 2004).

As a result of more than a century of land conversion to agriculture and industrial/municipal development in the basin, hydrologic function has been severely altered. Descriptions of flow-related habitat access problems for anadromous fish date back to the 1960's (CH2M HILL 1985). Each year the hydrologic regime experiences a rapid decrease in flows beginning with the onset of the irrigation season, when large numbers of Shasta Valley irrigators begin diverting water simultaneously. Dwinnell Dam and over 100 other adjudicated irrigation diversions now divert more than 110 cfs from the Shasta River from April 1 to October 1 (NAS 2003) providing irrigation for approximately 52,000 acres of land (about 10 percent of the watershed) during the growing season. Estimated consumptive use of irrigation water is approximately 100,000 acre feet per year. These diversions and water withdrawals create summer instream flows of approximately 15 to 20 cfs in the lower Shasta River, sometimes dropping to 5 cfs in dry years. Such flows are often not conducive to high quality coho summer rearing habitat.

Reductions in spring flows due to drought conditions and the onset of agricultural water deliveries cause young-of-year coho salmon outmigration from the Shasta River to the mainstem Klamath River earlier than in years when Shasta River baseflows were sustained at a higher level through the spring (CDFG 2003). These instream conditions force juvenile coho salmon to redistribute within the basin in response to diminishing spring flow conditions; upstream towards spring-fed habitat or downstream to the Klamath River. This flow regime also results in reduced summer rearing habitat throughout the basin. Persistent low flow conditions through the end of the irrigation season (October 1) can also constrain the timing and distribution of spawning adult coho salmon and increase disease transmission in these returning adults.

Scott River

Agriculture and grazing have been, and continue to be the major land use within the Scott River Valley (Gwynne 1993). Numerous legal and illegal water diversions and withdrawals occur throughout the basin resulting in decreased summer flows, increased water temperatures that can become lethal to coho, and extensions of periods of surface flow disconnection on the valley floor. Generally, water quantity and flow regime is poor in the southern portion of the Scott Valley from Etna Creek to Noyes Valley Creek. The Scott Canyon area, in contrast, has fair water quantity. In most years, low flows resultant from agricultural activities in the Scott River, occur during the months of June to November, resulting in elevated water temperature and loss of connectivity to side-channel and off-channel habitat areas. Scott Valley eastside tributaries tend to be ephemeral (Mack 1958), but their lower reaches have high IP which is vital to oversummering juveniles, and is generally lacking in the system. During the summer, and especially during critically dry periods, large portions of the mainstem Scott River become completely dry (SRWC 1997), cutting off access to summer rearing habitat in many tributaries and high IP areas. The East Fork Scott River often becomes nearly dewatered during the summer, due to water diversion. Limited water master service occurs in the basin, and unquantified surface and groundwater withdrawals are likely occurring in many areas.   Van Kirk and Naman (2008) found that late summer baseflows in the Scott River were 60 percent lower (6.541 Mm^3 versus 10.96 Mm^3) in the recent past (1977 to 2005) than in the historic period (1942 to 1976). Gaging records at Fort Jones show that it is common for mainstem discharge to fall to 10 cfs in drier water years. At this level of discharge, the Scott River mainstem can become a series of stagnant pools of water inhospitable to salmonids. As a result of the low flow problems experienced in the Scott River, a minimum flow of 30 to 35 cfs must be maintained to provide surface connectivity in the mainstem Scott River from the Canyon area up into the Scott Valley floor (Sommarstrom 2010). Additionally, surface flows of approximately 40 cfs must be achieved to ensure volitional migration of salmonids throughout the Scott Valley (Pisano 2010).

As a result of low flow conditions in the summer, in some years, thousands of juvenile salmon and steelhead are stranded and die in the Scott River basin (SRWC 1997) when stream flows go subsurface in the lower reaches of Etna, Patterson, Kidder (including Big Slough), Moffett and Shackleford creeks each summer through early fall. This drying has been documented to be a natural event (Siskiyou County Historical Society 1978), but it has become exacerbated by water withdrawal in the form of seasonal agricultural diversions, groundwater pumping, and by aggradation at tributary mouths. The end result is the dewatering of miles of instream habitat, lack of access to and from rearing habitat, and poor water quality that result in stressful and sometimes lethal water temperatures.

Lower Klamath

Although not as pronounced as other sub-basins, compared to historic conditions, the timing, magnitude and extent of flows in the Lower Klamath River are altered. There are only a few diversions in the Lower Klamath River area and these are negligible compared to the Klamath, Trinity, Scott and Shasta diversions. The amount of water diverted within the Lower Klamath River area is not known, but is assumed minor relative to available water supply. Generally, spring and summer flows are lower than historical flows, while fall and winter flows in the Lower Klamath River are generally similar to historical flows. The hydrologic function of tributaries in the Lower Klamath has also been altered. This is in evidence when lower portions of tributaries go dry from late spring to fall, with tributary drying believed to be exacerbated by an unnatural oversupply of sediment caused by historical and ongoing timber management on steep unstable slopes. Such timber management can and has caused small to large landslides which deposit sediment to downstream watercourses. When smaller tributaries are “overloaded” with sediment, stream flows may not have enough power to cut through sediment accretions and often times go subsurface in such scenarios. Seasonal intermittent drying is the most common pattern observed in Lower Klamath tributaries (Gale and Randolph 2000, Beesley and Fiori 2007). Most creeks begin drying up at the mouth in late spring/early summer and subsurface conditions progressively migrate upstream during summer/fall. Many creeks in the Lower Klamath River basin experience a disruption or complete cessation of flow during critical juvenile emigration periods for most if not all of the years monitored (Gale and Randolph 2000, Beesley and Fiori 2007).

The high levels of historic timber harvest in the Lower Klamath basin has likely resulted in a change in the "wet season" stream hydrograph. In particular, this change in vegetative canopy and slope cover has likely resulted in peak discharge levels of an increased intensity and shorter duration following storm events (Beesley and Fiori 2007). Conditions which cause surface flows to go subsurface are largely driven by the timing, duration, and magnitude of rainfall and river/tributary flows, excessive sedimentation emanating from tributaries, and the combination of sediment transport and backwater interactions between tributaries and mainstem Klamath. Because of alterations in the hydrology of tributaries, the timing and magnitude of rains in the fall is crucial for salmonid spawners attempting to gain access to spawning grounds (Voight and Gale 1998), and for juvenile fish seeking refuge in tributary habitats to overwinter (Soto et al. 2008, Hillemeier et al. 2009). Major diversions upstream of IGD and on the Trinity River cumulatively decrease the natural mainstem flows of the Lower Klamath River by an average of 915,000 to 1,020,000 acre-feet per year (NMFS 2010). Reductions in flow and changes in the hydrograph can increase the occurrence and severity of sediment barriers at many tributary mouths in the Lower Klamath as prolonged flushing flows are not as frequent or occurring for a long enough period of time as compared to historical unaltered conditions. Significant diversions decrease the quantity of mainstem flows on the Klamath River mostly during the summer months, when juvenile access to cooler tributaries and cooler mainstem water temperatures is essential.

5.2.3 Water Quality

Much of the Klamath basin is currently listed as water quality impaired for designated beneficial uses under section 303(d) of the Clean Water Act (Table 5). As such, total maximum daily loads (TMDLs) have been developed by Oregon, California, and the U.S. Environmental Protection Agency (USEPA) for specific impaired water bodies with the intent to protect and restore beneficial uses of water.

Water Body Name	Water Temperature	Sedimentation	pH	Organic Enrichment/Low	Nutrients	Ammonia	Cyanobacteria	Microcystin	Mercury
Butte Valley	X								
Copco Lake (Reservoir 1 and 2)							X	X	
Iron gate Reservoir							X	X	
Middle and Lwr Klamath River HA (beginning of Copco 1 reservoir to Trinity							X	X	
Klamath River from Oregon to the Pacific (specifically the Middle Klamath HA; Oregon to Iron Gate reach and IGD to Scott River reach; Middle and Lower Klamath HA; Scott River to Trinity River reach; and the Lower Klamath HA; Klamath Glen HSA	X			X	X			X	

Lost River HA: Tule Lake HSA & Mt. Dome HSA					X				
Lost River HA: Tule Lake and Lower Klamath Lake National Wildlife Refuge			X						
Middle Klamath River HA: Beaver Ck, Cow Ck, Deer Ck, Hungry Ck, and West Fork Beaver Ck*		X							
Middle and Lower Klamath River: China Ck, Fort Goff Ck, Grider Ck, Portuguese Ck, Thompson Creek and Walker *		X							
Lower Klamath HA; Klamath Glen*		X							
Salmon River HA	X								
Scott River HA	X	X							
Shasta River HA				X					
Shasta River HA: Lake Shastina									X
* Not begun yet. Action taken by or to be done by the North Coast regional Water Quality Control Board									

Table 5. 2008 - 2010 Impaired Water Bodies & TMDL Status Summary - North Coast (from NCRWQCB, 2011).

The river receives considerable inflow from major and minor tributaries between IGD and the estuary. Due to an increasing stream gradient and inputs from tributaries with water that is both cooler and generally lower in nutrient concentrations, the Klamath River is generally less eutrophic as the river approaches the Pacific Ocean. Both point and nonpoint sources of pollution contribute to the water quality impairments in the Klamath River. Land use pollutant source categories impacting Klamath River water quality are identified as wetland conversion, grazing, irrigated agriculture, timber harvest, and roads.

Upper Klamath

Water quality conditions within the Upper Klamath are often stressful to juvenile and adult coho salmon and are generally poor during much of the summer and early fall when mainstem water temperatures can exceed lethal thresholds above 25°C. Upstream impoundments and water withdrawals contribute to seasonal and daily changes in temperature regimes. Summary statistics compiled by the U.S. Environmental Protection Agency (USEPA) indicate that in June, water temperatures at locations between IGD and the confluence of the Scott River range from about 16 to 22°C, and in July, temperatures range from 16 to 26°C. In August the minimum mainstem temperatures are higher, but the maximum temperatures are lower than in July. Summer water quality varies within Upper Klamath River tributaries as well, and is heavily influenced by riparian corridor condition, instream sediment levels, and the extent to which diversions dewater the stream channel. Tributaries tend to have cooler stream temperatures in their upper reaches and warmer temperatures in their degraded lower reaches.

Additional water quality problems occur from the presence of both Iron Gate and Copco 1 Reservoirs. Iron Gate and Copco 1 Reservoirs are the two deepest reservoirs in the Project, and these reservoirs thermally stratify beginning in April/May. The surface and bottom waters do not mix again until October/November (Raymond 2008, 2009, 2010). The onset of seasonal stratification typically occurs in mid-to-late March, and the breakdown of stratification in October. The large thermal mass of the stored water in the reservoirs delays the natural warming and cooling of riverine water temperatures on a seasonal basis such that spring water temperatures in the Upper Klamath are generally cooler than would be expected under natural conditions, and summer and fall water temperatures are generally warmer (NCRWQCB 2010). This temporal water temperature pattern, known as a "thermal lag," is repeated in the Klamath River immediately downstream of IGD, where water released from the reservoirs is 1-2.5ºC (1.8-4.5°F) cooler in the spring and 2-10°C (3.6-18°F) warmer in the summer and fall as compared with modeled conditions without the dams (PacifiCorp 2004a, Dunsmoor and Huntington 2006, NCRWQCB 2010).

Dissolved oxygen conditions in Iron Gate reservoir vary seasonally due to thermal stratification, seasonal water temperature variations in inflowing waters, and seasonal nutrient loading and organic matter from upstream sources (PacifiCorp 2012). Figure 21 shows the relationship between temperature and dissolved oxygen downstream of IGD; as temperatures rise as the summer progresses, the percent saturation of DO drops. Under stratified conditions, seasonal anoxia (little or no oxygen) of bottom waters occurs. The onset of anoxic conditions occurs initially in bottom waters (typically commencing in May through June), and reaching a maximum in September wherein roughly the bottom 100 feet of the reservoir can experience dissolved oxygen concentrations less than 1.0 mg/L. Generally, daily mean dissolved oxygen (MDO) conditions are at or near saturation throughout the entire Upper Klamath reach due to the many cascades, rapids, and riffles in this steep reach of the Klamath River that provides mechanical reaeration. An exception is found in the reach immediately below IGD during late summer and fall periods, where relatively deep releases from Iron Gate reservoir entrain water with low dissolved oxygen (DO) concentration, resulting in discharges from the dam of water that is below 100 percent saturation (PacifiCorp 2012).

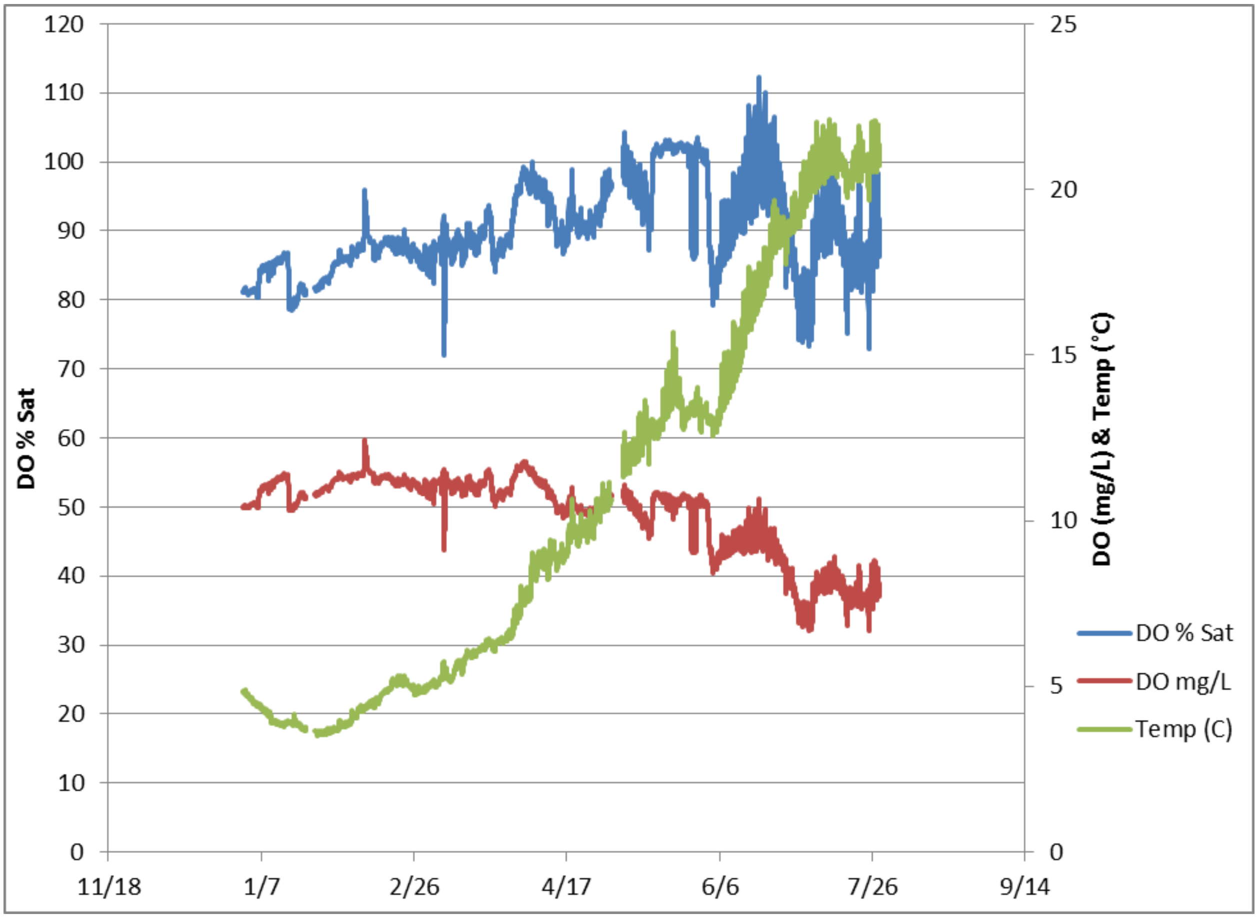

Figure 21. Water quality data collected with a YSI 6600 Datasonde on the Klamath River downstream of IGD (RM 189.7) from January 1 through July 28, 2011 (PacifiCorp 2012).

Downstream of IGD DO levels fluctuate seasonally and tend to increase in the downstream direction. Continuous Sonde data collected downstream of IGD during the summers of 2004–2006 show that roughly 45 to 65 percent of measurements immediately downstream of the dam did not achieve 8 mg/L. (Karuk Tribe of California 2002, 2007, 2009). Daily fluctuations of up to 1–2 mg/L measured in the Klamath River downstream of IGD (RM 190.1) can be attributed to daytime algal photosynthesis (adds oxygen) and nighttime bacterial respiration (consumes oxygen) (Karuk Tribe of California 2002, 2003, YTEP 2005, NCRWQCB 2010). Nocturnal DO levels directly below IGD can fall below 7.0 mg/L and can be stressful to coho salmon adults and juveniles during much of the late summer and early fall.

Farther downstream in the mainstem Klamath River, near Seiad Valley (RM 129.4), DO concentrations increase relative to the reach immediately downstream of IGD, but continue to exhibit variability, with mean daily values ranging from approximately 6.5 mg/L to supersaturated concentrations of approximately 10.5 mg/L, from June through November. (Karuk Tribe of California 2001, 2002, 2007, 2009). Reduced levels of dissolved oxygen can impact growth and development of different life stages of salmon, including eggs, alevins, and fry, as well as the swimming, feeding and reproductive ability of juveniles and adults (Carter

2005).   The Upper Klamath River basin is rich in volcanic/mineral soils making pH levels naturally high in surface waters. Given that the Klamath River below IGD remains in a weakly buffered state, pH levels throughout the river experience wide diel fluctuations as a result of high primary production (*i.e.*, algae and benthic macrophyte growth) during summer months (NMFS 2010). Between IGD and Seiad Valley, daily maximum pH values in excess of 9.0 have been documented. A pH of 7.0 is considered “neutral”, a pH of 9.0 or higher is considered “alkaline,” and a pH of 6.0 or below is considered “acidic. 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 (NMFS 2010).   Water quality data on pH concentrations taken in the years 2004-2006 by the USFWS, Karuk, and Yurok tribes show pH levels exceeding 8.5 routinely at stations located below IGD. Measurements of pH above 8.5 commonly occurred more than 25 percent of the time at many stations within the Klamath mainstem, with some stations exceeding a pH of 8.5 more than 40 percent of the time. Seasonally, pH tends to rise throughout the summer, peaking in late August and fluctuating widely between day and night (NMFS 2007). Chronic high pH levels in freshwater streams can decrease activity levels of salmonids, create stress responses, decrease or cease feeding, and lead to a loss of equilibrium (Murray and Ziebell 1984, Wagner et al. 1997).

Middle Klamath

Water quality conditions in the Middle Klamath are affected by seasonal high temperatures, low DO, and high pH (NMFS 2007).   Changes to water temperature continue from IGD and the temperature effects due to thermal stratification that occurs in Iron Gate Reservoir decrease moving downstream (PacifiCorp 2012). Water temperatures at Weitchpec during 2004 were consistently above 22ºC for much of July and August (YTEP 2005), whereas further upstream near Cade Creek (RM 110), the mean weekly maximum temperature (MWMT) exceeded 29ºC when monitored in 1992 (Fadness 2007). Minimum nighttime water temperatures at both locations were consistently above 20ºC for the same time period, even approaching 24ºC on several occasions. Daily maximum summer water temperatures have been measured at values greater than 26°C (78.8°F) just upstream of the confluence with the Trinity River (Weitchpec [RM 43.5]), decreasing to 24.5°C (76.1°F) near Turwar Creek (RM 5.8) (YTEP 2005). Downstream of the Salmon River (RM 66), summer water temperatures begin to decrease slightly with distance as coastal meteorology (i.e., fog and lower air temperatures) reduces longitudinal warming (Scheiff and Zedonis 2011) and cool water tributary inputs increase the overall flow volume in the river. In addition to hot ambient summer air temperatures, high temperatures in the Mid Klamath may be due in part to the decreased buffering capacity of cold water tributaries, which has been lessened by the existence of water diversions that remove cold water that historically entered the mainstem Klamath (e.g. Scott and Shasta River diversions). Temperatures at sub-lethal levels can effectively block migration, lead to reduced growth, stress fish, affect reproduction, inhibit smoltification, create disease problems, and alter competitive dominance (Elliott 1981, USEPA 1999).

Measured concentrations of DO in the mainstem Klamath River downstream of Seiad Valley (RM 129.4) continue to increase with increasing distance from IGD. Dissolved oxygen concentrations near Orleans (RM 59) are variable, with typical daily values ranging from approximately 6.5 mg/L to supersaturated concentrations of 11.5 mg/L from June through November (2001–2002 and 2006–2009) (Karuk Tribe of California 2002, 2007, 2009, Ward and

Armstrong 2010, NCRWQCB 2010). Dissolved oxygen 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 (YTEP 2005). Farther downstream, near the confluence with the Trinity River (RM 42.5) and at the Turwar gage (RM 5.8), minimum dissolved oxygen concentrations below 8 mg/L have been observed for extended periods of time during late summer/early fall (YTEP 2005). Highly fluctuating DO concentrations, such as those measured during summer 2004 in Weitchipec are common throughout the mainstem, and are believed to occur as a result of high primary productivity fueled by naturally elevated water temperatures and the high nutrient content of the Klamath River present from its headwaters (e.g. Upper Klamath Lake).

The most extreme pH values in the Middle Klamath basin typically occur just upstream of Shasta River; values generally decrease with distance downstream (FERC 2007, Karuk Tribe 2007, 2009, 2010). Measurements of pH at Weitchpec tend to rise throughout the monitoring season toward peak values in late August. Daily maximum values were greater than 8.5 for most of the summer, but attenuated when adult fish would likely be migrating through the area in early October. Measurements of pH above 8.5 commonly occurred more than 25 percent of the time at many stations within the Middle Klamath mainstem, with some stations exceeding a pH of 8.5 more than 40 percent of the time (Karuk Tribe 2007, 2008, 2009).

Shasta River

Surface diversions and groundwater withdrawals have eliminated or substantially degraded flows on the Shasta River and its tributaries. The alterations are most evident during late spring through early fall, when increasing air temperatures and low flow coincide with poor water quality (NRC 2004). Daily minimum temperatures in the lower mainstem in summer are typically greater than 20ºC, and daily maximums often exceeding 25ºC (NRC 2004). The Shasta River becomes progressively cooler as elevation and flows increase, but temperatures remain largely suboptimal for salmonids for most of its length from late June through early September (NRC 2004). Low flows with long transit times typical of those now occurring in the summer on the Shasta River cause rapid equilibration of water with air temperatures, which produces water temperatures exceeding acute and chronic thresholds for salmonids well above the mouth of the river (NRC 2004).

Higher temperatures also are associated with reduced amounts of DO in the water. Dissolved oxygen concentrations below saturation are apparently uncommon in the Shasta River, but where they occur, they coincide with high temperatures and low flows (Campbell 1995, Gwynne 1993). The lowest dissolved oxygen concentrations (2 to 4 mg/L) in the Shasta River are experienced in the reach from approximately East Louie Road to Montague Grenada Road, and from there to Yreka Ager Road to Highway 263, (NCRWQCB 2006). Dissolved oxygen concentrations less than 7 mg/L occur in these reaches between the months of May and September (NCRWQCB 2006). Dissolved oxygen concentrations fall below 9 mg/L in Lake Shastina in May to October, with levels reaching <1 mg/L at depths exceeding 7 meters. As occurs in the seasonal stratification in the Upper Klamath River reservoirs, dissolved oxygen levels fluctuate significantly diurnally, consistent with photosynthetic activity (NCRWQCB 2006). These conditions are created by low stream flows, high ambient air temperatures, and decreases in riparian cover, which historically kept stream temperatures low.

Data from 2000-2004 show that maximum pH typically exceeds the Basin Plan objective of 8.5 for most days from June through September (NCRWQCB 2004, 2005). While the Shasta River is not officially listed as pH impaired, summer pH values in mainstem Shasta River can be extremely high (>9.5).

Scott River

Excessive sediment loads and elevated water temperatures in the Scott River and its tributaries have resulted in the impairment of designated beneficial uses of water and the non-attainment of water quality objectives (NCRWQCB 2005). Summer temperature conditions do not support suitable salmonid rearing habitat in the mainstem of the Scott River and the East Fork of the Scott River (NCRWQCB 2005). Summer temperature conditions also do not support suitable salmonid rearing habitat in the lower reaches of Kelsey, Shackleford, Kidder, Patterson (west side), French, Wildcat, Etna, and Big Carmen creeks and the upper reaches of Moffet Creek and Sissel Gulch (NCRWQCB 2005). Water temperatures in the summer are poor throughout the mainstem Scott River, Wildcat Creek, Patterson Creek, and lower French Creek, while water temperatures are generally fair (near 16.7 ^{o}C or lower) in the upper reaches of other perennial tributaries. Temperature conditions degrade continuously through the summer in the Scott River, and also in the terminal reaches of its tributaries. By July, lethal water temperatures of 26.7 ^{o}C routinely occur in the mainstem, including portions of the Scott River Canyon (Chesney and Yokel 2003). Heating of surface waters is caused by summer flow diversions, natural cycles of drought, and high rates of sediment delivery which causes channels to widen and become more shallow limiting the development of well-defined thalwegs and pools.

Limited data exist on other water quality parameters. Dissolved oxygen of the Scott River has been monitored sporadically. Dissolved-oxygen data are available from 1967 to 1979 at Ft. Jones (Earthinfo, Inc. 1995) and from 1961 to 1967 and 1984 (CDWR 1986). The lowest concentrations of oxygen occur during late August and early September, when flows are low and temperatures are high. Data collected by the Karuk tribe show dissolved oxygen concentrations between 7.5 and 11 mg/l (Karuk Tribe 2009), with summer seasonal variations in some years dipping as low as 6.5mg (Karuk Tribe 2008). Average dissolved oxygen concentrations begin to increase in September, and reach around 11 mg/l starting in October, when adult fish are returning to spawn (Karuk Tribe 2009).

Lower Klamath

Coho salmon juveniles and smolts from upstream populations (e.g. Upper and Middle Klamath) use the LKR sub-basin during the summer and winter for rearing and acclimation, and adults use thermal refugia for holding prior to migrating upstream (Voight and Gale 1998, YTFP 1999, Soto et al. 2008, YTFP 2009a, Hillemeier et al. 2009, Silloway 2010, Belchik and Turo 2002). Downstream of the Salmon River confluence (RM 66), summer water temperatures begin to decrease with distance as coastal meteorology (i.e., fog and lower air temperatures) reduces longitudinal warming (Scheiff and Zedonis 2011) and cool water tributary inputs increase the overall flow volume in the river. Generally, temperatures near the headwaters of LKR tributaries are mostly very good or good, but water quality decreases in the lower reaches (Bjornn and Reiser 1991). The Yurok Tribal Fisheries Program (YTFP) and Green Diamond Resource Company (GDRC) have conducted a water temperature monitoring program in Lower Klamath tributaries since 1995 (YTFP 2009b). These efforts have revealed that tributary water temperatures in the Lower Klamath consistently remain within acceptable tolerances for coho salmon (Gale and Randolph 2000, Bell 1991). From 1995 to 2000, the annual variation in average daily water temperature was less than 10 ºC in most Lower Klamath tributaries, with the summer maximum temperature never exceeding 16 ºC in most of these watersheds. Lower Blue Creek had the highest recorded summer water temperatures of all monitored tributaries; however, water temperatures still fell within acceptable tolerances for salmonids throughout the year. In general, water temperatures in the Lower Klamath River are below 17 ºC in the fall when adults typically migrate upstream, and temperatures do not increase in the spring until most juveniles have outmigrated. However, mainstem waters entering the Lower Klamath River reach can be warm in summer months, and at three Lower Klamath gauging stations maximum water temperatures exceeding 24 ºC have been reported in summer months (Hiner 2006, Beesley and Fiori 2004 and 2008). Daily maximum summer water temperatures have been measured at values greater than 26°C (78.8°F) just upstream of the confluence with the Trinity River (Weitchpec [RM 43.5]), decreasing to 24.5°C (76.1°F) near Turwar Creek (RM 5.8) (YTEP 2005). These conditions can be stressful to juveniles rearing in these areas, however, water temperature is not believed to be a limiting factor in the Lower Klamath population unit, since available suitable habitat and cold water refugia exists in this reach to allow juveniles to limit their exposure to stressful conditions. Juveniles can move in and out of refugial areas as needed, and therefore are only exposed to high water temperatures for brief periods of time. Additionally, cooler fluctuating temperatures can also allow time for repair of proteins damaged by thermal stress, allowing persistence through periods of high maximum daily temperatures (Schrank 2003)

Water temperatures in the Klamath River Estuary are linked to temperatures and flows entering the estuary, salinity of the estuary and resulting density stratification, and the timing and duration of the formation of a sand berm across the estuary mouth. Temperatures in the estuary have been recorded as being above lethal thresholds; however, thermal refugia in tidal areas may exist (Wallace 1998, Bartholow 2005). When the estuary mouth is open, denser salt water from the ocean sinks below the lighter fresh river water, resulting in a saltwater wedge that moves up and down the estuary with the daily tides (Horne and Goldman 1994, Wallace 1998, Hiner 2006). The salt water wedge results in thermal stratification of the estuary with cooler, high salinity ocean waters remaining near the estuary bottom and warmer, low salinity river waters occurring near the surface. Under low-flow summertime conditions, when the mouth is often closed, surface water temperatures in the estuary have been observed at 18-24°C (64.4-75.2°F) and greater (Wallace 1998, Hiner 2006, Watercourse Engineering, Inc. 2011). Input of cool ocean water and fog along the coast minimizes extreme water temperatures much of the time (Scheiff and Zedonis 2011).

During the summer months, pH values also are elevated in the Lower Klamath River from Weitchpec downstream to approximately Turwar Creek. Daily cycles in pH occur, with pH usually peaking during later afternoon or early evening, following the period of maximum photosynthesis (NCRWQCB 2010). Estuary and mainstem reaches can experience wide diel fluctuations in pH during the summer and have been found to exceed upper thresholds of 8.5 during late summer months. Measurement of pH in the estuary range between approximately 7.5 and 9.0, with peak values occurring during the summer months (YTEP 2005). When large daily fluctuations are observed, they are likely caused by algal blooms that are transported into the estuary.

Dissolved oxygen concentrations within the mainstem river, the estuary, and in some of the off-estuary tributaries are generally adequate but can reach levels which are stressful to coho salmon during late summer. Dissolved oxygen concentrations below 7 mg/L have been noted during summer months but are generally above threshold levels during the spring and fall when coho salmon are most abundant in these areas (Hiner and Brown 2004, Hiner 2006, NMFS 2007, Beesley and Fiori 2004 and 2008). Dissolved oxygen concentrations in the Klamath Estuary vary both temporally and spatially; concentrations in the deeper, main channel of the estuary are generally greater than 6 to 7 mg/L throughout the year (Hiner 2006, YTEP 2005). Low dissolved oxygen concentrations (<1 to 5 mg/L) have been observed during summer months in the relatively shallow, heavily vegetated south slough (Hiner 2006, Wallace 1998). The low levels of dissolved oxygen observed in the slough are likely due to growth and subsequent decomposition of algae and macrophytes, which are not abundant elsewhere in the estuary.

5.2.4 Aquatic Diseases

Salmonids in the Klamath basin are exposed to a number of pathogens and diseases that can impact all life stages. Pathogens associated with diseased fish in the Klamath River include bacteria (*Flavobacterium columnare* and motile aeromonid bacteria), a digenetictrematode (presumptive *Nanophyetus salmincola*), myxozoan parasites (*Parvicapsula minibicornis* and *Ceratomyxa shasta*) and external parasites (Walker and Foott 1993, Williamson and Foott 1998). Ceratomyxosis (due to *C. shasta*) has been identified as the most significant disease for juvenile salmon in the Klamath basin (Foott et al. 1999, Foott et al. 2004). Infection by the myxozoan *C. shasta* (and co-infection by a second myxozoan, *Parvicapsula minibicornis*) Ich and columnaris have occasionally had a substantial impact on adult salmon downstream of IGD, particularly when habitat conditions include exceptionally low flows, high water temperatures, and high densities of fish (such as adult salmon migrating upstream in the fall and holding at high densities in pools). The combination of factors that leads to adult infection by Ich and columnaris disease may not be as frequent as the annual exposure of juvenile salmonids to *C. shasta* and *P. minibicornis*, as many juveniles must migrate each spring downstream past established populations of the invertebrate polychaete worm host. Despite potential resistance to the disease in native fish populations, fish (particularly juvenile fish, and more so at higher water temperatures) exposed to high levels of these parasites may be more susceptible to disease.

Upper Klamath

The Upper Klamath coho population is affected by increased rates of aquatic diseases. Disease effects vary annually based on water temperature, water year, and other factors (Bartholomew 2008). Given that most juveniles rear in tributaries (Lestelle 2007) the greatest impacts are to smolts during mainstem emigration. The current flow regime does not effectively redistribute carcasses within the IGD to Shasta River reach, resulting in high densities of decomposing fish downstream of popular spawning areas, specifically the areas directly below IGH and the confluence of Bogus Creek and the Klamath River mainstem (NMFS 2010). Compounding the issue is the large number of returning adult salmon that congregate and spawn in areas adjacent to the hatchery, thus increasing carcass concentrations in the IGH to Shasta River reach above natural levels (NMFS 2010). Potential average mortality due to infection is estimated to be approximately 50 percent at 17 °C and approximately 12 percent at 15 °C in the Upper Klamath and studies show mortality could be much higher at some sites (Bartholomew 2008). Although studies were not done in-situ, this research exemplifies the overall increase in infection rates thought to be occurring in the mainstem Klamath River. The long migration and exposure times experienced by the Upper Klamath coho population means that it is one of the most susceptible to disease and most likely to experiences abnormally high disease-induced mortality (Bartholomew 2008).

Modifications to the river's historical hydrologic regime have created instream conditions that favor disease proliferation and fish infection (Stocking and Bartholomew 2007). Less frequent fall pulse-flows, and the thermal lag created by IGD affect disease transmission from adult salmon carcasses to the intermediate polychaete host, increasing the potential for juveniles and smolts to become infected. Additionally, current hydrological conditions in the Upper Klamath basin do not allow for the redistribution of carcasses, creating areas of concentrations where polychaete and other intermediary hosts proliferate. Exposure to these diseases can cause decreased fitness, decreased viability, and in severe cases, mortality of significant numbers of smolts moving downstream.

Middle Klamath

In the Mid- Klamath River, the polychaete host for *C. shasta* and *P. minibicornis* is aggregated into small, patchy populations mostly concentrated between the Interstate 5 bridge and the Trinity River confluence, and especially above the Scott River (Stocking and Bartholomew 2007), exposing smolts and juveniles from several populations from the Upper, Middle, Scott and Shasta coho populations.

Spatially and temporally, mortality rates from exposure to disease vary by location and time of year but are consistently higher between IGD and the Scott River and are highest April through July (Bartholomew 2008). The reach of the Klamath River from the Shasta River to Seiad/Indian Creek is known to be a highly infectious zone with high actinospore exposure, particularly from May through August (Beeman et al. 2008). This portion of the river contains areas of dense populations of polychaetes within low-velocity habitats with *Cladophora* (a type of green algae), sand-silt, and fine benthic organic material in the substrate (Stocking et al. 2007). Juvenile coho salmon migrating downstream have been found to have infection rates as high as 90 percent (Bartholomew and Foott 2010) but these numbers may also include individuals from the Upper Klamath, Scott, and Shasta River populations. The number of juvenile salmonids that become infected is estimated to be 10 to 70 percent annually based on surveys of fish captured in the river (True et al. 2010).

In May 2004, the USFWS, the Yurok Tribe and the Karuk Tribe, reported high levels of mortality and disease infections among naturally produced juvenile Chinook salmon captured in downstream migrant traps fished in the Klamath River (Klamath Fish Health Assessment Team [KFHAT] 2005). The primary cause of the disease was found to be *C. Shasta*, with *P. minibicornis* observed as well.

High parasite prevalence in the areas downstream of IGD is considered to be a combined effect of high spore input from heavily infected, spawned adult salmon that congregate downstream of IGD and IGH and the proximity to dense populations of polychaetes (Bartholomew et al. 2007). Conditions commonly associated with fish kills include high temperature, intense blooms of bluegreen algae, high incidences of copepod (Lernaea) infestations, cysts, lesions, infection with

Flavobacterium columnare (columnaris disease), high pH, high concentrations of unionized ammonia, and low concentrations of dissolved oxygen (Perkins et al. 2000). Additionally, the release of large numbers of hatchery fish in this section of the river is believed to be increasing disease infection rates by creating competition, predation, and introducing hatchery diseases into the wild population. Researchers believe modifications to the river's historical hydrologic and sediment transport regime have likely created instream conditions that favor disease proliferation and fish infection (Stocking and Bartholomew 2007). Project dams block the downstream transport of coarse sediment and reduce scour of the riverbed during high flow events. NMFS (2010) concludes that these effects may promote substrate conditions that support the disease intermediate host.

Shasta River

Inspections conducted in lower and middle reaches of the Shasta River in the summer of 2009 and the spring of 2010 did not detect any evidence of the presence of the disease carrying polychaete worm, *M. speciosa*, consistent with study results from 2008 (YTFP 2010). This data supports the theory that although the Shasta River experiences warm summer water temperatures, low DO, and an altered flow regime like the Upper Klamath reach, evidence indicates that aquatic diseases may not be a known issue in the Shasta River basin. However, coho born and reared in the basin are highly susceptible to increased disease infection rates once they emigrate into the mainstem Klamath.

A substantial portion of coho juveniles leave the Shasta River as fry in the spring (Chesney et al. 2007) as conditions in the Shasta River begin their annual deterioration with the onset of the irrigation season and summer weather. Depending on the year, conditions in the Klamath River can be extremely deleterious in terms of relatively low flow releases from upstream reservoirs and warm water temperatures, all of which can combine to greatly reduce the survival probability of juvenile salmonids entering the Klamath River from the Shasta River basin (YTFP 2010).

Scott River

Similar to the Shasta River, infectious diseases are not thought to be a problem in the Scott River basin. Although Scott River coho salmon encounter little if any infectious diseases before beginning downstream migrations, as with Shasta River natal coho, once Scott River natal coho juveniles enter the mainstem Klamath a variety of diseases and stressful environmental conditions can have a significant impact on their survival and viability. A substantial portion of coho juveniles leave the Scott River as fry in the spring as conditions begin their annual deterioration with the onset of the irrigation season and summer weather (CA Department of Fish and Game, unpublished data). Depending on the year, conditions in the Klamath River can be extremely deleterious to emigrating Scott River juveniles.

Lower Klamath

While disease and parasites occur in the Lower Klamath reach, estuary, and Pacific Ocean, these areas are not known to be source areas for lethal disease infection. Generally, disease exposure is greatly reduced below the Trinity River confluence (Bartholomew 2008). However, coho that are weakened by disease or parasitic infection that occurred in the Middle or Upper Klamath reaches may succumb to those diseases once they enter the estuary or ocean as a result of the additional stress created by adapting to the saline environment (Bartholomew 2008).

5.2.5 Gravel Recruitment

For all practical purposes, the amount of sediment supplied to the Klamath River from the Klamath Basin upstream of Keno Dam is negligible (Reclamation 2011). Upper Klamath Lake, with its large surface area, traps nearly all sediment delivered from upstream tributaries, although some finer material may be transported through the lake during high runoff events.

Upper Klamath

Coho spawning and rearing, which requires suitable substrate conditions, has been observed in Bogus, Horse, Beaver, Canyon, Grider and Seiad Creeks, as well as in small sections of the mainstem Upper Klamath River within the first several miles downstream of IGD. Downstream of IGD, channel conditions reflect the interruption of sediment flux from upstream by reservoir capture and the eventual re-supply of sediment from tributaries entering the mainstem Klamath River (PacifiCorp 2004). Upstream dams block the transport of sediment into this reach of river. The lack of clean and loose gravel diminishes the amount and quality of salmonid spawning habitat downstream of dams. This condition is especially critical below IGD (FERC 2006). Supply of spawning gravel can also be decreased in the Upper Klamath due to tributary blockage from poorly designed road crossings. Where spawning habitat does exist, gravel quality and fluvial characteristics are likely suitable for successful spawning and egg incubation. As part of a study investigating mainstem coho salmon spawning within the Klamath River, Magneson and Gough (2006) noted that the dominant substrate within sampled redds was either gravel or cobble, while a geomorphic and sediment evaluation of the Klamath River performed by Ayers Associates (1999) concluded that little fine sediment was embedded within river bed and bar gravel deposits. The effects of the curtailment of gravel recruitment in this reach of the river, includes decreased spawning habitat availability, competition for available spawning areas, crowding of eggs and embryos, and potentially decreased survival.

Middle Klamath

Spawning adult coho salmon have been documented in Bluff, Red Cap, Camp, Boise, South Fork Clear, and Indian creeks (Soto et al. 2008) and spawning surveys by the Karuk Tribe found adults spawning in Aikens, China, Elk, and the South Fork of Clear Creek (Corum 2010). Spawning adults were also found to utilize side channels, tributary mouths, and shoreline habitat areas in the mainstem between Beaver Creek (RM 161) and Independence Creek (RM 94) (Magneson and Gogh 2006). However, the quality and amount of spawning habitat in the Middle Klamath River reach is naturally limited due to the geomorphology and the prevalence of bedrock in this stretch of river. Mainstem gravel recruitment from upstream has been severely curtailed due to the existence of dams and reservoirs, which blocks sediment from moving downstream, limiting gravels needed for mainstem spawning and incubation. Additionally, the existence of IGD disrupts the natural hydrograph of the system by eliminating seasonal flushing flows that keep spawning gravels clean of fine sediment and mobilize potentially disease laden bedload downstream and out to the ocean. As previously discussed, modifications to flushing flows also likely plays a role in the buildup of alluvial fans at tributary confluences, hindering coho spawning.

Ayers and Associates (1999) and Hardy and Addley (2001) indicate that flows in the Mid-Klamath have been adequate for some forms of channel maintenance in most years. Fine sediments in unregulated reaches regularly are flushed from riffles and pools during average water years and under normal flow conditions (Ayers and Associates, 1999). However, overall, low flows over sustained drought periods have resulted in greater deposition of fine sediments and, thus, adverse changes to channel features. This creates hydraulic conditions that are conducive to further accumulation of fine sediments (Klamath River Basin Fisheries Task Force, 1991), thereby exacerbating the problem. Flows of the magnitude necessary to transport accumulated fine sediments typically are much lower than those necessary to maintain functioning geomorphic features that may be adversely affected under current project dam operations, at least downstream to the Shasta River (PacifiCorp 2004).

Shasta River

Spawning of coho salmon has been observed in the Shasta River Canyon, Lower Yreka Creek, throughout the Blue Springs Complex area, and in Lower Parks Creek. Recent surveys have shown that channel conditions in the main stem of the Shasta River and its most important tributary, Parks Creek, generally are poor and may limit salmonid production. In some reaches, particularly in the lower canyon and the reach below the Dwinnell Dam, limited recruitment of coarse gravels is likely contributing to a decline in abundance of spawning gravels (Buer 1981). The causes of the decline in gravels include gravel trapping by Dwinnell Dam and other diversions, bank-stabilization efforts, and historical gravel mining in the channel. In a 1994 study of Shasta River gravel quality, Jong (1995) found that small sediment particles and fines (<4.75mm) were present in quantities associated with excessive salmon and steelhead egg mortality. He also concluded that gravel quality had deteriorated since 1980 when the DWR performed similar work in the Shasta basin. Greenhorn dam blocks the movement of gravel down Yreka Creek, and alters the Yreka Creek hydrograph.

Scott River

Spawning activity and redds have been observed in the East Fork Scott River, South Fork Scott River, Sugar, French, Miners, Etna, Kidder, Patterson, Shackleford, Mill, Canyon, Kelsey, Tompkins, and Scott Bar Mill Creeks. Other than the two anthropogenic barriers on Etna Creek and the mainstem Scott River, gravel transport in the Scott River Valley basin is unimpeded. Pebble count data and survey data indicate that suitable gravels sizes are found in conjunction with slopes also suitable for spawning (Cramer Fish Sciences 2010). These observations suggest that the amount of coarse sediment and its rate of delivery are not limiting spawning habitat availability in the Scott River Watershed.

Although gravel mobilization is unimpeded, historic land uses create a legacy of effects that are continuing to impact available spawning habitat. Data shows that spawning substrate is largely suitable throughout the basin, but the spatial extent of these areas is limited due to mine tailing piles and other legacy mining effects. Current conditions in the Scott River mimic hydraulic conditions similar to bedrock canyons where sediment used by salmonids has a lower likelihood of persistence due to increased (or more efficient) sediment transport compared to unconfined reaches (Cramer Fish Sciences 2010). The over extraction of streambed alluvium may also have stripped the alluvial cover from some river reaches exposing underlying bedrock, the net result of which is enhanced sediment transport, less persistent alluvium, and an overall loss of physical complexity (Cramer Fish Sciences 2010). Channel confinement by historic mining tailings indirectly affects the diversity of stream habitat that might otherwise be available. Many of these tailing piles are too large for the adjacent watercourse to reshape.

Lower Klamath

Recent spawning surveys found coho salmon spawning in Salt, High Prairie, Hunter, Hoopaw, Saugep, Waukell, Terwer, McGarvey, Tarup, Omagaar, Blue, Ah Pah, Bear, Surpur, Little Surpur, Pularvasar, One Mile, Tectah, Johnsons, Pecwan, Mettah, Roach, Cappell and Tully Creeks (Voight and Gale 1998). Additionally, Blue Creek and three of its tributaries (West Fork Blue Creek, Nicowitz, Crescent City Fork Blue Creek) have been shown to be important for spawning and rearing in the Lower Klamath (Voight and Gale 1998). The primary limiting habitat types for the LKR population are high quality spawning and rearing habitat. It is important to note, the areas that provide valuable rearing habitat can be different from those areas that may provide spawning habitat, however a few key tributaries in the Lower Klamath provide the majority of these habitats to the population. These important tributaries include Tectah, Terwer, Hunter, McGarvey, and Blue creeks (YTFP 2009b). Of the streams surveyed (in the 1990s) in the LKR sub-basin, the highest embeddedness (>50 percent) were Roaches, Pecwan, Cappel, WF McGarvey, SF Mettah, Johnsons, and Mynot creeks (GDRC 2006). In 2007 to 2008 the frequency of highly-embedded reaches seemed to decrease and Mynot, Hoppaw, and Ah Pah creeks had the highest incidence of embeddedness. It is evident that some reaches within these creeks experience high sedimentation and may have unsuitable gravel for egg incubation and fry emergence.

In summary, an altered sediment supply in many tributaries hinders fish passage, results in poor summer survival, poor spawning and incubation habitat suitability, and the loss and degradation of stream and off-channel habitat. Channel sedimentation and lack of channel structure (LWD) has resulted in significant loss to overwintering and summer rearing habitat as well. Long-term channel incision in the lower reaches of many tributaries has resulted in a coarsening of bed materials and likely reduced the amount of suitable salmonid spawning gravels. Such a high degree of sedimentation hinders successful spawning of adult coho salmon and emergence of fry, limits access to rearing habitats, increases competition and predation, and reduces macroinvertebrate densities (Gale and Randolph 2000, Beesley and Fiori 2007).

5.2.6 Large Woody Debris Recruitment

Large woody debris serves many different and critically important functions in a watershed. Channel stored wood can alter sediment storage and delivery dynamics, dampen peak flows, facilitate the formation and maintenance of critical salmonid habitats (e.g., spawning beds and pools), and provide cover for fish and other aquatic dependent species. Accumulations of large wood have been observed to be a significant component in floodplain and terrace deposits and help maintain complex instream and floodplain habitat. Fluvial deposited wood has also been attributed to the development of viable and resilient riparian forests.

Given the large size of the mainstem Klamath River, large woody debris does not play a significant role in the formation of permanent habitat or habitat complexity in the mainstem Klamath River downstream of IGD. Little or no data exists on the quantity or quality of large woody debris structures in the mainstem Klamath. Large woody debris does play a significant role in these processes in tributaries and at tributary confluences within the mainstem all along the corridor, and therefore is discussed where appropriate below. Large woody debris recruitment is most affected by timber harvest and agricultural practices that remove mature trees from the system.

Upper Klamath

Most stream reaches within the Upper Klamath are either lacking riparian forest altogether or lack complex, late seral forest. Grazing and flow impairments along the mainstem and in tributaries such as Horse, Humbug, Willow, and Cottonwood Creeks have severely degraded riparian function. Stream corridor vegetation was rated at fair (partially functional) to poor (non-functional) in all surveyed reaches of the Upper Klamath (based on USFS judgment). Wood frequencies have not been quantified in many tributaries above IGD in the Upper Klamath basin, but in Camp Creek and at Jenny Creek they were found to be poor (<1 key piece/mile) (ODFW CAP data).

Middle Klamath

Stream inventories conducted in 1997 by Fruit Growers Supply Company (FGS) on West Fork Beaver Creek and West Fork Cottonwood Creek indicate approximately 3.8 pieces and 5.4 pieces of LWD greater than 12 inches in diameter per 1,000 lineal feet within the bankfull channel of these streams, respectively. These levels are far below objective targets for LWD in Pacific Northwest forests (NMFS 1997) and are below the levels of LWD observed elsewhere in the Beaver Creek watershed. In the last two decades more than 300 instream structures, including log and boulder weirs, boulder clusters, mini debris jams, and woody channel margin structures have been placed in Beaver Creek, Cow Creek, and the West Fork of Beaver Creek (USFS 1996). Table 6 gives data on LWD levels found near or downstream of FGS property in the Klamath and Scott River watershed. It should be noted however that these LWD results are not unusual for managed commercial timberlands in the region of the action area.

Planning Watershed	Instream LWD Pieces/1,000 ft (Range)*	Average Diameter Inches (Range)	Average Length Feet (Range)
Klamath River Management Unit			
Beaver	15.4 (1.8–28.9)	13.3 (8.7–25.3)	22 (16–27)
Cottonwood	17.7 (1.8–22.1)	9.6 (8.3–17.4)	18 (17–21)
Doggett	45.8 (27.4–67.8)	13.2 (11.9–15.0)	25 (22–30)
Scott Valley Management Unit			
Moffett	7.3 (3.3–11.3)	37.8 (13.0–62.8)	17 (17–18)

*Table 6. Frequency and Characterization of Large Woody Debris on FGS lands in the Klamath River and Scott Valley Management Unit * LWD pieces included all wood > 4 inches in diameter (FGS 2011).*

Decreased levels of LWD in the Mid-Klamath are due to historic logging and grazing practices, and in part, to the altered hydrology and water table that is created by IGD and other basin diversions. Water diversions, withdrawals, and out of basin transfers can significantly decrease water tables and ground water storage, decreasing riparian growth. Effects of decreased LWD recruitment include simplified habitat, decreased macroinvertebrate production, decreased pool volume, and altered sediment mobility and trapping.

Shasta River

A habitat study of the lower 7 miles of the Shasta River conducted by the US Forest Service (Klamath National Forest) concluded that riparian conditions were poor (West et al. 1988/89). Similar findings resulted from cursory surveys of riparian and river conditions in and along the Shasta River between Grenada Irrigation District's diversion dam and the Interstate 5 crossing over the past few years (West et al. 1988/89) . An estimated 75 percent or more of the Shasta River lying upstream of Interstate 5 lacks suitable instream cover structure including woody debris structure.

Similar to areas of the Mid-Klamath, LWD is lacking in the Shasta River due to anthropogenic land use changes, including grazing and agricultural practices. Additionally, water diversions and withdrawals have likely lowered the water table throughout the basin, thereby limiting growth of riparian vegetation and channel forming wood. A system lacking large wood creates a deficit of shade and shelter, and decreases habitat complexity and pool volumes, all necessary components for oversummering juvenile survival.

Scott River

Woody debris is lacking throughout the mainstem Scott River and its tributaries. Mainstem habitat has been straightened, leveed, and armored, from mining and logging activities. Anthropogenic impacts have resulted in a lack of channel complexity from channel straightening and reduced amounts of woody material (Cramer Fish Sciences 2010). The present-day mainstem Scott River bears minor resemblance to its more complex historic form although meandering and straight channel planforms are still present (Cramer Fish Sciences 2010). The cumulative effect of these changes cannot be quantified, but it is clear that both the amount and quality and physical habitat has been reduced. Large woody debris that is available along the mainstem corridor is highly mobile during high flow events, further decreasing retention of large woody that does get recruited. Recent data regarding large woody debris in tributaries indicates that recruitment is improving in the uplands, providing more complex habitat and potential rearing areas in stream reaches above the valley floor. High (25 to 35 percent of watershed harvested) and very high (>35 percent of watershed harvested) rates of timber harvest have occurred in the following tributary sub-basins: Noyes Valley Creek, Mule Creek, Wildcat Creek, French/Miners creeks, Etna Creek, Moffett Creek, McAdams Creek, and lower Scott River (upper Canyon Reach). Historical harvest removed a large portion of trees in riparian areas that could have recruited as LWD to the Scott mainstem and/or its significant tributaries. Timber harvest activities have decreased in the last 10 years and upland riparian forest areas are in early stages of recovery. This recovery is expected to proceed slowly, as even-aged silviculture diminishes in favor of other types of forest management. With continued protection of riparian areas from harvest, NMFS expects LWD recruitment can eventually improve.

Lower Klamath

Currently, conifers comprise less than one third of the riparian canopy along the mainstem Lower Klamath River, and in a majority of the tributaries conifers make up less than 15 percent of the riparian canopy. Live conifers comprise less than 25 percent of the potentially recruitable LWD. Examples of a relatively healthy riparian forest include portions of upper Blue Creek where live conifers comprise between 27 and 77 percent of the total canopy and represent between 40 to70 percent of the potentially recruitable LWD (Gale and Randolph 2000). The lower reaches of Blue Creek, in contrast, exhibit poorly functional riparian areas due to channel incision and concurrent loss of floodplain connectivity, bank instability, and impacts resulting from feral cattle in the watershed and past logging practices (Beesley and Fiori 2008). The lack of riparian cover and forest regeneration in this area has impacted water quality during the summer and significantly reduced salmonid rearing capacity, especially during winter-spring (Beesley and Fiori 2008).

Active removal of fluvial deposited wood and decades of no or low LWD recruitment, however, has simplified stream and riparian forest complexity, reduced floodplain connectivity and productivity, and reduced the amount of off-channel habitat. LWD is the primary cover type in only about 25 percent of LKR tributaries and the lowest densities of LWD (<100 pieces/mile) occurred in Morek, Cappell, and Slide Creek (Gale and Randolph 2000). Conifers comprise between 1 and 19 percent of the riparian canopy in Lower Klamath tributaries and the riparian forest is dominated almost exclusively by deciduous tree species, such as red alder (*Alnus rubra*). Alders are substantially inferior to conifers for maintaining channel stability and floodplain connectivity, and for creating and maintaining productive fluvial habitats for fish and wildlife.

The lack of mature, conifer dominated riparian forests and fluvial LWD recruitment in Lower Klamath tributaries and the mainstem has resulted in increased water temperatures, poor sediment sorting, storage, and delivery dynamics, simplified stream reaches and floodplain areas with low habitat quality (see above). The poorest channel and riparian conditions have been noted in Waukell, Saugep, Surpur, and Little Surpur creeks (Gale and Randolph 2000), however, these conditions persist in virtually every Lower Klamath tributary, including Blue Creek (Beesley and Fiori 2008).

5.3 Factors Affecting Coho Salmon and their Critical Habitat in the Action Area

Reclamation's Klamath Project

Hydrologic alteration

In 1905, Reclamation began developing an irrigation project near Klamath Falls, Oregon. Marshes were drained, dikes and levees were constructed (NRC 2008), and the level of Upper Klamath Lake was raised in 1922. Starting around 1912, construction and operation of the numerous facilities associated with Reclamation's Klamath Project significantly altered the natural hydrographs of the upper and middle Klamath River. Reclamation's Klamath Project now consists of an extensive system of canals, pumps, diversion structures, and dams capable of routing water to approximately 220,000 acres of irrigated farmlands in the Upper Klamath River basin (NMFS 2010).

Data show that, regardless of climate conditions, there is now a lower magnitude of peak discharge in the Klamath River at Keno, Oregon, with a shift of more than one month, from the end of April, to the middle of March (NMFS 2010). Additionally, there is far less discharge (water quantity) during the spring and summer. Altered flows may interfere with environmental cues that initiate distribution of juvenile coho salmon in the river, alter seaward migration timing, and potentially impact other important ecological functions, leaving juveniles exposed to a range of poor quality habitat, and prolonged exposure to stressful over wintering and summer rearing conditions (NMFS 2010). Historically, river discharge did not reach base (minimum) flow until September. After implementation of Reclamation's Klamath Project, minimum flows for the year occur in the beginning of July, a shift in baseflow minimum of roughly two months earlier. These altered flows may also reduce the amount of short term (transitory and refugial) rearing habitat that is available. Additionally, off channel habitat has been significantly reduced due to the lack of variable flows that would otherwise inundate floodplains and side channels, creating important rearing habitat (NMFS 2010).

Project Water Consumption

The average Apr-Sept agricultural net diversions of Reclamation's Klamath Project were 269 TAF for the period 1985 to 2002, significantly more than the 217 TAF for the period 1962-1984 ($P = 0.015$; Mayer 2008). From 1962 to 2000, the positive trend in net diversion to the Reclamation's Klamath Project was significant. This increase in consumptive use could be due to changes in irrigation and cropping patterns and/or climate change (Mayer 2008). These increases in Project water consumption create a significant net loss of water in the mainstem channel downstream of IGD. This decrease of available water has caused several harmful effects on coho salmon and coho salmon habitat including: decrease of scouring flows, decrease in off channel habitat formation, poor water quality conditions, dramatic alteration of variable flow regimes, and alteration of timing of environmental cues for migration and juvenile movement (NMFS 2010).

Water Storage

Although Reclamation has not proposed a land idling component of its Water Bank Program, new storage capabilities, such as the recent additions of approximately 68,000 acre-feet (AF) of water storage on Agency Lake/Barnes Ranches and 28,800 AF on the Nature Conservancy's Williamson River Delta Restoration will likely continue (Reclamation 2007). Reclamation also plans to continue the partnership with the Lower Klamath National Wildlife Refuge, which allows for the storage of 12,000-15,000 AF of water. From 2003 to 2007, the years when the water bank was functioning, there was greater outflow from Upper Klamath Lake (UKL) and greater river flow at Keno than would have been expected based on historic storage levels (Mayer 2008). The capture and storage of instream flows can dramatically impact the potential benefits this water would have on downstream habitat, if allowed to travel downstream unimpeded. Additionally, reservoirs and lakes within the Project allow for the breakdown of large quantities of algae, which when transported downstream, can potentially contribute to disease effects for juvenile and adult SONCC ESU coho salmon in the system (NMFS 2010).

Agriculture

Besides irrigation associated with the Project, other non-Project irrigators operate within the Klamath River basin. Irrigated agriculture both above and surrounding UKL consists of approximately 180,000 acres. Current agricultural development in the Shasta River Valley consists of approximately 51,600 acres of irrigated land. Current agricultural development in the Scott River Valley, which has increased significantly since the 1970s, consists of approximately 29,000 acres of irrigated land with an estimated annual irrigation withdrawal of approximately 81,070 acre feet per year (Van Kirk and Naman 2008). Estimated consumptive use of water for irrigated agriculture is significant in the basin.

A series of diversion dams on the Trinity River, a tributary of the Klamath River, transfers water from the Klamath River basin to the Sacramento River basin. Starting in 1964 and continuing until 1995, an average of 1.2 million acre feet per year, or 88 percent of the Trinity River flow, was diverted into the Central Valley Project within the Sacramento River basin. This diversion contributed to the decline of coho salmon populations within the Klamath River basin. Currently, 51 percent of Trinity River flow is diverted to the Sacramento basin (USFWS and Hoopa Valley Tribe 1999).

There are two other major diversion systems within the Klamath River basin. Fourmile Creek and Jenny Creek diversions transfer water from the Klamath River basin into the Rogue River basin. Estimated annual (1960-1996) out of basin diversions from the Fourmile Creek drainage of the Klamath River basin to the Rogue River basin was approximately 4,845 acre-feet. Net out of basin diversions from the Jenny Creek drainage of the Klamath River basin to the Rogue River basin were approximately 22,128 acre-feet. Thus, the total average annual (1960 to 1996) diversions from the Klamath River basin to the Rogue River basin was 26,973 acre-feet (La Marche 2001).

As the value of farmlands increased throughout the Klamath River basin, flood control measures were implemented. During the 1930s, the U.S. Army Corps of Engineers implemented flood control measures in the Scott River Valley by removing riparian vegetation and building dikes to constrain the stream channel. As a result of building these dykes, the river became more channelized, water velocities increased, and the rate of bank erosion accelerated. To minimize damage, the Soil Conservation Service planted willows along the stream-bank and recommended channel modifications take place which re-shaped the stream channel into a series of gentle curves. The effectiveness of these actions has not yet been measured.

There has been a recent decline in UKL outflows since the 1960s, which may be due to increasing diversions, decreasing net inflows, or other factors (Mayer 2008). Declines in UKL are likely linked to declines in winter precipitation in the upper Klamath Basin in recent decades and declines in UKL inflow and tributary inflow, particularly base flows (Mayer 2008). Declines in tributary base flow could be due to increase consumptive use, in particular, groundwater utilization, and/or climate changes. Agricultural diversions from the lake have increased over the 1961 to 2007 period, particularly during dry years (Mayer 2008). Declines in Link River flows and Klamath River at Keno flows in the last 40-50 years have been most pronounced during the base flow season (Mayer 2008), the time when Reclamation's Klamath Project demands are the greatest. It is well known that Reclamation's Klamath Project demands increase in dry years (Mayer 2008).

Consumptive use of water is expected to negatively impact one or more of the VSP criteria for the interior Klamath population units because it reduces summer and fall discharge of tributaries that the populations utilize (Van Kirk and Naman 2008) and low flows in the summer have been cited as limiting coho salmon survival in the Klamath basin (CDFG 2002a, NRC 2004). Agricultural operations can negatively impact critical habitat of coho salmon by reducing the quality and quantity of water and water temperature available to rearing juveniles during the summer months.

Timber harvest

In general, timber management activities allow more water to reach the ground, and may alter water infiltration into forest soils such that less water is absorbed or the soil may become saturated faster, thereby increasing surface flow. Road systems, skid trails, and landings where the soils become compacted may also accelerate runoff. Ditches concentrate surface runoff and intercept subsurface flow bringing it to the surface (Chamberlin et al. 1991, Furniss et al. 1991). Significant increases in the magnitude of peak flows or the frequency of channel forming flows can increase channel scouring or accelerate bank erosion.

Timber harvesting in the action area has had a long-lasting effect on fish habitat conditions. Most notably, harvest of streamside trees during the early and middle 1900s has left a legacy of reduced LWD recruitment and contributed to elevated stream temperatures, particularly along the Klamath mainstem and along the lower reaches of the Scott River. However, Reclamation's Klamath Project plays a significant role in elevating water temperatures in the Klamath mainstem (NRC 2004). Sedimentation from modern-day harvest units, harvest-related landslides and an extensive road network continues to impact habitat although at much reduced levels as compared to early logging. Ground disturbance, compaction, and vegetation removal during timber harvest has modified drainage patterns and surface runoff resulting in increased peak storm flows which has increased occurrences of channel simplification and channel aggradation. Simplification of stream channels and sediment aggradation results in loss or destruction of salmonid habitat as pool complexes and side channel winter rearing habitat are often lost or degraded to such an extent as to no longer provide refugia for developing juveniles.
Timber harvesting activities can have significant effects on hydrologic processes that determine streamflow. Timber harvest and associated road construction alter runoff by accelerating surface flows from hillsides to stream channels (Chamberlin et al. 1991, McIntosh et al. 1994). These accelerated flows increase peak flows during rainstorms (Ziemer 1998). Also, removal of vegetation reduces evapotranspiration, which increases the amount of water that infiltrates the soil and ultimately reaches the stream. As a result, streams draining recently logged areas may see increased summer flows (Keppeler 1998).

In order to combat the severe alteration of salmon habitat caused by historical forest practices, several forest practices and management plans have been enacted in the Klamath basin. The Northwest Forest Plan (NFP) is an integrated, comprehensive design for ecosystem management, intergovernmental and public collaboration, and rural community economic assistance for federal forests in western Oregon, Washington, and northern California. Since adoption of the NFP in 1994, timber harvest and road building on Forest Service lands in the Klamath basin have decreased dramatically and road decommissioning has increased. It is expected that implementation of the NFP will help to recover aquatic habitat conditions adversely affected by legacy timber practices.

Along the lower Klamath River, Green Diamond Resource Company owns and manages approximately 265 square miles of lands below the Trinity River confluence for timber production. The company has completed an HCP for aquatic species, including SONCC ESU coho salmon, and NMFS issued an ESA section 10(a)(1)(B) Incidental Take Permit on June 12, 2007. The 50-year HCP commits Green Diamond to combating sediment production from approximately half of its high- and moderate-priority road sites, property-wide, over the first 15 years of implementation as well as places restrictions on timber harvest on unstable slopes and in fish-bearing watercourses. The HCP is expected to reduce over time, the impacts of Green Diamond's timber operations on aquatic species habitat.

Fish harvest

Coho salmon have been harvested in the past in both coho- and Chinook-directed ocean fisheries off the coasts of California and Oregon. More stringent management measures that began to be introduced in the late 1980s have reduced coho salmon harvest substantially. Initial restrictions in ocean harvest were due to changes in the allocation of Klamath River fall-run Chinook salmon (KRFC) between tribal and non-tribal fisheries. These restrictions focused on the Klamath Management Zone where the highest KRFC impacts were observed (Good et al. 2005). The prohibition of coho salmon retention was expanded to include all California waters in 1995 (Good et al. 2005). With the exception of some harvest by the Yurok, Hoopa Valley and Karuk tribes for subsistence, ceremonial and commercial purposes[6], the retention of coho salmon is also prohibited in California river fisheries. In order to comply with the SONCC ESU coho salmon conservation objective, projected exploitation rates on Rogue/Klamath River hatchery coho salmon stocks are calculated during the preseason planning process using the coho salmon Fishery Regulation Assessment Model (FRAM, Kope 2005). Season options are then crafted that satisfy the 13 percent maximum ocean exploitation rate. In recent years, these rates have been well below 13 percent with five of the last eight years at or below 6 percent and no year exceeding 9.6 percent. Due to the predicted low abundance of Sacramento River basin fall-run Chinook salmon, severe ocean salmon fishing closures were adopted for 2008; as such, ocean exploitation rates for Chinook were anticipated to be negligible in 2008.

Because incidental ocean exploitation and tribal harvest rates vary, the effects of salmon harvesting to the abundance of SONCC ESU coho salmon in the Klamath population units may vary from neutral to negative. However, by selecting for certain size classes, runs, or certain ages of individuals, harvesting can also impact genetic diversity. At this time, NMFS does not believe that incidental ocean exploitation and tribal harvest are a limiting factor for SONCC ESU coho salmon in the Klamath basin.

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[6] Coho salmon harvest by the Yurok Tribe, which are the only tribal harvest data available, ranged from 25 to 2,452 adults between 1992 and 2009 (Williams 2010). Except for three years, the majority of the tribal catch (58-79 percent) between 1997 and 2009 comprised of hatchery fish (Williams 2010). An average of approximately 60 percent of the annual number of harvested coho salmon between 1997 and 2009 were hatchery fish.

Climate change

Climate change is postulated to have a negative impact on salmonids throughout the Pacific Northwest due to large reductions in available freshwater habitat (Battin et al. 2007). The hydrologic characteristics of the Klamath River mainstem and its major tributaries are dominated by seasonal melt of snowpack (NRC 2004). Van Kirk and Naman (2008) found statistically significant declines in April 1 Snow Water Equivalent (SWE) since the 1950s at several snow measurement stations throughout the Klamath basin, particularly those at lower elevations (<6000 ft.). Mayer (2008) found declines in winter precipitation in the upper-Klamath basin. The overall warming trend that has been ubiquitous throughout the western united states (Groisman et al. 2004), particularly in winter temperatures over the last 50 years (Feng and Hu 2007, Barnett et al. 2008) has caused a decrease in the proportion of precipitation falling as snow (Feng and Hu 2007). Basins below approximately 1800-2500 m in elevation appear to be the most impacted by reductions in snowpack (Knowles and Cayan 2004, Mote 2006, Regonda et al. 2005). Some of the largest declines in snowpack over the Western U.S. have been in the Cascade Mountains and Northern California (Mote et al. 2005, Mote 2006). These declines in snowpack are expected to continue in the Klamath basin, increase the demand for water by humans (Döll 2002, Hayhoe et al. 2004) and decrease water availability for salmonids (Battin et al. 2007). These decreases in water supply and increases in irrigation demand are likely to negatively impact coho salmon in the Klamath basin.

Bartholow (2005) found that the Klamath River is increasing in water temperature by 0.5°C/decade, which may be related to warming trends in the region (Bartholow 2005) and/or alterations of the hydrologic regime resulting from Reclamation's Klamath Project, logging, and water utilization in Klamath River tributary basins. Particularly, changes in the timing of peak spring discharge, and decreases in water quantity in the spring and summer may affect salmonids of the Klamath River. Most life history traits (*e.g.* adult run timing, juvenile migration timing) in Pacific salmon have a genetic basis (Quinn et al. 2000, Quinn 2005) that has evolved in response to watershed characteristics (e.g. hydrograph) as reflected in the timing of their key life-history features (Taylor 1991, NRC 2004). In their natural state, anadromous salmonids become adapted to the specific conditions of their natal river like water temperature and hydrologic regime (Taylor 1991, NRC 2004).

Climate change may at best complicate recovery of coho salmon, or at worst hinder their persistence (Beechie et al. 2006, Van Kirk and Naman 2008). By negatively affecting freshwater habitat for Pacific salmonids (Mote et al. 2003, Battin et al. 2007), climate change is expected to negatively impact one or more of the VSP criteria for the interior Klamath population units. Climate change can reduce the spatial structure by shrinking the amount of freshwater habitat available to coho salmon. Diversity could also be impacted if one specific life history strategy is disproportionately affected by climate change. Population abundance can also be reduced if fewer juveniles survive to adulthood. Climate change affects critical habitat by decreasing water quantity and quality, and limiting the amount of space available for summer juvenile rearing.

Hatcheries

Two fish hatcheries operate within the Klamath River basin, Trinity River Hatchery (TRH) near the town of Lewiston and Iron Gate Hatchery (IGH) 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. Trinity River Hatchery releases roughly 4.3 million Chinook salmon, 0.5 million coho salmon and 0.8 million steelhead annually. IGH releases approximately 6.0 million Chinook salmon, 75,000 coho salmon and 200,000 steelhead annually, for a total of roughly 11,875,000 hatchery salmonids released into the Klamath basin annually. Effects from releases of large numbers of hatchery fish include: competition for food resources, disease transmission, and competition for suitable spawning and rearing habitat. Additionally, historic hatchery practices of fish releases coincided with a reduction in the flow of water released by Reclamation into the Klamath River, which in turn coincided with a deterioration of water quality, reducing the rearing and migration habitat available for both natural and hatchery reared fish. Recent changes in hatchery management practices have begun to alleviate some of the effects mentioned above. Smolt release timing has been changed to allow for increased survival, decreased completion, and less likelihood of disease transmission. Although these management strategies are intended to reduce impacts to wild salmonids, some negative interactions between hatchery and wild populations may still persist through competition between hatchery and natural fish for food and resources, especially limited space and resources in thermal refugia important during summer months (McMichael et al. 1997, Fleming et al. 2000, Kostow et al. 2003, Kostow and Zhou 2006). The peak emigration timing of coho salmon yearlings produced in the Shasta River occur during the month of April which is consistent with release timing of coho salmon and steelhead trout yearlings from IGH, but is well before the release timing of hatchery produced Chinook salmon smolts from IGH (Daniels et al. 2011). Emigration of coho salmon yearlings from the Scott River has been shown to occur over a much longer period of time with peak emigration numbers occurring anytime between March and early June (Daniels et al. 2011). The exact effects on juvenile coho salmon from competition and displacement in the Klamath River from the annual release of 5,000,000 hatchery-reared Chinook salmon smolts from IGH are not known and likely vary between years depending on hydrologic and habitat conditions present. The hatchery releases of yearling coho salmon (75,000 fish) and steelhead trout (200,000) are much smaller in number and although there may be some adverse competitive interactions that occur between these groups, it is likely that other factors related to disease and the poor condition of habitats in the major tributary streams have a greater impact on survival of wild coho salmon.

In a review of 270 references on ecological effects of hatchery salmonids on natural salmonids, Flagg et al. (2000) found that, except in situations of low wild fish density, increasing release numbers of hatchery fish can negatively impact naturally produced fish. It was also evident from the review that competition of hatchery fish with naturally produced fish almost always has the potential to displace wild fish from portions of their habitat (Flagg et al. 2000). The increase in density of juvenile salmonids, combined with the reduction in instream habitat resulting from decreased flows in June could have negative impacts on coho salmon juveniles. During the summer, sometimes hundreds or even thousands of juvenile salmonids can be forced by mainstem water temperatures into small areas with cold water influence (Sutton et al. 2007).

Another important consideration in regards to SONCC ESU coho salmon diversity, spatial structure, and productivity is how smaller coho salmon populations from tributaries such as the Scott and Shasta Rivers, which are important components of the ESU viability, are affected by straying of hatchery fish. Pearse et al. (2007) found that hatchery steelhead adults sampled from IGH in 2001 clustered strongly [genetically] with smolts sampled by screw trap in the Shasta and

Scott Rivers, suggesting that significant gene flow has occurred between IGH and these nearby tributaries, presumably due to 'straying' of returning hatchery adults. Outmigrating hatchery smolts are known to utilize the Shasta River, so it is likely that some may return to spawn there as well (Pearse et al. 2007). Although it is possible that the screw trap samples represent mixtures of smolts originating from multiple, distinct, upstream populations, the pairwise F_{ST} (Fixation index, a measure of population differentiation values) between IGH and the screw trap samples were among the lowest significant values observed (0.004–0.009), supporting the hypothesis of high gene flow between the hatchery and these populations (Pearse et al. 2007). CDFG (2002) found that 29 percent of coho salmon carcasses recovered at the Shasta River fish counting facility (SRFCF) had left maxillary clips in 2001, indicating that they were progeny from IGH. The average annual percentage of hatchery coho salmon in the Shasta River from 2001 to 2010 was 23, with a high of 73 in 2008 (Ackerman et al. 2006, 2007, 2008). These data indicate that a fair amount of straying of IGH fish occurs into important tributaries of the Klamath River, like the Shasta River, which has the potential to reduce the reproductive success of the natural population (Mclean et al. 2003, Chilcote 2003, Araki et al. 2007) and negatively affect the diversity of the interior Klamath populations via outbreeding depression (Reisenbichler and Rubin 1999, HSRG 2004).

Restoration

There are various restoration and recovery actions underway in the Klamath basin aimed at improving habitat and water quality conditions for anadromous salmonids. Congress authorized $1.0 M annually from 1986 through 2006 to implement the Klamath River Basin Conservation Area Restoration Program. The Klamath River Basin Fisheries Task Force (Task Force) was established by the Klamath River Basin Fishery Resources Restoration Act of 1986 (Klamath Act) to provide recommendations to the Secretary of the Interior on the formulation, establishment, and implementation of a 20-year program to restore anadromous fish populations in the Klamath River basin to optimal levels. The 16-member Task Force included representatives from the fishing community, county, state and federal agencies, and tribes. A Technical Work Group of the Task Force provided technical and scientific input. In 1991, the Task Force developed the Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program to help direct fishery restoration programs and projects throughout the Klamath River.

In addition to creating a fishery restoration plan for the river basin restoration program, the Task Force also encouraged local watershed groups to develop restoration plans for each of the five sub-basins of the Lower Klamath River basin. These groups included the Shasta River Coordinated Resource Management Planning Group (Shasta sub-basin), Scott River Watershed Council (Scott sub-basin), Salmon River Restoration Council (Salmon sub-basin), Karuk Tribe and Mid-Klamath Watershed Council (mid-Klamath sub-basin), and the Yurok Tribe (lower-Klamath sub-basin). Since 1991, over $1.3 M has been given to these groups to develop the sub-basin plans and conduct restoration activities. Funds from the Klamath Act are often leveraged to develop broader restoration programs and projects in conjunction with other funding sources, including CDFG restoration grants. As an example, nearly $1.9 M of CDFG restoration funding was spent on a variety of Klamath River basin restoration projects during the 2002-2006 period alone. While the Klamath River Basin Conservation Area Restoration Program ended in 2006, federal funds were authorized for fiscal year 2007, and the FWS continues to administer funds in the near term consistent with the goals of the program.

In August, 2004, the California State Fish and Game Commission listed coho salmon north of San Francisco Bay under the California Endangered Species Act (CESA). CDFG created both a multi-stakeholder Coho Recovery Team to address rangewide recovery issues, and a sub-working group [Shasta –Scott Recovery Team (SSRT)] to develop coho salmon recovery strategies associated specifically with agricultural management within the Scott and Shasta Rivers to return coho salmon to a level of viability so that they can be delisted. The SSRT continues to work cooperatively with CDFG on the Shasta and Scott River Watershed-wide Permitting Program (Permitting Program) being developed by CDFG in consultation with the Siskiyou RCD, Shasta Valley RCD, and agricultural operators within the Scott and Shasta River watersheds. The Permitting Program will implement key coho salmon recovery tasks while facilitating compliance with CESA and Fish and Game Code section 1602 because both agricultural water diversions and agricultural land practices may adversely affect coho salmon and its habitat. As of December 2011, the Permitting Program has been idled due to a lawsuit challenging the validity of the Program. It is unknown what the potential outcome of this lawsuit will be on the Permitting Program.

NOAA administers several grant programs to further restoration efforts in the Klamath River basin. Since 2000, NMFS has issued grants to the States of California and Oregon, and Klamath River basin tribes (Yurok, Karuk, Hoopa Valley and Klamath) through the Pacific Coast Salmon Restoration Fund (PCSRF) for the purposes of restoring coastal salmonid habitat. Habitat improvement projects implemented by these grant programs include large woody debris placement projects, side and off channel habitat restoration and creation, barrier removal and remediation, and wetland enhancement. California integrates the PCSRF funds with their salmon restoration funds and issues grants for habitat restoration, watershed planning, salmon enhancement, research and monitoring, and outreach and education. Screening has reduced entrainment mortality and increased abundance.

Restoration activities are expected to benefit coho salmon and their critical habitat. Beneficial effects included increased habitat availability, improved habitat complexity, improved access to side channel and off channel rearing habitat, and overall potential increases in survival and viability. These effects are expected to continue throughout the duration of the action, possibly increasing during that time period. Passage improvements have reintroduced access to critical habitat, and improved existing degraded habitat. Restoration activities are expected to improve upon one or more of the VSP parameters for the interior Klamath populations, including increasing spatial structure and diversity, and indirectly increasing abundance and productivity

Mining

Mining activities within the Klamath River basin began prior to 1900. The negative impacts of stream sedimentation on fish abundance were observed as early as the 1930s. Mining operations adversely affect spawning gravels, decrease survival of fish eggs and juveniles, decrease benthic invertebrate abundance, create adverse effects to water quality, and impact stream banks and channels. The greatest threat from instream gravel mining is the alteration of channel morphology and hydraulic processes which alter the quantity and quality of instream habitat (e.g., pools and riffles) available (Kondolf 1997). The greatest threat from upslope mining is the increased potential for chemical, sediment or other types of contaminants to enter watercourses. Threats from placer mining and suction dredging include the rearrangement or destabilization of substrate and subsequent changes to macroinvertebrate assemblages (Kondolf and Wolman 1993). Instream gravel mining affects habitat primarily through the skimming of gravel bars. Lowered bars result in unstable riffles that scour redds, wider and shallower channels that present migration barriers, and simplified habitat with fewer pools for juvenile rearing and adult holding (Kondolof and Swanson 1993). Past placer mining has damaged some riparian areas to the point where future recruitment of vegetation is impossible. Additional threats from placer mining include removal of riparian vegetation leading to long-term increases in water temperature and lack of wood recruitment, potential water diversions, potential streambank failures and increased sediment. When stream channels are changed or sediment concentrations are increased through placer mining, it can affect benthic invertebrates in the stream. Their populations can decline, or the species types may change and these changes can place stress on fish populations too (Wagener and LaPerriere 1985). Results showed that placer mining caused increased turbidity and increased amounts of settleable solids and suspended sediments. These effects were correlated with decreased density and biomass of invertebrates (Wagener and LaPerriere 1985).

Although mining in the Klamath basin has decreased significantly, legacy effects from these activities remain. Large tailing piles in the Scott River basin for example, continue to create barriers to floodplain and off channel habitat, and small private mining operations continue to displace spawning gravels, and potentially cause turbidity and sedimentation issues.

Road maintenance and culvert replacement

In 2000, NMFS issued a final rule with protective regulations for threatened salmonids pursuant to ESA section 4(d) (65 FR 42422; July 10, 2000). Limit number 10 of the prohibitions in these regulations relates to road maintenance activities (50 CFR 222.203(b) (10). Specifically, this limit provides that the prohibitions of taking threatened salmonids in these regulations do not apply to road maintenance activities if the activity results from routine road maintenance conducted by the employees or agents of a state, county, city, or port under a program that complies with a routine road maintenance program substantially similar to the "Transportation Maintenance Management System Water Quality and Habitat Guide [Oregon Department of Transportation (ODOT) 1999]." To qualify their road programs under Limit 10, Humboldt, Del Norte, Trinity, Siskiyou and Mendocino Counties (Five Counties) collaboratively developed the "Water Quality and Stream Habitat Protection Manual for County Road Maintenance in Northwestern California Watersheds" (Five Counties Salmon Conservation Program 2002) which is based largely on ODOT (1999). In November 1999, the California Resources Agency convened a group of interested state, local and federal agencies, fisheries conservation groups, researchers, restoration contractors, and others to discuss ways to restore and recover anadromous salmonid populations by improving fish passage at fabricated barriers. Now recognized as the Fish Passage Forum, this diverse group meets on a quarterly basis to promote the protection and restoration of listed anadromous salmonid species in California, primarily by encouraging collaboration among public and private sectors for fish passage improvement projects and programs. Road maintenance and culvert replacement will likely benefit coho salmon in the action area.

These effects are expected to continue throughout the duration of the action, and beyond. Road maintenance and culvert activities may have a neutral or, in many cases, a positive effect upon all of the VSP parameters for the Interior Klamath populations. Reestablishing access to historical habitat and new spawning areas through culvert replacement and removal of passage barriers is likely to increase the spatial structure of the SONCC ESU. Decreasing road-related sediment inputs will increase survival and productivity. Restoring access to historic habitat, increases diversity of the population, and allows adults access to spawning habitat, indirectly increasing abundance. Additionally, road maintenance and culvert projects decrease the likelihood of road-related mass-wasting and infrastructure failures that have the potential to result in take of SONCC ESU coho.

Fish Disease

Pathogens associated with diseased fish in the Klamath River include bacteria (*Flavobacterium columnare* and motile aeromonid bacteria), a digenetictrematode (presumptive *Nanophyetus salmincola*), myxozoan parasites (*Parvicapsula minibicornis* and *Ceratomyxa shasta*) and external parasites (Walker and Foott 1993, Williamson and Foott 1998). Ceratomyxosis (due to *C. shasta*) has been identified as the most significant disease for juvenile salmon in the Klamath basin (Foott et al. 1999, Foott et al. 2004). Significant kidney damage (glomerulonephritis) has been associated with *P. minibicornis* infection; however, the prognosis of such infections is not fully understood. However, individuals with dual infections of *C. shasta* and *P. minibicornis* would likely have low survival rates (Nichols and Foott 2005).

High winter and spring flows of 2006 were considered to provide a “natural experimental flow.” IGD flows exceeded 10,000 cfs in April of 2006 and sustained high flows lasted through the spring. This period of high flows was anticipated to have an effect on disease infection rates through the disruption or destruction of polychaetes, reduced actinospore concentrations, or juvenile salmonid exposure timing (*e.g.,* Stocking and Bartholomew 2007). The results of the FWS spring 2006 monitoring study indicated the prevalence of both *C. shasta* and *P. minibicornis* during May and June was lower in 2006 compared to previous studies in 2004 and 2005. The higher flows appeared to delay the peak of infection for both parasites, but peak prevalence of infection was still similar in magnitude to previous monitoring studies (FWS 2007). The delayed infection rates in 2006 may have resulted from one or more of the following: (1) A reduction in the polychaete host involved in the life cycle of these parasites due to scouring associated with high flows; (2) A dilution effect on the actinospore (infectious to fish) stage of the parasites; or (3) A reduced transmission/infection efficiency of the parasites due to environmental conditions (temperature, turbidity, velocity).

Results from the 2007 monitoring study indicate 37 percent of coho salmon juveniles tested positive for *C. shasta* and 66 percent of coho salmon juveniles tested positive for *P. minibicornis.* Disease prevalence rates were highest in the Upper Klamath River reach in mid-May when flows at IGD ranged from 1400 to 1700 cfs.

Recent monitoring in May and June of 2011 showed that polychaete densities were low at all three index sites on the Klamath River (i.e., I-5 Bridge, Tree of Heaven, Seiad Valley) compared to previous years (Bartholomew 2011). Parasite densities from January through July 2011 were considerably lower than during the same period in 2010 (Bartholomew 2011). The low polychaete and parasite densities were likely a function of relatively high flows and low water temperatures in the spring of 2011 (Bartholomew 2011). The historical annual prevalence of infection for *C. shasta* has been 35% in juvenile Chinook salmon during the past 5 years. The prevalence of infection rate for *C. Shasta* was 16.5% in all juvenile Chinook sampled above the Trinity River confluence from May through July 2011 (True 2011).

High water temperatures can stress adult salmon and slow upstream migration rates, facilitating the transmission of bacterial pathogens (*e.g.*, *Ichthyopthirius multifilis* and *Flavobacterium columnares*) between healthy and sick fish as they crowd into the few cold water refugial areas of the Klamath River (FWS 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, habitat availability, and meteorological conditions (FWS 2003). Of the over 34,000 fish estimated to have died during the event, approximately 344 were coho salmon (CDFG 2004).

The effects to coho salmon due to disease are expected to continue throughout the action period and into the foreseeable future. Disease effects are likely to negatively impact all of the VSP parameters of the Interior-Klamath population units because both adults and juveniles can be affected. In terms of critical habitat, disease impacts adult and juvenile migration corridors, and juvenile summer rearing areas.

5.4 Critical Habitat of Klamath Population Units

Within the action area, the essential habitat types of SONCC coho salmon ESU designated critical habitat are: (1) Juvenile summer and winter rearing areas; (2) juvenile migration corridors; (3) adult migration corridors; and (4) spawning areas. Areas for growth and development to adulthood are not covered in this critical habitat section because these areas are restricted to the marine environment for coho salmon, which is not in the action area. Within the essential habitat types, essential features of coho salmon critical habitat 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 (64 FR 24049; May 5, 1999).

Coho salmon that inhabit the Klamath River basin occupy temperate coastal regions as well as arid inland areas stretching from IGD in the north, all the way to the South Fork Trinity River, roughly 100 miles to the south of IGD. The geographic distribution of coho salmon in the Klamath basin encompasses approximately 38 percent of the entire range of the ESU. Thus, the conservation value of the designated critical habitat in the action area is extremely important for the species. Without the Klamath River and associated tributaries, a vast area of the SONCC coho salmon ESU would no longer support the species, fragmenting populations to the north and south, thereby increasing the risk of local extirpations within the ESU as well as increasing the extinction risk for the species.

The Lower Klamath River is not discussed here in the critical habitat section because it falls within the boundaries of the Yurok Tribe Reservation, and tribal lands are excluded from the SONCC ESU critical habitat designation.

5.4.1 Upper Klamath River

Due to decades of upper basin land use conversion from floodplains and extensive wetlands to irrigated agriculture and residential and commercial development, water quality and quantity conditions have contributed greatly to the reduction in functionality of essential habitat types in this reach and have diminished the ability of the habitat types to establish essential features. IGD flow releases have a proportionally larger effect on the flow regime in this reach than in downstream reaches, because tributary accretions increase river flows and dilute poor water quality conditions as one travels downstream. In this baseline assessment, NMFS has included flows from the NMFS (2010) RPA for Reclamation's Klamath Project as the current baseline for mainstem flows. The RPA flow regime is currently being implemented.

Juvenile Rearing Areas

For the Upper Klamath River Population Unit, juvenile summer rearing areas were historically compromised by unnatural low flow conditions. In addition historically and currently rearing areas are subject to high water temperatures, low dissolved oxygen levels, excessive nutrient loads, habitat loss, disease effects, pH fluctuations, non-recruitment of large woody debris, and loss of geomorphological processes that create habitat complexity. Water released from IGD during summer months is already at a temperature stressful to juvenile coho salmon, and solar warming can increase temperatures even higher as flows travel downstream (NRC 2004). Nocturnal DO levels directly below IGD can dip below 7.0 mg/L and may become stressful to coho salmon juveniles during much of the late summer and early fall. Between IGD 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). Dams also impair gravel and fine sediment recruitment downstream of Pacificorp's Project reservoirs, which result in poorly functioning floodplains that fail to support healthy riparian recruitment. Winter rearing areas suffer from non-recruitment of large woody debris and stream habitat simplification.

Juvenile coho salmon rearing habitat on the mainstem Klamath River is affected by mainstem water quantity. While the NMFS (2010) RPA flows do not jeopardize coho salmon, the existing RPA flows result in some loss of juvenile rearing habitat. With a few exceptions, the habitat reduction does not exceed a proportional 10 percent of maximum available habitat for juvenile coho salmon during the March through June period when compared with hypothetical flow without Reclamation's Klamath Project operations. RPA flows are expected to provide essential features of critical habitat and hydrological conditions representative of average and wetter exceedence. NMFS anticipates, under the RPA flows, the essential features of SONCC ESU coho salmon critical habitat will provide their intended conservation role (*i.e.,* function in a manner that supports the lifestages that require that habitat type)

Juvenile Migration Corridor

Historically, juvenile migration corridors suffered from low flow conditions. The corridors continue to experience disease conditions, and high water temperatures. With implementation of RPA flows, NMFS believes water velocities will no longer impede emigration timing or upstream and downstream redistribution. NMFS expects juvenile coho salmon are being afforded environmental cues under the RPA flows for emigration, and likely are better able to redistribute downstream to abundant overwintering habitat in the Lower Klamath River reach and downstream nonnatal tributaries.

Adult Migration Corridor

The current physical and hydrologic conditions of the adult migration corridor in the Upper Klamath River reach are likely properly functioning in a manner that supports the conservation role of the adult migration corridor. Water quality is suitable for upstream adult migration, and with implementation of RPA flows, flow volume is above the threshold at which physical barriers to migration may form.

Spawning Areas

Coho salmon are typically tributary spawners. However, low numbers of adult coho salmon do spawn in the Upper Klamath River mainstem reach annually. Upstream dams block the transport of sediment into this reach of river. The lack of clean and loose gravel diminishes the amount and quality of salmonid spawning habitat downstream of dams. This condition is especially critical below IGD (FERC 2006). Water temperatures and water velocities are generally sufficient in this reach for successful adult coho salmon spawning. However, due to the interruption of spawning gravel recruitment, the conservation value of spawning areas in this reach of the river is not properly functioning.

5.4.2 Middle Klamath River

The Middle Klamath River section begins above the Trinity River confluence and extends upstream 85 miles to the mouth of Portuguese Creek (rm 128). It is substantially different from the Klamath River upstream and downstream and adjacent sub-basins (Salmon and Scott Rivers), particularly in precipitation and flow patterns (Williams et al. 2006, Appendix 1, Figures B-D). IGD flow releases have a proportionally larger effect on the flow regime in this reach than the lower Klamath River reach, since two (Salmon and Trinity Rivers) of the four major Klamath River tributaries enter near the lower end of this section.

Juvenile Rearing Areas

Juvenile summer rearing areas in this stretch of river have been compromised relative to the historic state. A few tributaries within the Middle Klamath River Population Unit (e.g., Boise, Red Cap and Indian Creeks) support populations of coho salmon (NMFS 2007), and offer critical cool water refugia within their lower reaches when mainstem temperatures and water quality approach uninhabitable levels. As noted however, these cool water tributary reaches can become inaccessible to juveniles when low flows and sediment accretion create passage barriers; therefore, summer rearing habitat can be limited. In general, mainstem habitat is not suitable for productive summer or winter rearing, making tributary habitats highly valuable for growth and survival of coho. Generally, the conservation role of juvenile summer and winter rearing areas of the Middle Klamath River reach is impaired and functioning at a low level during summer months. RPA flows are also allowing for enhanced fall flow variability which NMFS anticipates are providing transitory habitat in mainstem side-channels and margins preferred by juvenile coho salmon. Transitory habitat can provide suitable cover from predators, and ideal feeding locations.

Juvenile Migration Corridor

Although much reduced as compared to the Upper Klamath reach of the river, disease effects in the Middle Klamath reach can limit the survival of juvenile coho salmon as they emigrate downstream. As with the Upper Klamath reach, NMFS expects juvenile coho salmon are being afforded environmental cues under the RPA flows for emigration, and likely are better able to redistribute downstream to abundant overwintering habitat in the Lower Klamath River reach and downstream nonnatal tributaries.

Adult Migration Corridor

NMFS believes that implementation of the NMFS (2010) RPA flows will alleviate many of the adult migration issues observed in the past and will improve critical habitat in the Middle Klamath reach. NMFS expects that implementation of the NMFS (2010) RPA fall and winter flow variability has alleviated instream conditions brought about by low flows that may have resulted in impairments to upstream adult migration, concentration of high number of salmonids in holding habitat, and subsequent disease outbreaks in adults that can become lethal. NMFS expects that implementation of RPA flows creates habitat conditions suitable for adult migration in the Middle Klamath reach.

Spawning Areas

There is some evidence that limited spawning of coho salmon occurs in the Middle Klamath River reach (Magneson and Gough 2006). However, the quality and amount of spawning habitat in the Middle Klamath River reach is naturally limited due to the geomorphology and the prevalence of bedrock in this stretch of river. It is unclear if there was historically very much mainstem or tributary spawning in this reach. However, due to high rates of historical sediment delivery impacting low gradient reaches of tributaries, NMFS believes spawning areas in this reach of the river are not properly functioning. Williams et al. (2008) determined that at least 34 coho salmon per-IP km of habitat are needed (3,900 spawners total) for the Middle Klamath coho salmon population to be at low risk for the spatial structure and diversity threshold. Adults and juveniles appear to be well distributed throughout the Middle Klamath; however use of some spawning and rearing areas are restricted by water quality, flow, and sediment issues. Although its spatial distribution appears to be good, many of the Middle Klamath tributaries are used for non-natal rearing, and too little is known to infer how the condition of critical spawning habitat is impacting the Middle Klamath population unit.

5.4.3 Shasta River

Juvenile rearing Areas

Juvenile rearing is currently confined to the mainstem Shasta River from RM 17 to RM 23, Big Springs Creek, Lower Parks Creek, and the Shasta River Canyon, as well as in Yreka Creek and the upper Little Shasta River. Stream temperatures for summer rearing are poor throughout the mainstem Shasta River from its mouth to the Big Springs area, and upstream of Lake Shastina (CDWR 1986).

Historically, the most vital habitat in the Shasta River basin were its cold springs, which created cold water refugia for juvenile coho salmon, decreased overall water temperatures, and allowed for successful summer rearing of individuals in natal and non-natal creeks and mainstem areas. These areas have been significantly adversely affected by water withdrawals, agricultural activities, and riparian vegetation removal. These land use changes have compromised juvenile rearing areas by creating low flow conditions, high water temperatures, insufficient dissolved oxygen levels, and excessive nutrient loads making the conservation value of juvenile rearing areas in the Shasta not properly functioning.

Juvenile Migration Corridor

Juvenile migration corridors suffer from low flow conditions, high water temperatures and low water velocities that slow and hinder emigration or upstream and downstream redistribution. Because there are significant water diversions and impoundments in the Shasta River, the unnatural and steep decline of the hydrograph in the spring may slow the emigration of coho salmon smolts, and increase water temperatures more quickly than would occur otherwise. In undertaking annual Shasta River downstream migrant trapping studies, CDFG observed a relationship between reduced baseflows, increasing water temperatures, and early outmigration of young-of-the-year (YOY) coho salmon (CDFG 2003). In years when spring baseflows were reduced early due to drought conditions and the onset of agricultural water deliveries, YOY coho salmon outmigration to the mainstem Klamath River occurred earlier than in years when Shasta River baseflows were sustained at a higher level through the spring (CDFG 2003). This suggests that juvenile coho salmon are prematurely forced to redistribute within the basin in response to diminishing spring flow conditions. As such, the conservation value of the juvenile migration corridor is not properly functioning in the Shasta River.

Adult migration corridor

The current physical and hydrologic conditions of the adult migration corridor in the Shasta River are likely properly functioning in a manner that supports the conservation role of the adult migration corridor. Water quality is suitable for upstream adult migration, and flow volume is above the threshold at which physical barriers may form. The irrigation season officially ends on October 1, and in most years in conjunction with late fall/early winter precipitation events, adult coho salmon have the ability to move out of the mainstem Klamath and into spawning areas in the Shasta River.

Spawning areas

The Shasta River in particular, with its cold flows and high productivity was once especially productive for anadromous fishes. The current distribution of spawners is limited to the mainstem Shasta River from RM 17 to RM 23, Big Springs Creek, lower Parks Creek, and the Shasta River Canyon. The loss of LWD recruitment, channel margin degradation, and excessive sediment has limited the development of complex stream habitat necessary to sustain spawning throughout much of the high IP areas of the Shasta Valley. Persistent low flow conditions through the end of the irrigation season (October 1) can also constrain the timing and distribution of spawning adult coho salmon,

5.4.4 Scott River

Juvenile rearing Areas

Numerous water diversions, dams and interconnected groundwater extraction for agricultural purposes, and the diking and leveeing of the mainstem Scott River have reduced summer and winter rearing habitat in the Scott River basin, limiting juvenile survival. Although rearing habitat still exists in some tributaries, access to and from these areas is hindered by dams and diversions, the existence of alluvial sills, and the formation of thermal barriers at the confluence of tributaries and stagnant, disconnected pools. Where passage is possible, there are thermal refugial pools and tributaries where the water temperature is several degrees cooler than the surrounding temperature, providing a limited amount of rearing habitat in the basin. Currently, valley-wide agricultural water withdrawals and diversions, groundwater extraction, and drought have all combined to cause premature surface flow disconnection along the mainstem Scott River. In addition, summer discharge has continued to decrease significantly over time, further exacerbating detrimental effects on coho salmon in the basin. These conditions restrict or exclude available rearing habitat, elevate water temperature, decrease fitness and survival of over-summering juveniles, and sometimes result in juvenile fish strandings and death. The conservation value of juvenile rearing areas is not properly functioning in the Scott River.

Juvenile Migration Corridor

As in the Shasta River, juvenile migration corridors suffer from low flow conditions, high water temperatures and low water velocities that slow and hinder emigration or upstream and downstream redistribution. Juveniles are often forced out of the Scott River prematurely, when conditions in the mainstem may not be suitable. Once fish leave the Scott River, they are exposed to ambient conditions in the mainstem Klamath, which often include increased disease rates, elevated water temperatures, and competition from hatchery fish. Disease effects in this stretch of river can limit the survival of juvenile coho salmon as they emigrate downstream. The conservation value of the juvenile migration corridor is not properly functioning in the Scott River.

Adult migration corridor

The current physical and hydrologic conditions of the adult migration corridor in the Scott River reach are likely properly functioning in a manner that supports its conservation role of the adult migration corridor. Water quality is suitable for upstream adult migration, and flow volume is above the threshold at which physical barriers may form.

Spawning areas

The Scott River is still an important spawning area for salmonids, as indicated by the annual outmigrant trapping by the California Department of Fish and Game (Chesney 2002). Numbers of fish are severely diminished, however, and habitat is poor for one or more stages of the life history of all anadromous salmonids (CDFG 1979). Historical placer mining in the mainstem and some tributaries has severely degraded spawning habitat, and has formed migration barriers during low flow years. The conservation value of spawning areas is not properly functioning in the Scott River.

5.4.5 Summary of Critical Habitat in Interior-Klamath Diversity Stratum

The current function of critical habitat in the Interior-Klamath Diversity Stratum is degraded relative to its unimpaired state. Sedimentation, low stream flows, poor water quality, stream habitat simplification, and habitat loss from poorly designed road crossings plague coho salmon streams in this stratum. Additionally, critical habitat in the Interior Diversity stratum often lacks the ability to establish essential features due to ongoing human activities. For example, IGD on the Klamath River, California, stops the recruitment of spawning gravels, which impacts both an essential habitat type (spawning areas) as well as an essential feature of spawning areas (substrate). Water utilization in many regions throughout the diversity stratum (*e.g.,* Shasta and Scott Rivers) reduces summer baseflows, which limits the establishment of several essential features such as water quantity and water quality.

5.5 Risk of Extinction of Klamath Population Units

While the Status of the Species section discussed the viability of the SONCC coho salmon ESU, this section provides a more in-depth discussion of the extinction risk of the Klamath River basin populations, which consist of the three mainstem Klamath River populations and two tributary population units (the Shasta and Scott River populations) that are affected by the proposed action. Within the California portion of the SONCC coho salmon ESU, estimating the risk of extinction of a given coho salmon population is difficult since longstanding monitoring and abundance trends are largely unavailable. Williams et al. (2008) proposed biological viability criteria, including 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. (2008) 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 population estimates against population viability thresholds proposed by Williams et al. (2008) allow NMFS to make conservative assumptions concerning the current risk of extinction of Klamath River mainstem and tributary populations. Generally speaking, none of the five population units of coho salmon affected by the proposed action are considered viable. See Table 7 for depensation numbers needed for each population to be considered not at risk from low population level stochastic pressures.

Population Unit	Depensation Number
Upper Klamath	425.
Middle Klamath	114
Shasta River	532
Scott River	441
Lower Klamath	205

Table 7. Depensation Numbers for all Klamath population units.
Data taken from Williams et al. 2010.

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 of extinction for this specific criterion. With regard to spatial structure and diversity, Williams *et al.*(2008) 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 Klamath River coho salmon populations are likewise failing to meet spatial structure and diversity conditions consistent with viable populations. Several of these populations have also recently failed to achieve the high risk abundance thresholds, underscoring the critical nature of recent low adult returns.

NMFS' 2005 status review concluded the effect of hatchery programs on the spatial structure, productivity and diversity within the SONCC coho salmon ESU is uncertain (70 FR 37160; June 28, 2005). More recently, the specific viability criterion proposed by Williams et al. (2008) considers the influence of hatchery fish within a population. Hatchery fish can affect natural salmon populations through increased competition, disease introgression and genetic dilution (NRC 1996). To limit these effects, Williams et al. (2008) propose that the fraction of naturally spawning fish within a given population that are of hatchery origin not exceed 5 percent in order to be at low risk of extinction. Populations in the Klamath River are influenced by hatchery fish, with native coho salmon present only in small numbers (NMFS 2004). The high proportion of hatchery-reared coho salmon within the Klamath River suggests the Klamath River populations are at least at a moderate risk of extinction with regard to their genetic diversity.

5.5.1 Upper Klamath

Population Size and Productivity. Based on juvenile surveys in the Upper Klamath between 2002 and 2005 there is low production in Upper Klamath tributaries with fewer than 200 juveniles found in most tributaries and most years (Karuk Tribe and HCRD, unpublished data). The greatest number of juveniles was just over 1,000, which were found in Horse Creek in 2005. Juveniles were found in 21 of the surveyed 48 tributary streams (Jong et al. 2008). In 2003, the total spawner abundance for surveyed streams in the Upper Klamath population was 10 adults. In

2004 it was 108 adults with the majority of fish found spawning in Seiad and Grider creeks (Karuk Tribe and HCRD, unpublished data). A weir on Bogus Creek, monitored returns to the hatchery, and various tributary spawner surveys provide some indication of what the population size might be presently. Returns to the hatchery between 2004 and 2009 have averaged around 900 fish with the lowest returns (70) in 2009 and the highest returns (1,495) in 2004. Returns to Bogus Creek are largely driven by hatchery strays but have averaged around 150 fish. Tributary spawner surveys indicate low numbers of coho salmon (<100) in the remaining habitat.

The depensation threshold for the population is 425 spawners (Williams 2008). Based on recent and longer term adult returns and juvenile abundance data, NMFS (2010) concluded that the Upper Klamath River Population Unit is at high risk of extinction given its low population size and low population growth rate.

Spatial Structure and Diversity. Coho salmon are currently spatially restricted to habitat below IGD. Coho salmon within the Upper Klamath River population spawn and rear primarily within several of the larger tributaries between Portuguese Creek and IGD, namely Bogus, Horse, Beaver, and Seiad creeks. Spawning surveys also give an indication of the population size and productivity. Spawning has been documented in low numbers within the mainstem Klamath River. From 2001 to 2005, Magneson and Gough (2006) documented a total of 38 coho salmon redds between IGD (RM 190) and the Indian Creek confluence (RM 109), although over two-thirds of the redds were found within 12 river miles of the dam. Many of these fish likely originated from IGH. A population of coho salmon parr and smolts rear within the mainstem Klamath River by using thermal refugia near tributary confluences to survive the high water temperatures and poor water quality common to the Klamath River during summer months.

Surveys by CDFG between 1979 and 1999 and 2000 to 2004 showed coho salmon were moderately well distributed downstream of IGD in the upper Klamath population area. However, NMFS (2010) concluded that the Upper Klamath River coho salmon population is at a high risk of extinction because its spatial structure and diversity are substantially limited compared to historical conditions.

5.5.2 Middle Klamath

Population Size and Productivity. Few data on adult coho salmon are available for this stretch of river. Adult spawning surveys and snorkel surveys have been conducted by the U. S. Forest Service and Karuk Tribe. A few tributaries in the mid-Klamath (e.g., Boise, Red Cap, Clear, and Indian creeks) are thought to support significant populations of coho salmon, however total spawner abundance and population productivity is unknown. Spawning surveys by the Karuk tribe in 2003, 2004, 2007, and 2008 in some spawning tributaries found only a handful of redds and adult coho salmon each year indicating a very small natal population size for this reach of the Klamath River. More recent coho salmon spawning surveys have been limited in the mid-Klamath and therefore information on adult distribution is scarce. Known adult spawning coho salmon have been documented in Bluff, Red Cap, Camp, Boise, South Fork Clear, Indian, and Grider creeks (Soto et al. 2008). Spawning surveys by the Karuk Tribe found adults spawning in Aikens, China, Elk, and the South Fork of Clear Creek. One estimate of the total population size is from 2001 to 2004; Ackerman et al. *(*2006) estimated a run size between 0 and 1,500. Juvenile counts indicate that productivity is relatively low with fewer than 12,000 juvenile coho salmon found between 2002 and 2009 during surveys of mid-Klamath tributaries (Six Rivers and

Klamath National Forest and Karuk Tribe, unpublished data). Many of these juveniles are likely from other populations and the actual number of juveniles produced by the mid-Klamath population could be much lower. Based on current estimates of the population, it is likely that the population is above depensation, but it is well below the low risk spawner threshold of 4,000 fish proposed by Williams et al. (2008). Therefore, NMFS (2010) concluded that the Middle Klamath River population is at moderate risk of extinction given the low population size and negative population growth rate.

*Spatial Structure and Diversity***.**

Juvenile surveys have been conducted over the past several decades by various parties including the Karuk Tribe, the Mid Klamath Watershed Council, and the Forest Service. These surveys have found coho salmon juveniles in Hopkins, Aikens, Bluff, Slate, Red Cap, Boise, Camp, Pearch, Whitmore, Irving, Stanshaw, Sandy Bar, Rock, Dillon, Swillup, Coon, Kings, Independence, Titus, Clear, Elk, Little Grider, Cade, Tom Martin, China, Thompson, Fort Goff, and Portuguese creeks (U.S. Forest Service unpublished data, Soto et al. 2008, MKWC, unpublished data). Most of the juvenile observations are of juveniles using the lower parts of the tributaries and it is likely that many of these fish are non-natal rearing in these refugial areas. Adults and juveniles appear to be well distributed throughout the Middle Klamath; however use of some spawning and rearing areas is restricted by water quality, flow, and sediment issues. Although its spatial distribution appears to be good, many of the Middle Klamath tributaries are used for non-natal rearing, and too little is known to infer its extinction risk based on spatial structure.

5.5.3 Shasta River

Population Size and Productivity. Adult spawning surveys and fish counting weir information started in 1934, though not including entire coho salmon runs. Currently, coho salmon entering the Shasta River are counted at the Shasta River Fish Counting Facility (SRFCF) operated by CDFG. Adult coho salmon returns were 30 and 9 in 2008 and 2009, respectively. Ackerman et al. (2006) used the coho salmon counts from this video weir combined with return timing information and the number of hatchery coho salmon carcasses recovered at the weir to develop approximations of run sizes for the Shasta River. The estimated number of adult coho salmon returning to the Shasta River ranges from 100 to 400 annually. At these low levels, depensation (e.g., failure to find mates), inbreeding, and genetic drift, which accelerate the extinction process, become a concern. These brood year population estimates are low, and have not trended upward over time. The estimates fall well below the low risk spawner threshold and below the high risk threshold proposed by Williams et al. (2008). Due to its proximity to IGH, the Shasta River likely has a higher rate of stray hatchery coho salmon than the Scott River, probably surpassed only by Bogus Creek. The average percentage of natural coho salmon carcasses recovered at the SRFCF in 2001, 2003, and 2004 was 84 percent, the remainder being hatchery origin fish. NMFS (2010) concluded that the Shasta River Population Unit is at high risk of extinction given the unstable and low population size and presumed negative population growth rate.

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

5.5.4 Scott River

Population Size and Productivity. The Scott River coho salmon population size is not precisely known, although Ackerman et al. (2006) estimated total run size for the Scott River basin. Estimated run sizes were 1,000 to 4,000 in 2001, 10 to 50 in 2002 and 2003, and 2,000 to 3,000 in 2004. Continuing adult spawning surveys and fish counting weir information that restarted in 2007 indicate that adult spawning coho salmon numbers approach 1,000 or more every third brood year (NMFS 2011), with abundance numbers ranging from 60 to 80 during the other two brood years. This relatively larger brood year population is still less than estimated pre-1960 annual returns of adult coho salmon. Table 8 provides current estimates of the Scott River population and yearling survival projections (Knechtle and Chesney 2011).

Brood Year	Yearling Year	Yearling Point Estimate	Adult Year	Adult Estimate	Yearlings to Adult	Percent Yearling Survival
2004	2006	75097	2007	1622	46.30	2.16
2005	2007	3931	2008	62	63.40	1.58
2006	2008	941	2009	81	11.62	8.61
2007	2009	62207	2010	927	67.11	1.49
2008	2010	2174	2011	37 /2	58.94 /2	1.74 /1

Table 8. Yearling coho salmon outmigrant abundance, adult coho salmon abundance estimates, ratio of outmigrant yearlings to adult returns, and proportion of outmigrant yearlings returned as adults, by Scott River brood years, 2004-2008 (Knechtle and Chesney 2011).

/1 Average percent yearling survival from brood years 2004, 2005 and 2007

/2 Projected adult estimate and yearling to adult ratio based on yearling point estimate of 62,207 and average percent yearling survival from brood years 2004, 2005 and 2007.

Variable rates of effort and differences in survey conditions between years may have influenced these estimates of run size. NMFS (2010) concluded that the Scott River Population Unit is at high risk of extinction, given the extremely low population size and presumed negative population growth rate.

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

5.5.5 Lower Klamath

Population Size and Productivity. Using juvenile coho salmon abundance estimates and overwinter and marine survival rates, Ackerman et al. (2006) estimated adult returns in 2002-2006 in Klamath River tributaries below the Trinity River confluence. The estimates ranged from 14 to 1,483 adults. Incorporating the upper and lower 95% CIs from juvenile sampling yielded a range of 1 to 2,026 adults. Estimates were rounded to the nearest 100 or 1000 for estimating basin wide abundance. Consistent spawner survey data are only available from Blue Creek but these data provide a relatively long period of productivity and abundance information for the population (Gale et al. 1998, Gale 2009). Between 1995 and 2008, 2,562 adult coho salmon were observed (Figure 22. Observed numbers of spawners ranged from 4 in 1995 to 1,040 in 2002. Approximately two percent of observed returns were jacks during this period. Although these surveys did not sample the full run of coho salmon, they can provide some indication of coho salmon production from Blue Creek.

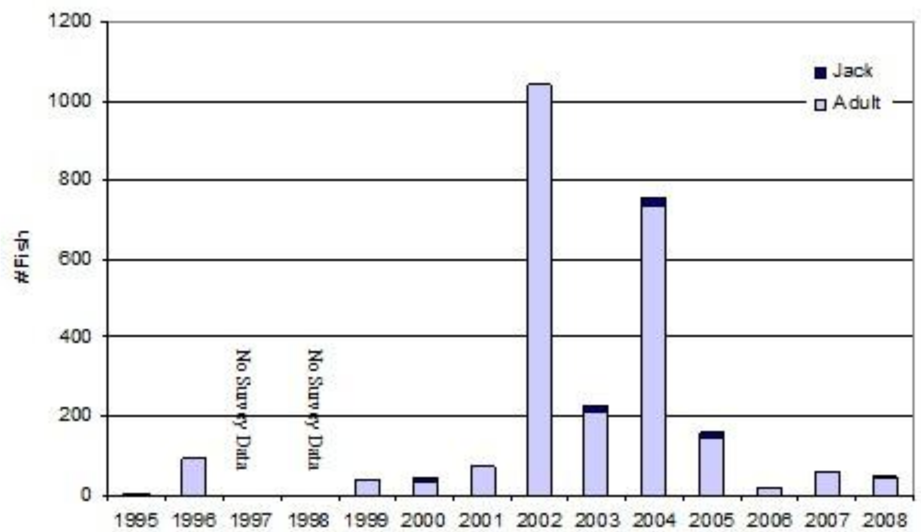

Figure 22. Coho salmon observed spawning in the Blue Creek watershed. Lower Klamath River between 1995 and 2008. Data are from YTFP snorkel surveys (Gale et al. 1998, Gale 2009c).

Carrying forward Ackerman et al's highest estimates for the Lower Klamath population into years 2008-2010, the average adult return estimates for the Lower Klamath Population Unit are still less than the Low Risk Annual Abundance Level. Therefore, the Lower Klamath River Population Unit has a moderate risk of extinction.

Spatial Structure and Diversity. Surveys conducted between 1996 and 2004 found coho salmon in nearly all surveyed streams in the Lower Klamath. Coho salmon were generally not well distributed in tributaries upstream of Blue Creek (Gale et al. 1998). Where they have been found they were generally only observed in the lower reaches of most tributaries (Voight and Gale 1998, YTFP 2009a). The distribution of juveniles appears diminished compared to historical accounts in Hunter, Hoppaw and Tarup creeks (Voight and Gale 1998). Very little is known about the life history and genetic diversity of the LKR population, but based on survey data, the population has been affected by out-of-basin stock planting and hatchery influences. Compared with other Klamath populations, however, tributaries in the LKR sub-basin may support some of the healthiest wild coho salmon in the basin. The population has a relatively high capacity for life history plasticity based on the diversity of unique habitat features. Given the decreased spatial structure, and likelihood of decreased diversity from hatchery and out of basin implants, NMFS believes the Lower Klamath River Population Unit to have a moderate risk of extinction.

VI. EFFECTS OF THE ACTION

In this chapter, the effects of the Proposed Action, which is the issuance of an ITP for implementation of the HCP for a 10-year period, are described. The effects discussion that follows is organized according to the principal causes of effects to SONCC ESU coho salmon from the proposed action, whether they are adverse or beneficial. In the PacifiCorp HCP (PacifiCorp 2012) there are seven categories of effects identified and are referred to as "Mechanisms for Potential Take" in Table 3 of the HCP (also Table 3 in this Opinion). In this Opinion NMFS describes Project effects on coho without and with implementation of conservation measures in the HCP in subsections 6.1- 6.5 and subsection 6.6, respectively. Project effects that may rise to the level of take of coho include blockage of fish passage, altered hydrologic flow regime, water quality impacts, blockage of downstream transport of sediment and wood, and disease. The Proposed Action has the potential to affect the following four essential habitat types within the action area: juvenile rearing habitat, juvenile and adult migration corridors, and spawning habitat. Therefore, the discussion of Effects of the Action on critical habitat focuses on these habitat types.

6.1 Blockage of Fish Passage

6.1.1 Effects on Critical Habitat

In terms of blockage of habitat, critical habitat is not designated above IGD, therefore there will be no effects to critical habitat in relation to passage effects of the proposed action above IGD.

6.1.2 Populations Affected and Individual Stressor Response

Under interim Project operations, blockage of habitat upstream of IGD would persist at its current extent for another 10 years until volitional fish passage is accomplished by removal of the dams under the KHSA or under a new FERC license with fish passage requirements.

The Upper Klamath Population Unit of coho salmon is characterized as an independent "long-run" population, meaning that it is distinct from coastal populations in which coho salmon migrate relatively short distances in coastal streams and rivers to spawn. Being a long-run population means over its historical evolution, the Upper Klamath coho population needed to adapt to a wide variety of environmental and habitat conditions during its migration to the entire available historical habitat. For example, coho once accessed higher-elevation, cooler streams influenced by snow melt late into the spring and summer and thrived under very different climatological patterns (very dry summers). Another example of impact on habitat-based adaptive traits is coho jumping ability. If stream systems in habitat currently blocked by Project dams had stream elevations that required coho to jump higher distances to access spawning habitat, the coho that evolved in this type of habitat would have greater jumping ability than coho that did not need to jump as high to reach spawning grounds. Such an impact could essentially eliminate the strong "jumping gene" that coho in the Upper basin evolved with as similar effects on other salmonids have been observed when passage barriers were removed after long periods of preventing migration (NPPC 2012, Waples et al. 2008).

In summary, the construction of Project dams eliminated habitat once occupied by Upper Klamath coho, gradually forcing them into the less diverse and degraded habitat that occurs below Iron Gate Dam. Given, the evolutionarily short timeframe of dam construction, the result of Project blockage of habitat is that the Upper Klamath population of coho has likely lost important traits and adaptive mechanisms specific to that upper basin habitat that enables population persistence through natural environmental variation, as well as future evolutionary change (Marchetti and Moyle 2001, Waples et al. 2008). NMFS believes coho salmon currently occurring below Iron Gate Dam would colonize habitat within the permit area upstream of Iron Gate Dam once upstream passage is provided (Simondet 2006). This reduction in adaptive traits and adaptation to varying types of spawning and rearing habitat likely adversely affects all life stages of Upper Klamath coho as adults, fry, parr, and smolts would all have been adapted to habitat conditions which have been blocked with the construction of Project dams. NMFS believes the proposed action will continue to negatively affect individuals of all life stages in the Upper Klamath River population in that blockage to approximately 58 miles of habitat above IGD will continue throughout the permit term (U.S. DOI 2007, NMFS 2007a). As is described in subsection 6.6, these negative effects will be offset by HCP conservation strategy actions to increase available habitat below IGD.

6.2 Altered Hydrologic Flow Regime

With implementation of the hydrologic flow regime provided in the NMFS 2010 Biological Opinion, NMFS and Reclamation, with PacifiCorp's cooperation, took significant steps to improve flows in the system to avoid jeopardizing the continued existence of the SONCC coho salmon ESU and also avoid the destruction or adverse modification of designated critical habitat downstream of IGD. Under current operations, flow releases from IGD are managed according to the flow levels described in the NMFS 2010 Biological Opinion and discussed previously as RPA flows. Flow release requirements from IGD have been described in the *Background and Consultation History* and *Environmental Baseline* chapters of this Opinion and include increased fall and winter flow variability, reduced October base flow, and increased spring discharge in select average and wetter exceedence categories.

The purpose of the flow variability program provided in NMFS (2010), and included in the PacifiCorp HCP and this proposed action, is to mimic the natural flow variability that would occur at the point of IGD release due to naturally-occurring precipitation run-off. PacifiCorp's role in the improved flow regime will be to participate in the multi-party evaluation of annual flow requirements for the Klamath River, and to cooperate via their facility operations and maintenance actions to ensure that RPA flows provided in the NMFS 2010 Opinion, or in future consultations between NMFS and Reclamation, downstream of IGD can be achieved. NMFS is also part of the multi-party team that evaluates annual instream flow conditions and achievement of RPA flows.

Additionally, under the NMFS 2010 Opinion, it was expected that PacifiCorp would participate in a program to implement ramping rates at Project facilities that are more conducive to maintaining suitable habitat conditions for SONCC coho salmon ESU downstream of IGD. The HCP has included a ramping program that is in alignment with the NMFS 2010 Opinion. The NMFS 2010 Opinion concluded that flow ramping rates established in the Opinion would protect rearing and migrating SONCC coho salmon ESU downstream from Iron Gate dam. The NMFS

2010 Opinion expected that habitat effects from established ramping rates would be representative of conditions that would be observed under natural flow conditions. Currently, PacifiCorp is coordinating with Reclamation on ramp down rates.

The effects discussed below in this subsection for the Altered Hydrologic Flow Regime under the Proposed Action without implementation of the HCP are essentially the same as effects for Improvement of Instream Flow Conditions Downstream of IGD under the Proposed Action with implementation of the HCP (see subsection 6.6.2). However, the difference is that, with implementation of the HCP, PacifiCorp's participation is ensured as a crucial party to achievement of the flow regime established by the NMFS (2010) RPA. NMFS' 2010 Biological Opinion required Reclamation to cooperate with PacifiCorp in order to implement flow release requirements from IGD, but the biological opinion could not require PacifiCorp to cooperate, because PacifiCorp's Project is not part of Reclamation's Klamath Project operations, which was the proposed action in that biological opinion. Issuance of an ITP to PacifiCorp, which is the Proposed Action in this biological opinion, would require implementation of the HCP by PacifiCorp.

6.2.1 Effects on Critical Habitat

The effects on critical habitat from the RPA flow regime have been previously evaluated and described in the NMFS 2010 Opinion, and we have no new information that would cause us to reconsider these effects with implementation of the HCP. RPA flow regime effects on critical habitat described in the NMFS 2010 Opinion are summarized below.

<u>Anticipated Effects of Increasing Fall and Winter Flow Variability on SONCC Coho Salmon ESU Designated Critical Habitat</u>

NMFS anticipates increased flow variability will reduce Reclamation's Klamath Project and PacifiCorp Project related effects to essential features of SONCC coho salmon ESU designated critical habitat over an extended range of the mainstem Klamath River (IGD to Seiad Valley). As NMFS concluded in our 2010 Opinion to Reclamation, fall and winter flow variability below IGD in response to climatological events will improve water quality conditions, increase the amount of complex and transitory habitat, and flush sediment from low velocity areas of the channel. Fall and winter flow variability are intended to mimic elements of the Klamath River natural flow regime. For example, flow recommendations that may be implemented as a result of the Variable Flow Technical Team described in the HCP may include ascension of the base flows through November, resulting in an expansion of side channel habitat preferred by adult coho salmon for spawning. NMFS anticipates enhanced fall flow variability through the RPA will provide transitory habitat in side-channels and margins preferred by juvenile coho salmon (NMFS 2010). This habitat is expected to provide suitable cover from predators, and ideal feeding locations.

<u>Anticipated Effects of Reducing October Minimum Base Flows from 1,300 cfs to 1,000 cfs</u>

October base minimum flows at IGD will be reduced to 1,000 cfs. While NMFS has determined that at the onset of October, a 1,000 cfs minimum base flow is prudent, NMFS expects, through the implementation of the Fall Flow Variability Program, IGD releases will more closely reflect the mainstem Klamath River natural flow regime with the onset of fall precipitation. Therefore, NMFS expects IGD releases during the month of October may include pulse flows and ascension of the base flows. The extent of these flow increases will reflect the natural hydrological and climatological condition. Prior to fall precipitation, when IGD releases in October may be as low as 1,000 cfs, NMFS anticipates the following effects to coho salmon individuals and their critical habitat:

Juvenile coho salmon and their critical habitat- During the fall months, coho salmon parr migrate through mainstem habitat as they redistribute from thermally suitable, summer habitat into winter rearing habitat characterized by complex habitat structure and low water velocities (Lestelle 2007). In the Upper Klamath River reach, characterized by the R-Ranch, Trees of Heaven and Seiad Valley reach level study sites, the volume of juvenile coho salmon habitat under a 1,000 cfs IGD release is generally similar as predicted under a 1,300 cfs IGD release. (NMFS 2010). Habitat modeling results (Hardy 2006 et al.) indicate habitat availability is not sensitive to the 300 cfs flow reduction, such that NMFS expects juvenile coho salmon will experience sufficient habitat availability under a 1,000 cfs base flow during the month of October over the period of the proposed action (NMFS 2010).

Adult coho salmon and their critical habitat- During October, adult coho salmon use the mainstem Klamath River as a migration corridor. Adult coho salmon escapement monitoring in the past decade has confirmed successful passage during IGD releases of 1,000 cfs in the fall period (*e.g.*, FWS mainstem redd/carcass surveys, CDFG Shasta and Bogus Creek video weir studies, IGH returns). NMFS anticipates no hindrances to adult coho salmon migration through the mainstem Klamath River reach in October when flows may be as low as 1,000 cfs.

No adverse effects to adult coho salmon spawning are anticipated as a result of the October minimum base flows described in the 2010 Opinion. Mainstem coho salmon spawning has not been observed prior to November 15 (Magneson and Gough 2006). NMFS anticipates flow variability through fall and winter months when coho do spawn is likely to enhance mainstem salmon spawning habitat by expanding spawning habitat under periods of higher flow.

Anticipated Effects of Implementing RPA Spring Flows on SONCC Coho Salmon ESU Designated Critical Habitat

RPA Spring flows that increase flow requirements at IGD will provide hydrological conditions representative of average and wetter exceedence (non-drought periods), and therefore will support essential features of critical habitat for coho, as analyzed in NMFS (2010). The analysis for this action, which uses Weighted Usable Area (WUA) to characterize the quality and quantity of useable habitats as described in NMFS (2010), concludes the RPA Spring flows will increase the amount and diversity of microhabitat features such as flow, depth, velocity, substrate and cover for juvenile coho.

Adult Migration Corridor

RPA Spring flows will not adversely affect adult migration corridors in the Klamath mainstem because adults are not expected to be in the freshwater system in the spring.

Juvenile-to-Smolt Rearing and Migration Corridors

RPA Spring flows are expected to provide sufficient water depths and velocities to allow for successful coho salmon smolt outmigration through the Upper Klamath River reach, and reduce transit time through areas of high disease infectivity as a result of the RPA flows (NMFS 2010). Additionally, higher velocities resulting from the RPA Spring flows are also expected to degrade the function and formation of slow "dead zones" within the channel that can harbor disease pathogens (Hardy et al. 2006), thereby reducing the overall impact of disease infection on coho salmon.

Although NMFS expects that implementation of RPA Spring flow requirements will result in improvements in the system's flow regime, NMFS expects critical habitat will continue to be adversely affected in that flows will continue to allow for substrate conditions to develop that lead to disease outbreaks, thus negatively affecting the conservation value of critical habitat for the juvenile to smolt rearing corridor in the reach between the Shasta River confluence upstream to IGD. Further discussion on the role flow plays in the relationship to habitat and disease outbreaks can be found in section 6.5 *Disease* of this Opinion. NMFS expects the largest impacts to critical habitat from altered flows to occur near the Trees of Heaven at RM 170, where the greatest incidence of disease conditions occurs. NMFS expects these conditions which lead to disease outbreaks and infections of juveniles to gradually improve over the permit term, but NMFS does not anticipate they will be eliminated. More discussion on the topic of disease can be found in Section 6.5.

6.2.2 Populations Affected and Individual Stressor Response

Effects of the RPA flow regime on coho salmon individuals and populations were described in the NMFS 2010 Opinion, and we have no new information that would cause us to reconsider these effects with this proposed action. RPA flow regime effects on coho salmon individuals and populations described in the NMFS 2010 Opinion are summarized below.

Adults

Coho adult movement is often precipitated by flow variability, and NMFS expects the RPA flow regime will maintain adult coho salmon movement and spawning availability through the Upper Klamath reach. NMFS anticipates no hindrances to Upper Klamath population adult coho salmon migration through the mainstem Klamath River reach in October when flows may be as low as 1,000 cfs, and no impact to adults as a result of the Spring flows. As such, NMFS does not believe RPA flows will negatively affect the Upper Klamath population adult migration and timing, or distribution of any of the Shasta and Scott River populations during the permit term.

Juvenile-to-Smolt Life Stage

Prior to implementation of the RPA flow regime in 2010, fall pulse-flows occurred less frequently and therefore disease transmission from adult salmon carcasses to *Manayunkia speciosa*, the intermediate polychaete host for the fish pathogens was likely more prevalent (NMFS 2010). NMFS anticipates enhanced flow variability through the fall and winter will help disrupt the fine sediment habitat of *M. speciosa* and increase the redistribution of adult salmon carcasses in the mainstem Klamath River, thereby reducing actinospore concentrations of *C. shasta* and *P. minibicornis* the following spring; ultimately reducing disease rates amongst juvenile salmonids in the mainstem Klamath River. RPA flows are also expected to increase smolt survival in the Upper and Middle Klamath River reaches by decreasing smolt transit rates, thereby reducing disease risks associated with *C. shasta* and *P. minibicornis*. Further discussion on how flows affect disease formation and infection of individuals can be found in section 6.5 *Disease* of this Opinion.

Although NMFS expects that implementation of RPA flow requirements will result in improvements in the system's flow regime, which NMFS expects will reduce disease outbreaks in juveniles, NMFS does not expect that these flows will result in the elimination of habitat conditions that lead to disease outbreaks that infect juveniles. We expect these conditions to persist throughout the permit term, particularly in the reach from IGD to the Trees of Heaven located at RM 170. We do, however, anticipate that the RPA flows will lessen the severity and duration of these disease outbreaks over the course of the permit term. Populations most likely to benefit from these reductions include the Upper Klamath, Shasta and Scott Rivers, and to a lesser degree the Middle Klamath. Benefits to these populations are expected by increasing the fitness of individual juveniles as they are subjected to reduced disease conditions, which NMFS expects will translate to improved juvenile to smolt survival rates.

NMFS anticipates increased fall and winter flow variability through the implementation of the RPA flows will reduce incidental take of juvenile coho salmon from disease infection over an extended range of the mainstem Klamath River (IGD to Seiad Valley). Flows are expected to provide environmental conditions necessary to trigger fall redistribution to abundant overwintering habitat in the Lower Klamath River reach and downstream natal tributaries. The variability in flows will allow for greater habitat diversity and quantity for coho population units (Upper Klamath, Shasta, and Scott population units). RPA flows are expected to support a greater abundance of life history strategies resulting in increases to the diversity of affected populations. Diversity of life history strategies is an important factor that may help increase the viability of coho salmon in the Klamath Basin, and the SONCC coho salmon ESU. NMFS expects coho salmon parr, pre-smolt and smolt (*i.e.*, juvenile) individuals of the Upper Klamath, Shasta, and Scott River population units to experience fitness benefits as a result of the implementation of the RPA flows.

These fitness benefits are likely to include increased growth from the availability of more suitable rearing habitat, lower risks of disease infection from *C. shasta* and *P. minibicornis* resulting in better growth and survival through the smolt life stage, reduced competition with hatchery-reared salmonids, and lower risks of predation. Through enhanced fitness, juvenile coho salmon will experience higher freshwater survival rates resulting in increased abundance.

Coho salmon smolts are also anticipated to experience reduced exposure to disease and other instream risks to survival (*e.g.*, predation) under the RPA flows as a result of shorter transit times through the Upper Klamath River reach. Increased abundance of returning adults will, over time, increase the productivity of affected populations. Hence, over the action period, the implementation of the RPA flows should improve the productivity (*i.e.,* population growth) of the Upper Klamath, Scott and Shasta rivers population units.

6.3 Water Quality Effects

Dissolved Oxygen (DO)

Dams and reservoirs in major river systems have long been known to create downstream water quality impairments that can dramatically alter natural ecosystems through changes in natural flow regimes, and changes in the physical, chemical, and biological processes that form a natural ecosystem. For example, Bevelhimer and Coutant (2006) reported that approximately 40% of all FERC-licensed projects have requirements to monitor and/or mitigate downstream DO conditions. Discharges from dams can contain dissolved and suspended organic matter that exert a biological or chemical oxygen demand as it decomposes, causing further depletion of dissolved oxygen in downstream rivers. This phenomenon becomes particularly enhanced in late summer and early fall as air temperatures rise and plant activity decreases. The reductions in the natural flow regime and the presence of river reservoirs also alter the natural temperature cycling in river systems with storage of large masses of water subject to solar heating. Water temperatures have an effect on DO concentrations as cooler water is more capable of dissolving oxygen into the water column than warm water. For example, cold-water streams in summer typically have saturated values near 11-12 mg/L; warm-water streams or lakes have saturated values near 8-9 mg/L (Bevelhimer and Coutant 2006). Examination of dams and reservoirs under the purview of the Tennessee Valley Authority also concluded that poor water quality conditions in rivers containing hydropower dams was largely influenced by upstream sources of pollutants and organic matter similar to conditions in the Klamath River basin (Bevelhimer and Coutant 2006). In essence, hydropower systems do not create water quality problems in and of themselves, but do act to concentrate and magnify water quality problems in riverine systems.

Although the Project facilities are not a source (but rather a net sink) of the large nutrient loads, the reservoirs do create impoundments of water that can contribute to the occurrence of algal blooms (fed by the large nutrient loads from upstream) and related water quality effects. High nutrient loading becomes a food resource for plant material (e.g., algae) which in turn becomes a food resource when plant material seasonally dies off (e.g., bacterial breakdown of plant life). When algae dies and bacteria thrive, bacterial respiration will consume oxygen, while there is little photosynthesis occurring in the water column adding oxygen. Thus, DO conditions deteriorate in the late summer/early fall as this natural cycle progresses. Low DO conditions are at their highest at nighttime with nocturnal DO levels directly below IGD likely below 7.0 mg/L during late summer/early fall. As noted in the discussion on known DO conditions within the action area in the *Environmental Baseline* section of this Opinion, DO can dip to levels below 6 mg/L and 85% saturation.

Water Temperature

As described in the *Environmental Baseline* section of this Opinion, system reservoirs create a "thermal lag" compared to the same location in the Klamath River under a hypothetical scenario without the Project dams and reservoirs. The natural seasonal trends of warming river temperatures in the spring and cooling temperatures in the fall are "lagged" about 2 to 4 weeks with the existence of Project dams and reservoirs compared to a hypothetical scenario without the Project dams and reservoirs. During the spring period, the thermal lag resulting from the presence of Iron Gate reservoir causes a more gradual warming of the river below IGD (as compared to a hypothetical scenario without the Project dams and reservoirs). In the Middle Klamath reach minimum nighttime water temperatures are consistently above 20°C in the summer. McCullough (1999) found that salmonids are typically absent from waters in which daily maximum temperatures regularly exceed 22–24ºC for extended periods, although bioenergetics considerations or presence of thermal refugia may push distribution limits into slightly warmer water. Growth and survival are usually highest when temperatures stay within an optimal temperature range; this range differs among species and life-history stages, but for juvenile salmonids in the Klamath system, optimal temperatures are 12–18ºC (Moyle 2002).

As summer transitions into the fall period, the thermal lag resulting from the presence of Iron Gate reservoir causes a more gradual cooling of the river below IGD (as compared to a hypothetical scenario without the Project dams and reservoirs). However, 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).

Modeling performed during the Klamath TMDL process indicates that under a dams-in scenario, water temperatures in the Klamath basin would improve following full implementation of the TMDL program with corresponding actions taken by landowners and land managers to reduce elevated temperatures (NCRWQCB 2010). A thermal lag would still likely occur in the spring and late summer/fall, but overall water temperatures would move towards meeting attainment objectives as stated in the Klamath TMDL (Reclamation and CDFG 2011). The TMDL modeling indicates the thermal lag experienced currently would continue with the dams still in place from downstream of Iron Gate Dam to approximately Seiad Valley (RM 129.4). Based on TMDL model results, water temperature from Seiad Valley (RM 129.4) to the Salmon River (RM 66.0), would meet water quality objectives (Reclamation and CDFG 2011).

6.3.1 Effects on Critical Habitat

Adult Migration Corridors and Spawning Habitat

During adult coho migration and spawning, water quality conditions in the Klamath mainstem are believed to be suitable for SONCC ESU coho salmon as water quality generally improves greatly with the onset of fall precipitation and tributary accretions, prior to coho movement above the Middle Klamath reach. Because water quality conditions improve in the Klamath mainstem prior to coho migration to the most water quality impaired reaches of the river, NMFS does not believe water quality effects from the Project impair the functionality of the adult migration corridor for coho, and NMFS does not believe water quality effects from the Project impair the functionality of mainstem spawning habitat in regards to suitable water quality for successful mainstem spawning and egg incubation.

Juvenile-to-Smolt Rearing and Migration Corridors

Due to Project effects, NMFS expects designated critical habitat from IGD to the downstream extent of the Upper Klamath reach will continue to be adversely affected from poor water quality conditions that impair the ability of critical habitat to provide high quality summer rearing habitat for coho juveniles.

6.3.2 Summary of Water Quality Effects on Individuals, Stressor Response and Populations Most Likely Affected

Adults

Coho salmon upstream migration and spawning downstream of IGD typically occurs during periods when dissolved oxygen conditions are suitable for adults (mid-Oct through December). NMFS does not expect that low DO conditions negatively affect adults of any of the coho populations within the action area (NMFS 2010).

By mid- to 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 near RM 100) registered water temperatures in excess of 23°C during late September 1992 (Fadness 2007). However, spawning, incubation, and emergence later in the fall should not be affected, as “lagged” temperatures converge with temperatures that would be expected under the hypothetical scenario without the effects of Project dams and reservoirs, and are within suitable ranges for the adult life stage.

Juvenile-to- Smolt Life Stage

The effects of low dissolved oxygen on aquatic organisms can range from acute mortality to impaired function. Impaired functions can include growth, swimming and avoidance behavior. Davis (1975) reported effects of dissolved oxygen on salmonids, indicating that at dissolved oxygen (DO) concentrations greater than 7.75 mg/L salmonids functioned without impairment, at 6.00 mg/L onset of oxygen-related distress was evident, and at 4.25 mg/L widespread impairment is evident. These values are consistent with those reported by the USEPA (1986). USEPA reported that for life stages other than embryos and larvae, no impairment was observed at DO levels of 8 mg/L, slight impairment was evident at 6 mg/L, moderate impairment at 5 mg/L, severe impairment at 4 mg/L, and acute mortality at 3mg/L and lower. Low DO can affect fitness and survival by altering embryo incubation periods, decreasing the size of fry, increasing the likelihood of predation, and decreasing feeding activity (Carter 2005). Under extreme conditions, prolonged exposure to low dissolved oxygen concentrations can be lethal to salmonids.

However, organisms can tolerate low dissolved oxygen concentrations for short periods of time, as low as 2 mg/L, but prolonged and repeated exposure to low DO has detrimental effects on activity, feeding, growth rates, and other normal biological functions. The growth of young fish can be significantly slowed under low DO conditions if DO falls to 3 mg/L for part of the day, even if it rises to 100% saturation at other times (Bevelhimer and Coutant 2006). Given the general understanding of DO effects on aquatic organisms, more recent studies examining coho survival under natural conditions have found coho tolerance for low DO in the natural environment may be higher than expected. Winter studies in Alaska on juvenile coho found all juvenile coho survived for 24 hours when DO concentrations were 3.1 mg/L and high survival was observed when juveniles were exposed for 4-5 days to a DO of 3.2-3.3 mg/L (Ruggerone, 2000). A study examining utilization of emergent wetlands by juvenile coho in the Chehalis River in Washington found that emigrating coho were surviving in freshwater wetlands at extremely low DO concentrations; although DO concentrations as low as 0.5 mg/L may have resulted in juveniles preferring to utilize better conditions elsewhere (Henning et al 2006). Another recent study conducted in slough environments in Washington found coho surviving in late spring DO conditions as low as 4.8 mg/L while emigrating through the slough environments (Beamer et al, 2010). What is important to consider in these studies is that coho juveniles can be exposed to low DO conditions under natural conditions such as in emergent wetlands (high vegetative as well as bacteriological productivity) which provide important food resources and cover in the life cycle of coho. Although these natural habitats may experience periods of low DO, there is evidence to indicate that low DO is not necessarily lethal to emigrating coho. Juvenile coho salmon can be present when DO conditions may not be suitable, resulting in fewer opportunities to forage and potential reductions in growth and survival. NMFS (2007) indicates that low dissolved oxygen conditions likely limit the nightly period during which juvenile fish leave refugia habitat to forage within the mainstem Klamath River. Recent studies indicate the exposure of juveniles to low DO below IGD is likely not lethal (Henning et al 2006, Beamer et al 2010), nor is there any direct evidence to indicate this is occurring. Based on previous studies and data results, NMFS does expect that juvenile coho residing within the six (6) mile reach below IGD may be periodically exposed to harmful levels of DO from the period of late July to late September although implementation of the HCP can help minimize exposure times to low DO (NMFS 2010, PacifiCorp 2011, Karuk 2008). However, some individuals may avoid adverse water quality conditions by rearing within lower tributary reaches and refugia within the mainstem Klamath River, where water quality conditions are suitable. Based upon known in-situ data, DO levels for rearing juveniles outside of the summer/fall period is likely not affecting the fitness of juveniles during this time period.

Juvenile coho salmon (parr and smolts) have been observed residing within the mainstem Klamath River downstream of IGD within the Upper Klamath Population Unit throughout the summer and early fall in thermal refugia during periods of high ambient water temperatures (>22°C). Mainstem refugia areas are often located near tributary confluences, where water temperatures are 2 to 6°C lower than the surrounding river environment (NRC 2004, Sutton *et al.*2003). Habitat conditions of refugia zones are not always conducive for coho salmon because several thousand fish can be crowded into small areas, leading to predator aggregation and increasing competition, thereby triggering density dependent mechanisms. Robust numbers 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 have been documented in very small numbers, utilizing cold water refugia areas within the Middle and Lower Klamath Population Units (Sutton *et al.*2004). No coho salmon were observed within extensive cold-water refugia habitat adjacent to lower river tributaries such as Elk Creek (RM 107), Red Cap Creek (RM 53), and Blue Creek (RM 16) during past refugia studies (Sutton *et al.*2004). However, Naman and Bowers (2007) captured 15 wild coho salmon ranging in size from 66 mm to 85 mm in the Klamath River between Pecwan and Blue creeks near cold water seeps and thermal refugia during June and July of 2007.

NMFS (2007) indicated that warmer temperatures extending into the fall may reduce the ability of coho juveniles to use habitat in the mainstem during those periods. This may reduce growth or survival of juvenile coho redistributing into habitats in the mainstem. Some coho salmon smolts may stop migrating entirely for short periods of time if factors such as water temperature inhibit migration. 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). Salmonid smolts may further delay their downstream migration by residing in the lower river and/or estuary (Voight 2008). In- river studies have found that juvenile survival was lower in the reach from IGH to the Scott River than in reaches farther downstream (Beeman 2007). In 2007, estimated apparent survival of 123 hatchery radio-tagged coho salmon from IGD RM 20.5 was 70 percent (95-percent Cl = 0.586 to 0.814), which was comparable to the 2006 results (FWS, unpublished data). Reduction in survival rates may be due to extended rearing behavior in poor conditions in the Upper Klamath River.

High summertime water temperatures are likely to continue to be a stress on juveniles of the Upper Klamath, Scott and Shasta Rivers, and Middle Klamath populations. NMFS believes that the coho salmon populations of the Upper Klamath, Scott and Shasta rivers, and Middle Klamath may have some reduced fitness levels due to occasional periods of low DO and warm water temperatures. However, the combined water quality effects on fitness are not well understood.

In summary, NMFS anticipates that the Project without implementation of the HCP conservation measures will continue to negatively affect juveniles of the populations of the Upper Klamath, Scott and Shasta Rivers, and to a lesser degree Middle Klamath as they continue to be exposed to poor water quality conditions in the Upper Klamath River. The Middle Klamath population receives tributary inputs moving in a downstream direction, resulting in amelioration of poor water quality discharged from IGD. This population, like the Scott and Shasta River populations however, can be impacted by poor water quality in the Upper Klamath reach if juveniles spend residence time in the Upper Klamath in spring and summer months. Without implementation of HCP measures to minimize and mitigate for Project effects, NMFS believes substantial adverse effects from periods of exposure to low DO and high water temperatures will be expressed in terms of reduced growth rates, and impacts to the overall health of these life stages reducing juvenile-to-smolt survival rates as compared to an unaltered system. NMFS anticipates these adverse impacts will be at their highest levels throughout the Upper Klamath reach.

6.4 Blockage of Downstream Transport of Sediment and Wood

6.4.1 Effects on Critical Habitat

Large dams, such as IGD on the Klamath River, can stop the recruitment of spawning gravels and large woody debris, which impacts both an essential habitat type (spawning areas) as well as an essential feature of spawning areas (substrate). Blocking recruitment of LWD to river systems supporting coho impairs rearing areas for cool water refugia, food resources, and cover from predation for juveniles.

Adult Migration Corridor and Spawning Habitat

The lack of clean and loose gravel diminishes the amount and quality of salmonid spawning habitat downstream of dams. Geomorphology analyses suggest that the primary impact of the Project on alluvial features (and therefore on potential salmonid spawning material) is limited to the eight-mile reach from IGD downstream to the confluence with Cottonwood Creek (PacifiCorp 2004, FERC 2007). Near Cottonwood Creek, there is a sharp break in surficial geologic lithologies between the volcanic Cascades Province (west and upstream of Cottonwood Creek area) and the Klamath Province (east and downstream of Cottonwood Creek area). The Klamath Province is generally a larger producer of sediment recruitment as slopes are steeper and generally more unstable. Thus, sediment production in the Cascades Province is relatively much less, meaning the importance of the sediment that is produced in this region can be more critical to the formation of suitable spawning gravels in the Upper Klamath reach. NMFS is unable to quantify the amount of spawning gravels that becomes trapped by Project dams as recruitment of spawning gravels depends on many factors which cannot be adequately predicted (e.g. bedload moving flows, and nature and prevalence of gravel producing events such as landslides). Coho salmon downstream of IGD may be indirectly harmed by a reduction of spawning habitat resulting from long-term depletion of spawning gravel. NMFS concludes that critical habitat in the Upper Klamath reach will continue to be adversely affected by the proposed action, in terms of continued interruption of gravel recruitment as compared to an unaltered state, negatively affecting spawning potential in this reach. NMFS believes the lack of adequate spawning gravels in the mainstem downstream of IGD results in spawning habitat in the Upper Klamath reach that is not properly functioning.

Juvenile-to-Smolt Rearing and Migration Corridors

The production of coarse sediment in the Upper Klamath reach, or its retention as is the case in the Project, is important in regards to the disease mechanisms that occur downstream of IGD. Project reservoirs may contribute to the conditions favoring the population of the intermediate host *M. speciosa* below IGD by blocking the downstream transport of coarse sediment and reducing scour of the riverbed during high flow events (NMFS 2010). These altered substrate conditions allow for the formation of disease conditions downstream of IGD that can infect juveniles and result in mortality prior to ocean entry.

Although Project dams are assumed to reduce downstream transport of LWD, the consistently low amount of LWD in reaches both upstream and downstream of Project reservoirs suggest that LWD supply is limited by the characteristics of the Klamath River channel and riparian conditions (PacifiCorp 2012). LWD is not retained as readily in large stream channels as in small channels, because wood is much more easily transported in large channels (Lestelle 2006, Bilby and Bisson 1998). Channel type (i.e., extent of confinement) also influences how much wood is retained in a channel. Confined channels with boulder or bedrock substrate contain about half or less number of pieces of wood found in similarly-sized, unconfined reaches with small substrate (Lestelle 2006, Bilby and Wasserman 1989, Bilby and Bisson 1998). The amount and sizes of wood that are recruited into a stream channel also greatly affects the extent of wood retained within a channel. Where riparian forests are composed of small trees, stream channels contain much less wood compared to heavily forested areas with large trees (Montgomery et al. 2003). Lack of LWD impairs juvenile rearing in that LWD forms cover for juveniles to avoid predators, provides substrate for the production of juvenile coho prey items, and is often associated with deeper, cooler pools providing some refugia from warm surface waters. NMFS concludes the interruption of sediment and wood recruitment as a result of Project dams and reservoirs results in juvenile rearing habitat and juvenile migration corridors in the Upper Klamath reach, and to a lesser degree Middle Klamath reach, as not properly functioning.

6.4.2 Populations Affected and Individual Stressor Response

Adults

NMFS anticipates that adults of the Upper Klamath population will continue to be adversely affected during the proposed action permit term due to reduced spawning gravels as compared to unaltered conditions. The trapping of spawning gravels without mitigation through HCP gravel augmentation may continue to depress the Upper Klamath population, in terms of abundance and productivity, most significantly as this population inhabits the reach most affected by limited mainstem spawning gravels.

Juvenile-to-Smolt Life Stage

NMFS believes disease outbreaks are partially due to interruption of coarse gravel recruitment that would not occur in an unaltered environment. Impairment of gravel recruitment is believed to have a nexus to the formation of habitats leading to disease outbreaks below IGD that can infect juvenile coho; gravel in natural flows help scour channel beds breaking up fine sediment and organic matter in the river bed that can lead to disease. The relationship between gravel, scour, and disease was explained in the *Environmental Baseline* of this Opinion and is further described below in the discussion of disease effects.

NMFS anticipates the presence of Project reservoirs, without the minimization measures proposed in the HCP, will continue to interrupt the natural transport of LWD down the Klamath mainstem, although the significance of this interruption on Upper Klamath, Scott and Shasta Rivers, Middle Klamath, and Lower Klamath populations is believed to be relatively minor as recruitment of LWD above IGD is small compared to recruitment from the Middle Klamath to estuary reach. LWD levels increases in the downstream direction of the Klamath as natural conditions support the growth of large late-seral conifers which produce habitat-forming LWD pieces. Although LWD recruitment above IGD is now at relatively low levels, continued low levels of LWD in the Upper Klamath reach may impair juvenile growth and survival because LWD, even if rather limited in quantity, would still provide cover for juveniles in the Upper Klamath reach to avoid predators, provide substrate for the production of juvenile coho prey items, and is often associated with deeper, cooler pools providing some refugia from warm surface waters. The population most likely to be adversely affected from interruptions in LWD recruitment from the Project is the Upper Klamath population.

6.5 Disease

6.5.1 Effects on Critical Habitat

Adult Migration Corridor and Spawning Habitat

With implementation of RPA flows, NMFS does not anticipate that critical habitat will be affected from disease conditions for the purpose of adult migration and spawning (NMFS 2010). NMFS expects that implementation of fall and winter flow variability will result in alleviation of conditions previously described that can lead to interruption in migration, concentration of high numbers of adults in holding pools, with subsequent opportunities for large disease outbreaks during warm fall weather (NMFS 2010).

Juvenile-to-Smolt Rearing and Migration Corridors

Throughout the duration of the permit term, although actions will be taken to improve these substrate conditions via implementation of RPA flows in an attempt to reduce disease outbreaks (NMFS 2010), NMFS anticipates these conditions will develop periodically throughout the permit term and will impact the conservation value of critical habitat in terms of providing suitable rearing habitat for juveniles and smolts inhabiting the affected river reach. NMFS expects critical habitat will continue to be adversely affected throughout the proposed action term via the development of substrate conditions that lead to disease outbreaks in the mainstem reach between IGD and the confluence with the Scott River where disease forming conditions are most prevalent (see *Environmental Baseline* discussion in this Opinion). Thus, we anticipate that the conservation value of juvenile rearing and migration corridors will be most compromised from IGD to the confluence with the Scott River.

6.5.2 Populations Affected and Individual Stressor Response

Studies of outmigrating coho salmon smolts by Beeman et al. (2008) estimated that disease-related mortality rates were between 35 and 70 percent in the Klamath River near IGD. In 2008, mortality rates were as high as 85 percent in May (7-day exposure for age 1+ coho smolts), and 96 percent (age 0+ coho smolts) and 84 percent (0+ Chinook smolts) in June (3-day exposure). Incidences and severity of disease vary by location and environmental conditions within the mainstem Klamath River. Disease effects are most pronounced for juveniles that are rearing or migrating in the mainstem Klamath River when water quality conditions make them more susceptible to disease and when actinospore concentrations are high. Once infected with *C. shasta*, fish survival rates are generally low. Incidence of disease is highest within the reach between the Shasta and Scott Rivers with decreasing incidences downstream. Although the prognosis of juvenile coho salmon infected with *P. minibicornis* is unknown, infections contribute to additional stresses to juveniles, which cumulatively decrease growth and survival. In NMFS (2010), NMFS concludes that disease formation and infection occurs as a result of IGD blocking the downstream transport of coarse sediment and reducing scour of the riverbed during high flow events, which may promote substrate conditions that support the intermediate host, resulting in increased incidence and susceptibility of disease. Substantial uncertainty remains regarding the specific causes of disease prevalence in the Klamath River and the reasons for significant variability in the presence of the parasite from year to year. Fish disease is expected to continue through the interim period and negatively impact the Upper Klamath, Scott and Shasta Rivers, and Middle Klamath population units of coho salmon (NMFS 2010).

Adults

With PacifiCorp's cooperation in the implementation of RPA flows, NMFS anticipates disease outbreaks in adult coho will be unlikely during the permit term. NMFS expects that implementation of fall and winter flow variability will result in alleviation of habitat conditions that can lead to interruption in coho migration, concentration of high numbers of adults in holding pools, with subsequent opportunities for large disease outbreaks during warm fall weather (NMFS 2010). NMFS has no new information that leads us to believe the effects of RPA flows on coho adults via implementation of the HCP is different than those analyzed in our 2010 Opinion.

Juvenile-to-Smolt Life Stage

Less frequent fall pulse-flows may also affect disease transmission from adult salmon carcasses to the intermediate polychaete host. Disease effects in the Klamath mainstem can limit the survival of juvenile coho salmon as they emigrate downstream. Low flows can slow the emigration of juvenile coho salmon, which can in turn lead to longer exposure times for disease, and greater risks due to predation (NMFS 2010). Under an unaltered hydrologic regime, fall and winter freshets help distribute salmon carcasses downstream into lower sections of the watershed, effectively dispersing nutrients, as well as infective spores that enter the aquatic environment as the carcass decomposes. Inadequate fall flows between IGD and the Shasta River can result in high densities of decomposing fish downstream of popular spawning areas, specifically the areas directly below IGH and the confluence of Bogus Creek and the Klamath River mainstem. Compounding the issue is the large number of returning hatchery-origin adult salmon that congregate and spawn in areas adjacent to the hatchery, thus increasing carcass concentrations in the IGH to Shasta River reach above natural levels. The high carcass densities have helped create areas where high spore loads from decomposing carcasses combine with an unchecked polychaete population. Researchers theorize that these areas represent a zone of disease where the rate and efficiency at which disease pathogens are transmitted from polychaete host to juvenile salmonids dramatically increase (Stocking and Bartholomew 2007). Severe infection of juvenile coho salmon by *C. shasta* may be contributing to declining adult coho salmon returns in the Klamath basin (Foott et. al. 2010). Infections by the parasitic pathogen *P. minibicornis* have been detected in 65 percent of young-of-year and 71 percent of yearling coho salmon in the Klamath River mainstem (Nichols et. al. 2008). Significant kidney damage (glomerulonephritis) has been associated with *P. minibicornis* infection; however, the prognosis of such infections is not fully understood. Individuals with dual infections of *C. shasta* and *P. minibicornis* would likely have low survival rates (Nichols and Foott 2005).

6.6 Effects on SONCC Coho Salmon Evolutionarily Significant Unit Associated with Implementation of the Habitat Conservation Plan Coho Conservation Strategy

6.6.1 Passage and Access-Related Habitat Enhancements

To mitigate for the continued blockage of approximately 58 miles of coho habitat during the permit term, the HCP under the proposed action will implement a conservation strategy that includes performing measures to reach the following targets: (1) maintain and improve access to existing spawning and rearing habitat in approximately 60 miles of Upper Klamath tributaries between April (juvenile rearing) and November (spawning) of each year, and (2) remove existing passage barriers to create permanent access to at least one mile of potential spawning and rearing habitat in Upper Klamath tributaries. Proposed action effects to critical habitat associated with passage issues will be confined to tributaries where conservation actions described previously in the *Description of the Proposed Action* section of this Opinion are expected to occur. Although the HCP describes sites that are currently considered target areas for access improvement projects, NMFS expects that there may be additional suitable tributaries in the Upper Klamath River that may be selected in consultation with the TRT and funded through the CEF during the permit term. NMFS expects any additional tributaries for access improvement will have similar habitat value for coho habitat as those sites described in the HCP and described in the *Description of the Proposed Action* section of this Opinion.

As described in chapter II of this Opinion, *Description of the Proposed Action*, specific projects described as conservation measures above will be selected and implemented (through the CEF) to create, maintain, and/or improve access and passage by coho salmon to habitats downstream of IGD. These projects include either the removal or improvement of passage impediments at specific sites, all of which are situated in the Upper Klamath Population Reach (IGD to Portuguese Creek). As described in Section 2.2 of this Opinion, project-related effects in this Opinion are described in general terms, as specific effects cannot be determined until actual proposals are submitted and approved for funding.

6.6.1.1 Effects on Critical Habitat

Adult Migration Corridor and Spawning Habitat

NMFS expects projects that enhance or restore access to migratory and spawning habitat will increase the conservation value of existing critical habitat, particularly in the upper reaches of the basin. Increasing available spawning habitat will allow for occupation of new habitats by returning adults, increasing spatial structure and productivity. As the projects are expected to take place where access is restricted or non-existent, NMFS does not expect adverse effects to critical habitat will occur; we assume beneficial effects from these projects. Therefore, projects that open up previously blocked habitat are expected to expand functional critical habitat for the conservation of coho salmon over the 10-year period.

Juvenile-to-Smolt Rearing and Migration Corridors

Typically, in-stream work with heavy equipment for restorative purposes takes place during the lowest flows of the year (summer/early fall). Working in this time period is most preferred in order to minimize disturbances to active channel beds, minimize the production of sediment, minimize disturbance of aquatic species such as coho, and allow enough time to revegetate disturbed soils. NMFS expects that HCP passage projects will follow this standard practice and that projects are also likely to occur during naturally low flow periods in the late summer or early fall when juveniles, if present within a work area, are utilizing available rearing habitat. In-water work may require disturbing some beneficial rearing habitat structure(s) in order to alleviate a passage barrier, but those impacts are expected to be quite localized and negligible in terms of the increase in the conservation value of habitat. Temporary effects to critical habitat may include disturbance of the channel bed resulting in localized sediment plumes, or diversion of surface waters if necessary to isolate a permanent barrier removal worksite. Such diversions would likely be of relatively short duration with reconnection of the worksite upon completion of the project. NMFS anticipates adverse effects to critical habitat from passage improvement actions in the Upper Klamath basin to be minor and of short duration as most projects are anticipated to occur as one time disturbance events and are likely to begin and end during the summer period when flows are lowest and measures to minimize impacts to juveniles occurring near work sites are easiest to implement (e.g., project site dewatering and relocation of juveniles out of work sites). As is typical for the region, once disturbance to the project site(s) is completed, the site typically recovers within one additional year (e.g., revegetation of disturbed soils, elimination of turbid flows, and reoccupancy of site by juvenile salmonids). Although HCP conservation measure projects may result in minor and short duration adverse effects during implementation, NMFS expects this project on a whole will result in improvements to the function and role of critical habitat in these project reaches in the longer term (10 + years). NMFS expects the improved habitat will increase in conservation value for juvenile growth and survival to the smolt life stage as additional habitat is expected to become available relieving occupancy pressures on existing limited rearing habitat. The HCP monitoring program will help to assess the degree to which improved habitat is utilized by coho during the permit term.

6.6.1.2 Populations Most Likely Affected and Individual Stressor Response

Adults

The permanent removal of barriers blocking access to at least one mile of suitable spawning and rearing habitat is expected to result in the increased abundance and spatial structure of coho salmon in the Upper Klamath population unit as adults are expected to spawn in tributary reaches currently unavailable, in addition to juveniles having access to rearing habitat also currently unavailable. Additionally, maintaining and improving access to approximately 60 miles of spawning and rearing habitat in upper basin tributaries may result in increasing the number of adults per kilometer of IP habitat in the systems where restorative projects occur. Any increases in the production of adults, through gaining access to new habitat, or through the maintenance and improvement of existing habitat, may help to alleviate to some degree, the depensation risks facing the Upper Klamath population during the permit term. As mentioned previously, instream work typically occurs during the summer/early fall when flows are lowest. Adults will not be present during this time period and NMFS expects no adverse effects to adults from these passage projects.

Juvenile-to-Smolt Life Stage

By the active removal of temporary or seasonal barriers such as “swimmer dams” (resulting from the instream manual placement of boulders and cobbles to create deep pools), sediment build-up, and log jams as described in the HCP, NMFS anticipates juveniles from the Upper Klamath, Scott and Shasta Rivers, and Middle Klamath populations will have access to quality habitat to increase growth and survival rates of the juvenile-to-emigrating smolt life stage. NMFS anticipates Upper Klamath juveniles will receive the most direct benefit from these actions, but as Scott and Shasta River and Middle Klamath juveniles may spend some residence time in the

Upper Klamath reach prior to downstream emigration, they too can benefit from the conservation actions. The direct manual removal of such barriers, whether human-caused or not, is expected to provide access to suitable, quality tributary rearing areas for coho juveniles. Coho juveniles currently do not have access to a sufficient quantity of rearing habitat, thus leaving them concentrated in mainstem habitat where they are subject to poor habitat conditions which can negatively affect growth and survival. Juvenile coho are likely to realize immediate survival improvements, since some of the target sites provide cool water refugia during the summer/fall period. Overall, the strategy to improve and eliminate passage impediments increases connectivity among fragmented and isolated habitat patches in this drainage.

Ebersole et al. (2006) found that coho smolt size was influenced by overwintering location due to spatial patterns of overwinter growth rates. They found the largest smolt sizes in their study were associated with fish remaining in and moving into one spawning tributary (Moore Creek) during the winter months, even though the creek experienced intermittent summer flows. Such improvements in smolt fitness and freshwater survival can result in improvements to returning adult abundance (Lum 2003, Shaul et al 2007, Beamish et al 2010). Improvements in adult returns can benefit further ecosystem responses via increases in stream nutrient levels when adults die after spawning. Adult spawned-out carcasses provide additional food resources for developing juveniles through the process of decay. Healthier juveniles benefitting from improved food resources can produce healthier smolts, which can result in healthier adults to return to their natal systems.

These population level benefits are expected to occur at some point during the proposed permit term, and to result in benefits that can last long after the expiration of the permit as the one mile of barrier removal is expected to be permanent in nature. For example, a project (e.g., culvert removal) that opens 0.5 mile of currently blocked suitable spawning and rearing habitat, can result in access to this habitat for coho into perpetuity, barring any events that cause another permanent barrier. Such perpetual access can help increase all VSP parameters (abundance, productivity, spatial structure, and diversity) for the Upper Klamath River population.

NMFS expects that juveniles of the Shasta and Scott River populations and to a lesser degree, the Middle Klamath population can experience benefits in the form of increased access to quality tributary habitat in the Upper Klamath reaches as juveniles leave their natal river systems in search of quality rearing habitat in the Upper Klamath River. As with the Upper Klamath River population, having access to quality rearing habitat for Scott and Shasta Rivers and Middle Klamath populations can help to improve growth and survival in the juvenile-to-emigrating smolt life stage potentially resulting in increased adult abundance.

As projects are likely to occur in summer, localized and/or brief disruptions and displacement of coho juveniles in the immediate work areas involving barrier removal or passage improvement may be experienced. Such displacement can be minimized by the strategic scheduling of in-water work during periods when fish are either absent, or few in number, avoiding or minimizing direct impacts to individuals. Juveniles displaced from work areas are likely to temporarily occupy nearby habitats until work has concluded and disturbances to work sites abate allowing for reoccupation of the previous habitat.

In total, the actions described above are expected to increase current levels of coho abundance and spatial structure in the Upper Klamath population unit. Actions related to passage improvement may also increase abundance in the Scott and Shasta Rivers, and to a lesser degree Middle Klamath populations as those populations experience access to previously unavailable quality rearing habitat. These combined actions will help ensure that coho salmon populations remain stable and improve during the term of the ITP while parallel actions (KHSA implementation or FERC relicensing) are taken to address fish passage in the longer term.

6.6.2 Improvement to Instream Flow Conditions Downstream of Iron Gate Dam

As described in section 6.2 of this Opinion, implementing the NMFS 2010 Opinion RPA flows and flow variability requires the cooperation of PacifiCorp, which controls releases out of IGD. As described in PacifiCorp's HCP, to minimize the effects of the Klamath Hydroelectric Project in its contribution to altered river flows, PacifiCorp will take actions to provide instream flow releases, facilitate flow variability, and maintain flow ramping rates below IGD that adhere to flow requirements contained in the current NMFS BiOp for Reclamation's Annual Operations Plan (NMFS 2010). PacifiCorp's cooperation in these actions via implementation of their HCP is expected to also include any potential for revisions to the RPA flows should this occur as a result of consultation between NMFS and Reclamation during the proposed action permit term. With implementation of the HCP conservation strategy, PacifiCorp commits to cooperate in implementation of the components outlined in the NMFS 2010 Opinion RPA. This commitment through the proposed action of issuance of an ITP to PacifiCorp will provide for effective implementation of the components of the RPA detailed previously, and will allow for the full achievement of expected benefits to coho salmon analyzed in the 2010 Opinion.

Section 6.2 of this Opinion describes the anticipated effects of this HCP conservation measure (cooperation in implementing RPA flows), on critical habitat and individual populations. With PacifiCorp's cooperation in the implementation of RPA flows, NMFS anticipates the extent and severity of disease outbreaks will be reduced as compared to more recent conditions (NMFS 2010). Although NMFS expects reductions in the extent and severity of disease outbreaks with implementation of the RPA flows, we do not anticipate adverse effects from disease on coho juveniles will be eliminated. Continued disease effects are likely to negatively impact individual juvenile-to-smolt survival in the Upper Klamath, Scott and Shasta Rivers, and to a lesser degree Middle Klamath population units who may spend less residence time in the Upper Klamath reach where disease is most severe. NMFS has no new information that leads us to believe the effects of RPA flows on coho juveniles under the Proposed Action for this Opinion will be different than those analyzed in our 2010 Opinion.

6.6.3 Improvement of Water Quality (Dissolved Oxygen) Downstream of Iron Gate Dam

In regards to water temperature effects in the Klamath mainstem from implementation of the conservation strategy outlined in the HCP, NMFS expects no measurable changes to current mainstem temperature conditions during the permit term. The flow variability program, although expected to result in increases and enhancement of suitable rearing habitat, is not expected to result in changes to the water temperature regime of the Klamath mainstem downstream of IGD. Thus, the thermal lag effects described in the *Environmental Baseline* section and in section 6.3 of this Opinion are expected to continue throughout the proposed action permit term. Adverse

Project effects on mainstem water temperatures will be mitigated through the HCP conservation strategy to protect and enhance existing cool water refugia sites where they occur at mainstem and tributary confluences. The HCP conservation measures are also not expected to result in any changes to the Klamath mainstem pH values as pH conditions in the mainstem are largely a result of water quality conditions that occur upstream of IGD (see section 5.2.3 *Water Quality* of this Opinion). Improvements to DO levels below IGD are expected with implementation of a turbine venting program under the conservation strategy of the HCP, and other water quality impairments downstream of IGD will be mitigated for by the HCP's proposed improvement and protection of suitable habitat where it exists in the Upper Klamath reach.

6.6.3.1 Effects on Critical Habitat

Adult Migration Corridor and Spawning Habitat

NMFS does not believe water quality effects from the Project negatively affect the conservation value of critical habitat for adult migration and spawning purposes (NMFS 2010). Migration and spawning typically occurs when water quality conditions in the Klamath mainstem are considered suitable (generally after mid-September). Dissolved oxygen concentrations are typically lowest in the middle to late summer prior to the onset of the adult migration period.

Juvenile-to-Smolt Rearing and Migration Corridors

NMFS expects implementation of a turbine venting program (see section 2.2.3.4 of this Opinion) will improve critical habitat function by providing more suitable water quality conditions for juvenile summer rearing for approximately six miles downstream of IGD. As demonstrated by recent testing by PacifiCorp, NMFS expects significant improvement in DO via implementation of the HCP conservation strategy. We expect that the conservation value of critical habitat in this reach will be improved over the course of the proposed action permit term, such that foraging opportunities are improved below IGD resulting in improved summer rearing and foraging habitat.

6.6.3.2 Populations Most Likely Affected and Individual Stressor Response

Adults

Migration and spawning typically occurs when water quality conditions in the Klamath mainstem are considered suitable (NMFS 2010). Therefore, the water quality improvement measures proposed in the HCP are not expected to affect coho adults.

Juvenile-to-Smolt Life Stage

As described in Chapter II of this Opinion, *Description of the Proposed Action*, reaeration actions are proposed by PacifiCorp (via turbine venting and blower operations) to improve dissolved oxygen conditions during summer for foraging juvenile coho salmon downstream of IGD. The purpose is to increase dissolved oxygen above ambient levels. The objective is to reduce stress on juveniles rearing in the mainstem in proximity to IGD, increasing survival probability for those individuals. PacifiCorp has implemented turbine venting on a trial basis beginning in 2009 to improve dissolved oxygen concentrations downstream of IGD. Recent turbine venting testing (fall 2010) demonstrated that dissolved oxygen saturation rose by 14.9 percentage points (a 29 percent increase) and average dissolved oxygen concentration rose by

1.81 mg/L (a 33 percent increase) during venting treatment as compared to no treatment. If an ITP is issued, PacifiCorp will develop a standard operating procedure in consultation with NMFS for on-going turbine venting operations and monitoring.

Monitoring of DO conditions below IGD by both the Karuk Tribe and PacifiCorp demonstrate that without the implementation of the conservations measures proposed in PacifiCorp's HCP, DO conditions could become stressful to juvenile coho, resulting in the likely avoidance of habitat downstream of IGD. Figure 24 shows daily DO conditions found below IGD in 2008. This Karuk Tribe monitoring found DO dropping to less than 6.0 mg/L for a period of time in late summer, but average DO levels throughout the summer generally were above 7.0 mg/L (Karuk 2008). Results of DO monitoring during the 2010 PacifiCorp turbine venting tests showed DO improvements from a low ambient DO of 5.56 mg/L under no treatment conditions, to a DO of 7.37 mg/L after a few days of implementing turbine venting with the addition of a forced air blower on the IGD discharge (PacifiCorp 2011). These increases in dissolved oxygen were seen throughout the reach of the river for a distance of approximately six miles downstream of IGD. The mean dissolved oxygen for the venting plus blower treatment was 7.91 mg/L. No increase in total dissolved gas was observed during the experiment. Turbine venting testing by PacifiCorp indicates that turbine venting produced a negligible increase in total dissolved gas in turbine discharges to the river. In all cases, total dissolved gas measurements were below 110 percent, which is the criterion established by USEPA to prevent fish harm from potential gas bubble disease (USEPA 1976).

As discussed previously, the lowest DO concentrations are found at night. Juvenile coho salmon can be actively foraging at night, however NMFS expects they are avoiding nighttime foraging in the area downstream of the IGD. Such avoidance strategies would result in juveniles seeking out more suitable habitat downstream where DO conditions are improved, resulting in stressful overcrowding conditions in such suitable downstream habitat due to increased competition for cover and food resources. In turn, these stressful overcrowding conditions may result in reduced individual fitness by slower growth and perhaps inadequate food availability.

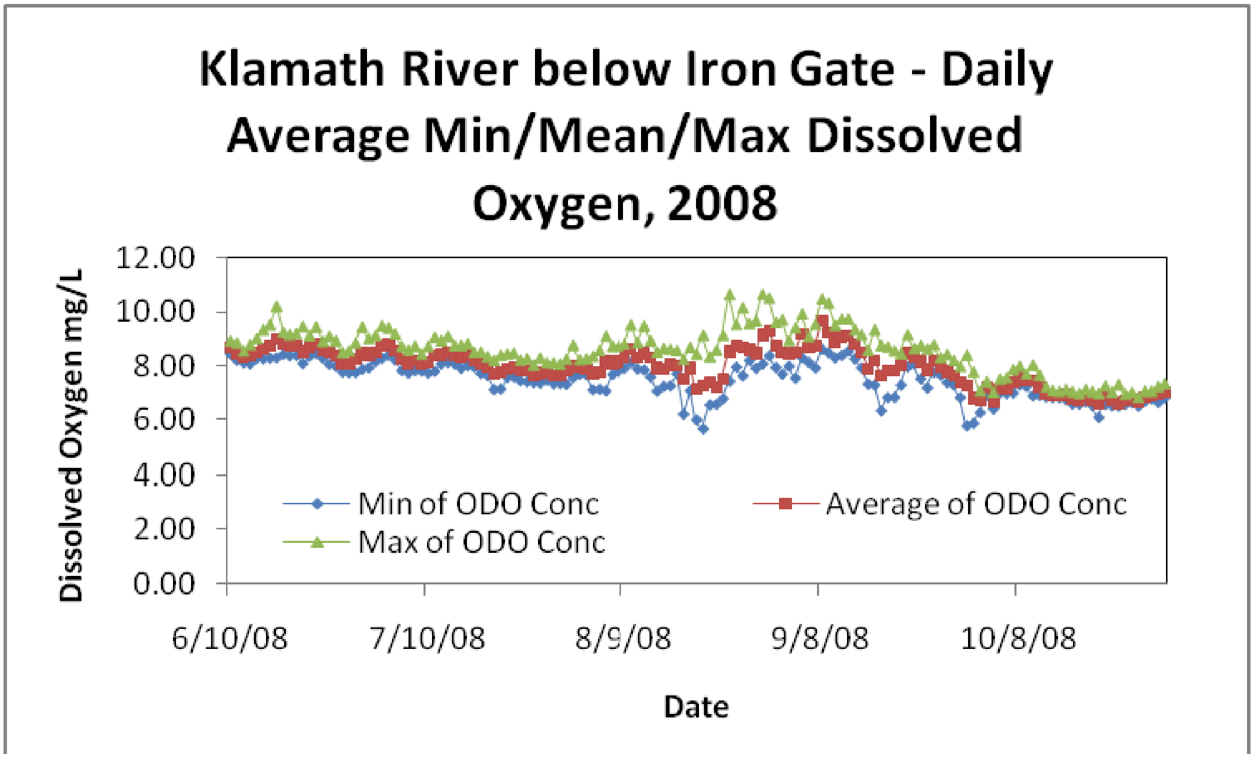

Figure 23. Daily maximum, mean, and minimum dissolved oxygen in the Klamath River below IGD from June to October, 2008 (From Karuk 2008).

Bevelhimer and Coutant (2006) developed a method to model fish growth below dams in the Tennessee River Valley Authority system to evaluate potential improvements for fish under simulated conditions with minimum DO levels of 3, 4, 5, or 6 mg/L relative to baseline conditions. As with PacifiCorp, the improvements to DO were expected via turbine venting and blower operations. The model predicted that trout size would increase with improving DO with the greatest improvement in growth (modeled at nearly a 50% increase) directly below dams.

Presuming the re-aeration actions proposed by PacifiCorp (via turbine venting and blower operations) maintain dissolved oxygen near the levels observed in 2010 (7.91 mg/L), juvenile growth and overall health, and by inference survival, should increase above current baseline conditions for approximately 6 miles downstream of IGD, the stretch of the Upper Klamath reach most susceptible to low DO levels (PacifiCorp 2011). As measured in recent tests of turbine venting plus blower operation, implementation of the conservation strategy is expected to have no deleterious effects on either juvenile or adults in this area.

We expect that over-summer survival of juvenile coho salmon should increase with improving dissolved oxygen conditions brought about by these reaeration actions. Higher dissolved oxygen concentrations should afford juvenile coho salmon greater foraging opportunities outside the confines of the existing thermal refugia areas, ultimately resulting in higher survival rates for juvenile coho salmon that rear downstream of IGD during summer. Juveniles of the Upper Klamath and Scott and Shasta River populations are most likely to benefit from DO improvement as juveniles from these populations are the most likely to utilize mainstem habitat below IGD. NMFS expects juveniles from the Upper Klamath, Scott, and Shasta Rivers will experience improved daily and nighttime DO conditions during late summer/early fall with implementation of turbine venting operations by PacifiCorp under the requirements of the HCP.

6.6.4 Gravel Augmentation and Large Woody Debris Recruitment

The augmentation of gravel and LWD downstream from IGD is intended to replenish some of the habitat-building materials blocked by the Project. Gravel will be deposited in the mainstem Klamath River near the dam. The targeted amounts of augmented gravel will compensate, to the maximum extent practicable, for the estimated effects of Project reservoirs on the reduction in gravel during the permit term in the reach of the river from IGD downstream to the confluence with Cottonwood Creek (at RM 182)[7] as shown in Figure 2 (indicated as symbol number 18). Thus, the effects will primarily occur in the upper part of the mainstem basin within a few miles of the dam. Gravel augmentation serves two purposes: (1) provide clean spawning substrate for use by adult coho; and (2) scour areas harboring known populations of the polychaete that is an intermediate host for disease agents. The scouring mechanism will be enhanced by the implementation of the Flow Variability Program as prescribed in the Proposed Action. Increased variability in flow discharge will produce peaks that will assist in mobilizing the gravel substrate, thereby facilitating the scour events.

6.6.4.1 Effects on Critical Habitat

Adult Migration Corridor and Spawning Habitat

The augmentation of gravel in the river downstream from IGD will enhance conditions for coho salmon spawning in the river during fall. Properly functioning spawning substrate provides ample interstitial flow through the redds, and is of suitable size to permit efficient redd excavation by spawning adults. Effective salmon spawning has been observed downstream of other dams, where suitable substrate has been present (Giorgi 1992, Swan 1989, Geist and Dauble 1998). We expect the same potential to be realized below IGD. The Project-related effects on gravel, and the concomitant benefits of gravel augmentation, are expected to be largely restricted to the uppermost several miles of the Upper Klamath reach below IGD. As such, gravel augmentation is not expected to substantively alter conditions further downstream in the Middle Klamath and Lower Klamath reaches. In the Sacramento-San Joaquin River system, gravel augmentation is a common practice, and researchers there have observed increased spawner use of the new gravel supplied by gravel augmentation (Cummins et al. 2008, Merz and Chan 2005). Overall, NMFS expects that implementation of the gravel augmentation measures will improve the functionality and conservation value of critical habitat for adult spawning below IGD as compared to current conditions.

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[7] Geomorphology analyses suggest that the primary impact of the Project on alluvial features (and therefore on gravel quantities available for gravel-related scour) is limited to the eight-mile reach from IGD downstream to the confluence with Cottonwood Creek (PacifiCorp 2004, FERC 2007).

Juvenile-to-Smolt Rearing and Migration Corridors

The quarterly augmentation of LWD recruitment to the Upper Klamath reach will add to the habitat complexity below IGD resulting in improvements to the conservation value of critical habitat for rearing juveniles. The transport of trapped LWD on a quarterly basis either to the Klamath mainstem directly or for use in constructed habitat features, will improve habitat complexity or in some cases, provide localized thermal refugia in the form of shade. Both of these habitat features enhance survival of juvenile coho by affording protection from predators and cooling water during critical periods in the late summer and fall. NMFS believes the quarterly transport of the expected small amount of LWD trapped by Project reservoirs to areas downstream of IGD, or to be reserved for the construction of habitat enhancement projects (e.g. complex wood jam structures), will not result in adverse effects to juvenile and smolt migration corridors as the interruption is of a relatively short duration. Once placed downstream of IGD, or utilized in constructed habitat projects, the LWD will begin providing services similar to an unaltered system.

Gravel augmentation may provide some benefit to juveniles residing in streams where augmentation has occurred. Minor benefits may occur if the placed gravel provides surface structure for food resources (e.g. insects or invertebrates) that juvenile coho prey upon, or the gravel provides clean, large interstitial spaces for coho fry to find cover from predators. NMFS has determined the Gravel Augmentation Program will result in conservation benefits to coho salmon and its designated critical habitat. All fluvial sediment supplied to reaches downstream of Iron Gate Dam is delivered to the Klamath River between Keno Dam and Iron Gate Dam. Sources within this reach are estimated to supply 24,160 tons/yr of coarse sediment (1.3 percent of the cumulative average annual basin-wide coarse sediment delivery) (Stillwater Sciences 2010). Although NMFS considers the amount of gravel augmentation proposed in the HCP as reasonable given the availability of suitable gravels to be placed in the mainstem channel, gravel recruitment downstream of IGD will continue to be impaired during the 10-year interim period as the total amount of gravel trapped by all Project dams cannot reasonably replaced under a gravel augmentation plan.

As is typical for instream restoration projects in the region, NMFS expects in-water work for gravel augmentation will occur during the summer period when flows are lowest making placement of gravels with heavy equipment the easiest. Substantive adverse effects are not expected with implementation of these gravel augmentation and LWD-related conservation measures. In-water work may require disturbing some beneficial habitat structure in order to improve overall gravel and LWD quantities and effectiveness, but those impacts are expected to be quite localized and negligible in terms of the destruction of productive juvenile habitat. In-water work may require disturbing some beneficial habitat structure in order to improve gravel quantities and effectiveness to meet conservation measure objectives, but those impacts are expected to be quite localized and minor in terms of the destruction of productive habitat. Overall, NMFS expects improvements to the conservation value of existing juvenile habitat areas from the implementation of HCP gravel and LWD measures. Section IV, *Status of the Species*, reviews the importance of LWD to coho lifestages.

6.6.4.2 Populations Most Likely Affected and Individual Stressor Response

As proposed in the HCP, PacifiCorp will develop a gravel augmentation plan in coordination with NMFS and CDFG shortly after permit issuance. The parties will collaborate to determine where gravel should be placed in the Upper Klamath reach and how much gravel should be augmented approximately annually. Gravel placement projects will be monitored to determine if the project objectives are being met and enable subsequent augmentation efforts to reflect findings from previous replenishment (i.e., adaptively managed). Future augmentation efforts would be based on monitoring results and discussion of achievement of biological objectives, such as assessment of bed mobilization, effectiveness of flow recurrence intervals, and other measures determined necessary to evaluate effectiveness of augmentation efforts.

Although the HCP will augment gravel below Iron Gate dam in the reaches most impacted by retention of spawning gravels, the Project itself will continue to trap spawning gravels recruited to the mainstem above IGD. Without the effects of Project dams and reservoirs, this spawning gravel would be allowed to transport downstream in the reaches currently "sediment starved" (Stillwater Sciences 2010). All fluvial sediment supplied to reaches downstream of Iron Gate Dam is delivered to the Klamath River between Keno Dam and Iron Gate Dam. Sources within this reach are estimated to supply 24,160 tons/yr of coarse sediment (1.3 percent of the cumulative average annual basin-wide coarse sediment delivery) (Stillwater Sciences 2010). Although NMFS considers the amount of gravel augmentation proposed in the HCP as reasonable given the availability of suitable gravels to be placed in the mainstem channel, spawning gravel recruitment downstream of IGD will continue to be impaired during the 10-year interim period as the total amount of gravel trapped by all Project dams cannot reasonably replaced under a gravel augmentation plan.

Adults

The augmentation of gravel below IGD will have several beneficial ecological effects. NMFS expects the presence of suitable spawning substrate will encourage adult use of the area for spawning, as well will also improve conditions for egg incubation and increase survival probability through the emergent fry stage (Merz and Chan 2005). Scientific literature indicates other benefits of gravel augmentation will likely accrue in the form of increased secondary production of aquatic organisms, such as occurs when clean un-embedded substrate is replenished to watersheds (Merz and Chan 2005**,** Cummins et al. 2008). The increase of interstitial surface area and improved interstitial flow are likely mechanisms contributing to this effect.

Juvenile-to-Smolt Life Stage

Localized and/or brief disruptions of the immediate area involving placement of gravel augmentation and LWD may be experienced during project activities. The strategic scheduling of in-water work during periods when juvenile fish are either absent, or few in number, can avoid or minimize direct impacts to individuals. LWD is known to be a valuable feature in juvenile coho salmon rearing habitat. Greater amounts of large wood often equate to more frequent and larger pools, which in turn, results in a greater number of juvenile coho per channel length (Roni and Quinn 2001). LWD provides important refuge sites to avoid higher water velocities and provides cover from predators (Lestelle 2006, Peters 1996). The addition of LWD has also been shown to increase salmonid abundance, survival and production (Keeley et al. 1996, Solazzi et al. 2000, Roni and Quinn 2001, Whiteway et al. 2010, White et al. 2011). NMFS anticipates the release of expected limited LWD pieces caught by Project reservoirs on a quarterly basis will not adversely affect juveniles in the Klamath mainstem as the interruption of LWD will be limited to a few months, with the LWD providing rearing and cover space shortly after it is released downstream of IGD, or utilized in constructed habitat features.

NMFS anticipates that populations of Upper Klamath, Scott and Shasta Rivers, and Middle Klamath will primarily benefit from the quarterly addition of LWD to the Upper and Middle Klamath River reaches. The Scott and Shasta populations can benefit as juveniles are known to utilize mainstem habitats above the tributary confluences and NMFS expects this habitat utilization will continue throughout the permit term.

Floating configurations of LWD can serve as an additional foraging habitat for young coho as the LWD contains plant and invertebrate life. Construction of complex wood jams can serve the same purposes as well and lead to the development of downstream pool habitat that would not occur without the presence of the wood jam. NMFS anticipates that the placement of these features will increase juvenile survival for the Upper Klamath, Scott and Shasta Rivers, and Middle Klamath populations. As these structures and LWD pieces make their way down the Klamath River mainstem, they can also provide these same benefits to juveniles of the Lower Klamath River population.

6.6.5 Understand and Reduce Disease-Related Effects

As described in PacifiCorp's HCP, actions to reduce the formation of habitat conditions leading to disease outbreaks include a Klamath River Fish Disease Research Fund to solicit and fund fish disease research projects to enhance understanding and fill knowledge gaps related to factors and conditions causing disease in coho salmon in the Klamath River. Research and studies conducted under the Klamath River Fish Disease Fund will address the critical need for more information on the causes and control of fish disease in the Klamath River system, primarily resulting from the myxozoan parasites *C. shasta* and *P. minibicornis*. As described above, the infection rate in coho salmon is high, yet the overall level of population level impacts caused by habitat conditions that lead to disease outbreaks is uncertain. Klamath River Fish Disease Research Fund actions will address this uncertainty by funding research and studies that will inform and improve management actions to reduce the incidence of fish disease. As described in chapter II of this Opinion, *Description of the Proposed Action*, PacifiCorp's HCP actions also include gravel augmentation and a flow variability program. These actions are in part aimed at decreasing the abundance of the intermediate polychaete host (*M. speciosa*) for disease pathogens *C. shasta* and *P. minibicornis* in the Klamath River through sediment scour and/or flow manipulations. The augmentation of gravel in the river downstream from IGD will enhance gravel-related scour of the disease host *M. speciosa*, particularly during runoff events. Increases in fall and early winter flow variability will likely contribute to a reduction of disease risks associated with *P. minibicornis* and *C. shasta* in the Klamath River downstream of IGD. In concert, these actions (gravel augmentation and flow variability) will increase the scour intensity and frequency, and reduce disease host prevalence. Based on information from Stocking and Bartholomew (2007), NMFS believes that high flow pulses in the fall and winter will have the benefit of redistributing adult salmon carcasses downstream that might otherwise become concentrated in the mainstem below IGD. We further believe that available evidence suggests an increase in flow variability will likely reduce disease incidence in the Klamath River downstream of IGD by aiding the scour of periphyton (*Cladophora*) habitat preferred by the polychaete intermediate host (*M. speciosa*) of the disease pathogens *C. shasta* and *P. minibicornis*. Working together in concert, NMFS anticipates these actions will improve the survival of Upper Klamath, Scott and Shasta Rivers, and Middle Klamath populations of coho salmon. We expect as the permit term progresses and gravel augmentation actions are implemented in combination with implementation of scouring flows, juvenile coho residing in the Upper Klamath reach, which may include juveniles from the Scott, Shasta, and Middle Klamath populations during spring and summer months, will be exposed to fewer disease conditions. Disease can reduce their fitness by stressful and/or lethal infections. NMFS expects research activities will further enhance these reductions by better understanding the effectiveness of gravel augmentation efforts at reducing or eliminating areas of disease formation. Thus, as the permit term advances we expect to find infection rates in the Upper Klamath reach to decline resulting in improved fitness of Upper Klamath, Scott and Shasta Rivers, and Middle Klamath population juveniles and improvements to juvenile-to-smolt survival rates.

The effects of flow variability to meet RPA requirements and gravel augmentation on SONCC ESU coho salmon critical habitat and on individuals and populations have been described in this Opinion in sections 6.2 and 6.6.4. Disease research in and of itself through implementation of the HCP is not expected to directly affect SONCC ESU coho salmon individuals or critical habitat. Any permits necessary to capture and/or handle coho during research activities will be conducted under a separate permit under ESA Section 10(A)(1)(a) and any take associated with such research will not be authorized under an ITP issued to PacifiCorp.

6.6.6 Enhancement of Klamath Mainstem Migratory and Rearing Habitat

As described in PacifiCorp's HCP and Chapter II, *Description of the Proposed Action*, of this Opinion, specific actions are to be taken during the term of the ITP to improve and maintain the quality and quantity of thermal refugia along the mainstem Klamath River downstream of IGD. The HCP targets 28 coldwater refugia sites along the mainstem Klamath River for improvement and maintenance of habitat cover and complexity. The HCP also proposes to increase the extent and/or duration (by about 30 to 50 percent of the total existing extent and/or duration) of nine coldwater refugia sites along the mainstem Klamath River. Increasing the extent or duration of existing refugia sites on the Klamath mainstem may be accomplished by channel realignment to improve flow in the refugia area, increasing the flow from tributaries that create refugia, or adding structures at the refugia sites to increase the duration and extent of the coldwater plume (i.e. limit evaporation). The nine sites identified in the HCP are considered the most feasible and accessible for refugia extension work during the interim period. For example, a few tributaries within the Middle Klamath River Population Unit (e.g., Boise, Red Cap and Indian Creeks) support populations of coho salmon (NMFS 2007), and offer critical cool water refugia within their lower reaches when mainstem temperatures and water quality approach inhospitable conditions. These conservation actions will help offset the negative effects of the IGD "thermal lag" at some level and will help ameliorate naturally hot summer river conditions in the middle and upper basin (Braunworth et al. 2002).

6.6.6.1 Effects on Critical Habitat

Adult Migration Corridor and Spawning Habitat

Generally, improvements to rearing habitat may result in marginal beneficial effects on adult migration and spawning corridors as the projects themselves must be targeted at improving juvenile rearing habitat. Beneficial effects to corridors for migration and spawning could occur if the rearing enhancement project results in improved conditions for access to spawning grounds. For example, channel realignment projects to improve flows for limited rearing habitat may have the added benefit of improving tributary flows during the coho migration period (late fall/early winter), particularly in years where fall precipitation is well below average resulting in low flows during migration. In this case, channel realignment to improve flows may aid in gaining access to spawning grounds, which may have otherwise been inaccessible without direct modification of the channel. NMFS expects incidences of these kinds of indirect benefits to adult migration corridors and spawning habitat to be relatively rare during the permit term as the relevant conservation measure goals of the HCP are tied to addressing the major limiting factors for coho viability in the upper portions of the basin, lack of suitable juvenile summer and overwintering rearing habitat. NMFS does not expect that projects designed to improve juvenile rearing habitat will adversely affect adult migration corridors and spawning habitat.

Juvenile-to-Smolt Rearing and Migration Corridors

Thermal refugia are considered a critical habitat feature for coho salmon in the Klamath River. Juvenile coho salmon have been observed residing within thermal refugia in the mainstem Klamath River throughout the summer and early fall when ambient water temperatures in the river are above about 22ºC (NMFS 2010). Mainstem refugia areas are often located near tributary confluences, where water temperatures are 2 to 6°C lower than the surrounding river environment (NRC 2004, Sutton et al. 2004). Thermal refugia along the Klamath River are used mostly by juvenile coho salmon upstream of Portuguese Creek.

NMFS expects that the conservation value of the highly important thermal refugia sites in the Upper Klamath reach will be enhanced with the proposed action. NMFS believes this enhancement will be achieved via actions to make these refugia accessible to coho juveniles that may be exposed to stressful conditions in the mainstem. Thus, this habitat becomes more valuable as it is able to provide cover, good water quality, cool temperatures, and additional food resources to juveniles residing at times in stressful mainstem conditions.

Substantive adverse effects are not expected with implementation of these refugia-related conservation measures. However, localized and/or brief disruptions of the immediate area involving refugia improvements may be experienced. The strategic scheduling of in-water work during periods when fish are either absent, or few in number, can avoid or minimize direct impacts to individuals. In-water work may require disturbing some beneficial habitat structure in order to improve overall refugia conditions and usability, but those impacts are expected to be quite localized and negligible in terms of the destruction of productive habitat.

6.6.6.2 Populations Most Likely Affected and Individual Stressor Response

Adults

NMFS does not anticipate there will be any adverse effect on SONCC ESU coho adults with implementation of rearing habitat enhancement projects. NMFS expects all projects will take place during low-flow summer periods. As such, NMFS expects that all projects will take place outside of the adult migration and spawning period resulting in little potential for adult exposure to project-related stressors (e.g. stream diversion and turbidity). Indirect benefits for adults from rearing habitat enhancement projects could occur and have been described in section 6.6.6.1 above in regards to benefits to critical habitat. Projects that improve flows to adult migration and spawning habitat may result in improved spawning conditions for adults, thus improving their opportunities for successful spawning during the 10-year permit term.

Juvenile-to-Smolt Life Stage

Sutton and Soto (2010) reported that during the summer in the mainstem Klamath River, juvenile coho salmon respond positively to cooler tributary temperatures by congregating in large schools at the mouths of these tributaries, referred to as thermal refugia. Their research summarizes results for studies conducted since 2006. Results showed that juvenile coho salmon started using thermal refugia when the Klamath River mainstem temperature approached approximately 19° C. The majority of the juvenile coho salmon within the studied thermal refugia were found in the slower velocity habitat associated with cover. Juvenile coho salmon counts in the studied thermal refugia dramatically decreased at temperatures >22-23° C, suggesting that this approximates their upper thermal tolerance level. Figure 25 depicts average mainstem temperatures over a three-year period in the Middle Klamath reach (Karuk 2008). As can be seen, peak temperatures between July and August can approach 26° C, which may be getting near thermal tolerance levels for juvenile coho (Braunworth et al. 2002). Thermal refugia locations near tributary confluences with the mainstem can also provide well-oxygenated water as well as transporting food resources for juvenile coho. In essence, these coldwater tributaries are currently critically important to the growth, health, and ultimately survival of juvenile coho residing in the Middle and Upper Klamath reaches as the Klamath mainstem habitat has been degraded over many decades. The strategic scheduling of in-water work during periods when fish are either absent, or few in number, can avoid or minimize direct impacts to individuals.

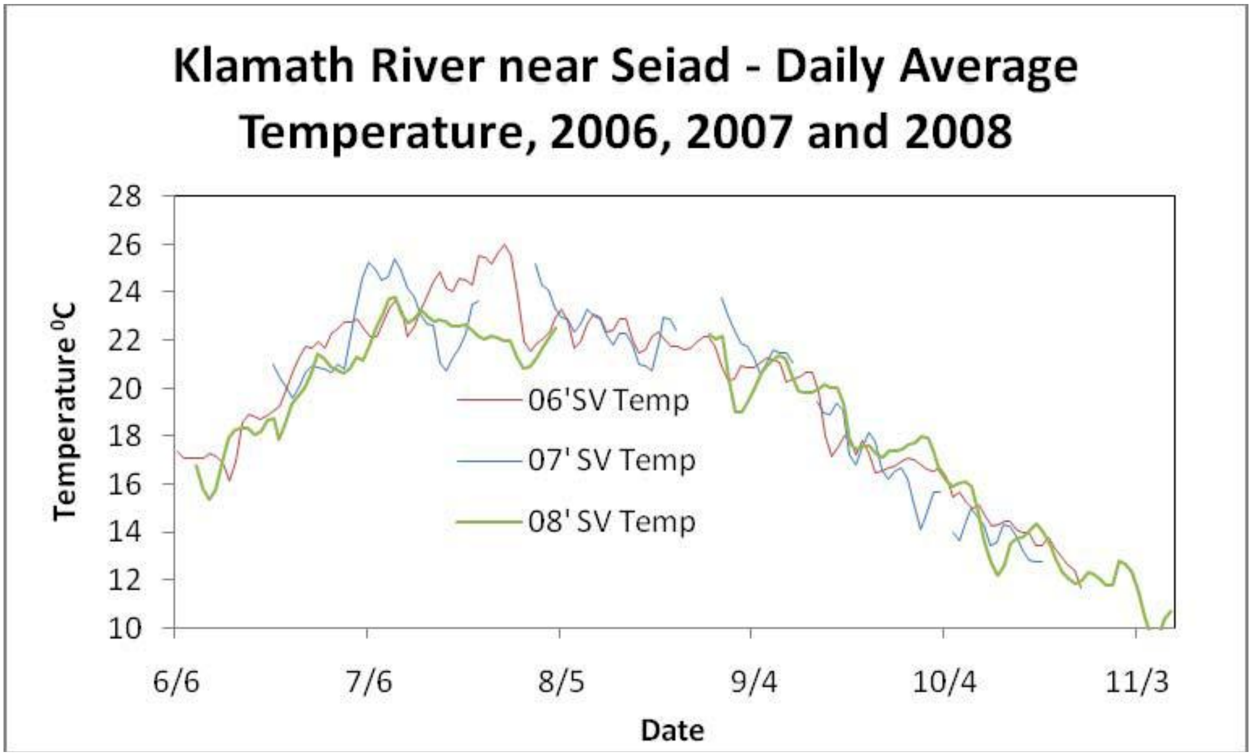

Figure 24. Klamath River near Seiad Valley daily average temperature for the 2006, 2007 and 2008 monitoring season (from Karuk 2008).

Under the Proposed Action, the suite of conservation actions that improve access to thermal refugia, and improve thermal conditions in specific locales, will, in concert, improve the probability of survival for juvenile coho rearing in the Upper and Middle Klamath reaches over baseline conditions. NMFS believes juveniles of the Upper Klamath, Scott and Shasta rivers, and Middle Klamath populations will all experience increased fitness levels as a result of this HCP conservation measure as these juveniles find access to the improved refugia sites and experience more suitable conditions for growth and survival. Individual fitness will be improved by gaining access to inaccessible thermal refugia habitat which will reduce temperature related stress responses, increase overall health via access to well-oxygenated waters, increase access to food resources, and reduce predation pressures by providing access to cover habitat. Fitter individuals may also be less susceptible to the adverse effects of disease infection which may be acquired during residence time in the Upper Klamath reach.

6.6.7 Enhancement of Juvenile Rearing Habitat in Key Tributaries Downstream of IGD

Section 2.2.3.7 of this Opinion describes the conservation actions proposed in the HCP to improve rearing habitat for coho in key tributaries of the Klamath River downstream of IGD. Essentially, the projects will focus on improving connectivity for juveniles in the Upper Klamath, Scott and Shasta Rivers, as well as enhancing and protecting existing rearing habitat.

6.6.7.1 Effects on Critical Habitat

Adult Migration Corridor and Spawning Habitat

Generally, improvements to tributary rearing habitat may result in marginal beneficial effects on adult migration and spawning corridors as the projects themselves must be targeted at improving juvenile rearing habitat. Beneficial effects to corridors for migration and spawning could occur if the tributary project results in improved conditions for access to spawning grounds. As described above in section 6.6.6.1, projects that result in improved flows during the coho migration period during drought years could have an indirect benefit of improving migration corridors for adults. NMFS expects incidences of these kinds of indirect benefits to adult migration corridors and spawning habitat to be relatively rare during the permit term for the reasons previously described. Because such projects are typically scheduled to be implemented outside the coho migration and spawning period, NMFS does not expect that projects designed to improve key tributary juvenile rearing habitat will adversely affect adult migration corridors and spawning habitat.

Juvenile-to-Smolt Rearing and Migration Corridors

Agricultural operations can negatively impact critical habitat of coho salmon by reducing the quality and quantity of water and water temperature available to rearing juveniles during the summer months. Specifically, the spatial structure, population abundance, and productivity can be impacted by agricultural activities. Summer and early fall agricultural diversions in both the Shasta and Scott rivers in some years, especially dry water years, can virtually dewater sections of these rivers, impacting coho salmon within these streams as well as those in the Klamath River who may otherwise utilize these rivers for rearing. Although the Shasta River and Scott River populations spawn in watersheds that lie outside the area adversely affected by the Project, poor habitat and water quality conditions in these sub-basins disperse larger numbers of coho salmon fry and parr out of the Shasta and Scott basins and into the mainstem Klamath River each spring than would otherwise occur if these tributaries met the ecological needs of coho salmon (Chesney and Yokel 2003).

Water utilization in many regions throughout the Interior diversity stratum (e.g., Shasta and Scott Rivers) reduces summer baseflows, which limits the establishment of several essential features such as water quantity and water quality. Although the habitat conditions in these tributaries are not affected by the Project, the current degraded conditions of these tributary habitats can act to limit their use by coho salmon and require more use of the mainstem Klamath River. Improvements such as protecting and enhancing existing rearing habitat, improving water quality and flow, and providing connectivity within and to rearing habitat will increase the opportunity and capacity of key tributaries to provide suitable habitat for juvenile rearing.

Substantial adverse effects to rearing habitat are not expected with implementation of these specific habitat-related conservation measures. However, localized and/or brief disruptions of the immediate area involving habitat enhancement projects may be experienced. We recognize that without thoughtful planning, project deployment activities may pose an injury or mortality risk to individual juveniles in the target area. The strategic scheduling of in-water work during periods when fish are either absent, or few in number, can avoid or minimize direct impacts to individuals. In-water work may require disturbing some beneficial habitat structure in order to increase habitat conditions and quantity, but those impacts are expected to be localized and negligible in terms of the overall impacts to productive habitat. In summary, the conservation value of critical habitat for juvenile rearing in the areas targeted for conservation actions will increase as these actions will protect and enhance coho habitat as affected by flows in the Klamath River mainstem corridor downstream of IGD, in tributaries of the upper Klamath River, and in the Shasta River and Scott River and their tributaries.

6.6.7.2 Populations Most Likely Affected and Individual Stressor Response

Adults

As previously mentioned, instream projects typically are implemented during low-flow summer/early fall periods. As such, NMFS expects that all tributary rearing habitat projects will take place outside of the adult migration and spawning period resulting in little potential for adult exposure to project-related stressors (e.g., stream diversion and turbidity). Beneficial effects to adults could occur if funding through a water transaction program helps to ensure that adequate spawning flows are achieved in systems that suffer from overextraction of water during spawning periods when flows are insufficient to provide adults access to spawning grounds (e.g., Scott and/or Shasta Rivers).

Juvenile-to-Smolt Life Stage

Rearing juvenile coho salmon are often forced to enter the Klamath River when they are not yet mature enough to swim in strong currents or avoid predators, and where they are exposed to poor water quality and pathogens. While not restricted to the Shasta and Scott Rivers, this response to anthropogenic factors nevertheless appears to impact these two populations to a greater degree than other tributary-based populations within the Klamath River basin (NAS 2004).

Projects that result in restoring connectivity in stream reaches of juvenile rearing habitat in tributaries of the Upper Klamath, Scott, and Shasta Rivers, provide flow augmentation via water transactions in key reaches used for coho spawning and juvenile rearing in tributaries of the Upper Klamath, Scott and Shasta Rivers, enhance rearing habitat in key rearing tributaries of the Upper Klamath, Scott and Shasta Rivers, and protect important summer rearing habitat along tributaries of the Upper Klamath, Scott and Shasta Rivers are expected to improve the fitness of these populations via improved growth and survival rates for their juvenile-to-smolt life stages. Localized and/or brief disruptions of the immediate area involving connectivity projects may be experienced. Project deployment activities may pose an injury or mortality risk to individual juveniles in the target area, however, with thoughtful planning and measures to exclude juveniles from the work site, these risks can be substantially reduced. The strategic scheduling of in-water work during periods when fish are either absent, or few in number, can avoid or minimize direct impacts to individuals.

Funding for a water transaction program in the Scott and Shasta rivers can result in providing additional flows in these important systems when rearing could become impaired by low flows. Providing additional flow in these systems may also result in water quality improvements (e.g. temperature, DO), improving the growth and survival (fitness) of juveniles utilizing habitats subject to low flow conditions. Creating sufficient high quality tributary rearing habitat will help improve juvenile growth and survival and help bolster the viability of Upper Klamath, Scott and Shasta rivers, and to a lesser degree, Middle Klamath populations of coho salmon. The Middle Klamath population can benefit during those periods when juveniles move upstream of their natal habitats to seek out suitable rearing areas (e.g. coldwater refugia sites). Use of new or improved rearing sites may help to improve the growth and survival of Middle Klamath population juveniles over the permit term.

VII. EFFECTS OF INTERRELATED AND INTERDEPENDENT ACTIONS

7.1. Effects of Implementation of the Hatchery and Genetic Management Plan

Hatchery programs have the potential to significantly alter the genetic composition (Reisenbichler and Rubin 1999, Ford 2002), phenotypic traits (Hard et al. 2000, Kostow 2004), and behavior (Berejikian et al. 1996, Jonsson 1997) of reared fish. Genetic interactions between hatchery and naturally produced fish can decrease the amount of genetic and phenotypic diversity within populations and even an ESU as a whole by homogenizing once disparate traits of hatchery and natural fish. The result can be progeny with lower survival (McGinnity et al. 2003, Kostow 2004) and ultimately, a reduction in the reproductive success of the natural populations (Reisenbichler and McIntyre 1977, Chilcote 2003, Araki et al. 2007) which can potentially compromise the viability of natural stocks due to out breeding depression (Reisenbichler and Rubin 1999, HSRG 2004). Williams et al. (2008) considers a population to be at least at moderate risk of extinction if the proportion of naturally spawning fish that are of hatchery origin exceeds 5 percent. NMFS and CDFG are currently developing hatchery and genetic management plans (HGMPs) for the Iron Gate, Trinity River, and Mad River hatcheries that will improve hatchery management and reduce impacts on naturally spawning populations of coho salmon.

As described in PacifiCorp's HCP, IGH will continue to operate during the 10-year term of the ITP and the conservation measures in the HCP include implementation of an HGMP for coho salmon at IGH. Current IGH production goals are outlined in Table 9. Implementation of the HGMP will result in biologically-based hatchery management strategies and practices that ensure the conservation and recovery of coho salmon, as well as other salmon species and steelhead (for more details concerning the effects of the action on non-listed species, please refer to the EFH Assessment (Appendix B). Through implementation of the HGMP, the IGH will be operated to conserve coho salmon during the interim period. The conservation focus for coho salmon under the HGMP program will help to protect the remaining genetic resources of the Upper Klamath River coho population unit. The HGMP will be implemented as an additional conservation action pursuant to a permit under ESA Section 10(a)(1)(A) once the permit is issued to provide improvements in hatchery operations to aid the viability of the Upper Klamath coho salmon population unit.

7.1.1 Effects on Critical Habitat

As the HGMP implementation only involves the release of hatchery-reared smolts to the river and does not include disturbance to habitat, NMFS does not anticipate implementation of the HGMP will result in adverse effects to designated critical habitat in the Klamath basin.

7.1.2 Populations Most Likely Affected and Individual Stressor Response

When released into the freshwater, hatchery fish may compete with naturally produced fish for food and habitat (McMichael et al. 1997, Fleming et al. 2000, Kostow et al. 2003, Kostow and Zhou 2006). The exact effects on juvenile coho salmon from competition and displacement in the Klamath River from the annual release of 5,000,000 hatchery-reared Chinook salmon smolts from IGH are not known. However, Chinook salmon are released from IGH at virtually the same time that coho salmon peak emigration occurs in the Klamath River, near the middle of May, the same period that the hydrograph is in sharp decline. In a review of 270 references on ecological effects of hatchery salmonids on natural salmonids, Flagg et al. (2000) found that, except in situations of low wild fish density, increasing release numbers of hatchery fish can negatively impact naturally produced fish. It was also evident from the review that competition of hatchery fish with naturally produced fish almost always has the potential to displace wild fish from portions of their habitat (Flagg et al. 2000). During May, and into the summer, sometimes hundreds or even thousands of juvenile salmonids can be forced by water temperatures into small areas with cold water influence (Sutton et al. 2007). The NRC (2004) recommended altering the number of fish released at IGH and TRH in order to gain a better understanding of the extent to which hatchery fish impact natural production. Competition between hatchery and naturally-produced salmonids can also lead to reduced growth of naturally produced fish (McMichael et al. 1997). Kostow et al. (2003) and Kostow and Zhou (2006) found that over the duration of the steelhead hatchery program on the Clackamas River in Oregon, the number of hatchery steelhead in the upper basin regularly caused the total number of steelhead to exceed carrying capacity which triggered density-dependent mechanisms that impacted the natural population. Competition between hatchery and natural salmonids in the ocean can also lead to density-dependent mechanisms that affect natural salmonid populations, especially during periods of poor ocean conditions (Beamish et al. 1997, Levin et al. 2001, Sweeting et al. 2003).

PacifiCorp will implement the HGMP developed by CDFG and PacifiCorp for IGH. The primary goal of this HGMP is to devise biologically based hatchery management strategies that contribute to the conservation and recovery of coho salmon. Implementation of the HGMP is important to ensure that ongoing IGH operations contribute to the conservation and recovery of listed coho salmon in the Klamath River basin.

During the term of the HGMP, the coho program at the IGH will be operated in support of the basin’s coho salmon recovery efforts by conserving a full range of the existing genetic, phenotypic, behavioral, and ecological diversity of the run. Measures contained in the HGMP include an active broodstock management plan, based on real-time genetic analysis that will be implemented each year to reduce the rate of inbreeding that has occurred in the hatchery population over time. HGMP measures also include hatchery culture improvements to increase egg-to-smolt survival rates. Egg incubation survival will be investigated to identify measures that will improve survival such as changes to incubation methods, improvements in egg rearing water quality, filtering organic matter from the water source and/or decreasing egg density in incubation trays. Covering of raceways with netting is being done to reduce bird predation on the rearing juveniles. Monitoring and evaluation activities will also be conducted to ensure that the performance standards and indicators identified for the program are achieved, and that critical uncertainties are addressed.

Species	Number released	Released	Run timing
Chinook Salmon	5,100,000 smolts	May-June	Mid-September to early November
	900,000 yearlings	November	
Coho	75,000 yearlings	March	Late October to early January
Steelhead	200,000 yearlings	March-May	November to March

Table 9. IGH Production Goals

Another important consideration in regards to the SONCC coho salmon ESU diversity, spatial structure, and productivity is how smaller coho salmon populations from tributaries such as the Scott and Shasta Rivers, which are important components of the ESU viability, are affected by straying of hatchery fish. Pearse et al. (2007) found that hatchery steelhead adults sampled from IGH in 2001 clustered strongly [genetically] with smolts sampled by screw trap in the Shasta and Scott Rivers, suggesting that significant gene flow has occurred between IGH and these nearby tributaries, presumably due to straying of returning hatchery adults. Outmigrating hatchery smolts are known to utilize the Shasta River, so it is likely that some may return to spawn there as well (Pearse et al. 2007). Although it is possible that the screw trap samples represent mixtures of smolts originating from multiple, distinct, upstream populations, the pairwise F_{ST} (Fixation index, a measure of population differentiation values) between IGH and the screw trap samples were among the lowest significant values observed (0.004—0.009), supporting the hypothesis of high gene flow between the hatchery and these populations (Pearse et al. 2007). CDFG (2002b) found that 29 percent of coho salmon carcasses recovered at the Shasta River fish counting facility (SRFCF) had left maxillary clips in 2001, indicating that they were progeny from IGH. The average percentage of hatchery coho salmon carcasses recovered at the SRFCF from 2001, 2003, and 2004 was 16 percent (Ackerman and Cramer 2006). These data indicate that substantial straying of IGH fish occurs into important tributaries of the Klamath River, like the Shasta River, which has the potential to reduce the reproductive success of the natural population (Mclean et al. 2003, Chilcote 2003, Araki et al. 2007) and negatively affect the diversity of the interior Klamath populations via outbreeding depression (Reisenbichler and Rubin 1999, HSRG 2004). However, recent preliminary findings by NMFS Southwest Fisheries Science Center suggest that hatchery and wild fish have already interbred in the Klamath basin, and a pure wild stock no longer exists (CDFG 2011). The total impacts of hatchery strays on Klamath River populations is not well understood, but based on known straying data and preliminary genetic typing, hatchery releases have adversely affected wild populations, particularly in the upper basin.

Although there are risks to Klamath coho populations from continued releases of coho smolts from IGH, due to the significantly depressed status of the Upper Klamath, Scott, and Shasta populations, releases of coho will continue to contribute towards coho abundance, one of the VSP criteria (NMFS 2010). At the individual level, there are some risks associated with implementing HGMP guidelines. Most of these are in the form of potential impacts on adults that will be captured from the natural population for use as spawners in the hatchery. During the collection and holding period prior to spawning there is the possibility that survival may be compromised and lower than realized for fish at liberty in the wild. Given this conservation dilemma, the ongoing operation of IGH and the implementation of HGMP measures at the hatchery will help improve the fitness of hatchery-produced coho, thereby increasing survival probability through the returning adult life stage. The HGMP program will operate in support of the Klamath River basin's coho salmon recovery efforts by conserving a full range of the existing genetic, phenotypic, behavioral and ecological diversity of the run. The program's conservation measures, including genetic analysis, broodstock management, and rearing and release techniques, will help maximize fitness and reduce straying of hatchery fish to natural spawning areas. Active broodstock management, based on real-time genetic analysis, will reduce the rate of inbreeding that has occurred in the hatchery population over time. Additionally, the potential for longer term increases in the proportion of natural-origin fish in the total hatchery spawning population will increase population diversity and fitness. Hatchery culture practices under the HGMP program will help increase egg-to-smolt survival rates by increasing survival during egg incubation and reducing bird predation by covering raceways with netting.

We anticipate that the implementation of an HGMP at IGH will improve the general fitness of the target 75,000 hatchery produced coho smolts, thereby increasing survival probability through the returning adult life stage. Improved smolt to adult return rates in combination with the production of more wild-like fish are desirable outcomes. At the individual level, there are some risks associated with implementing HGMP guidelines and the production of 75,000 smolts. Most of these are in the form of potential impacts on adults that will be captured from the natural population for use as spawners in the hatchery. In general, we anticipate implementation of the HGMP will result in positive benefits to the Upper Klamath, Scott and Shasta river populations.

VIII. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the Proposed Action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

NMFS believes that the SONCC coho salmon ESU and its critical habitat may be affected by numerous actions by State, tribal, local, or private entities that are reasonably certain to occur in the action area during the proposed action permit term. These actions include, but may not be limited to, those discussed below. Although each of the following actions may reasonably be expected to occur, we lack definitive information on the extent or location of many of these categories of actions in the 10-year proposed action timeframe. The following discussion provides available information on the expected effects of these activities on salmonids.

Timber Management on Other Private Lands

Timber management, with associated activities such as harvest, yarding, loading, hauling, site preparation, planting, vegetation management, and thinning, occurs in the action area. Future private timber harvest levels in the action area cannot be precisely predicted, however, we assume that harvest levels on private lands within the action area in the foreseeable future will be within the approximate range of harvest levels that have occurred since the listing of the northern spotted owl in 1992, or slightly less given a current global economic contraction.

Implementation of Timber Harvest Plans (THPs) under the California Forest Practice Rules (CFPRs) has not consistently provided protection against unauthorized take in relation to salmonids listed by NMFS under the ESA, such as listed SONCC ESU coho salmon. It is NMFS' opinion that CFPRs have not in the past and continue to not provide for complete salmonid habitat protection and recovery and are resulting in chronic impairments in shade, LWD, stream temperature, and sediment levels. Although improvements in harvest practices has been achieved since the listing of the SONCC coho salmon ESU, NMFS continues to express to the California Board of Forestry our ongoing concerns with habitat impacts from road building, unstable slope management, inadequate riparian protection, and cumulative watershed effects. Recent revisions to the CFPRs address some concerns related to salmonids, however, until all issues are resolved, unauthorized take from direct, indirect, and cumulative effects of listed Pacific salmonids from timber harvest and its associated activities may be occurring and likely will continue to occur. The extent and amount of any unauthorized take is unknown.

Reasonably foreseeable effects of timber management activities will likely impact designated critical habitat for the SONCC coho salmon ESU. There are fish-bearing streams on private land within the action area. Within the action area, direct, indirect, and cumulative effects of timber harvesting on private lands may degrade the habitat features identified as essential for the conservation of coho salmon. Unless these private landowners have agreed to adopt timber practices in a manner that is more protective of SONCC ESU coho salmon and its critical habitat (e.g., via an approved Habitat Conservation Plan), then adverse effects from timber management is expected to continue during the proposed action permit term. The effects include chronic impacts to spawning and rearing habitat in important tributaries within the action area.

Control of Wildland Fires on Non-Federal Lands

Control of wildland fires may include the removal or modification of vegetation due to the construction of firebreaks or setting of backfires to control the spread of fire. This removal of vegetation can trigger post-fire landslides as well as chronic sediment erosion that can negatively affect downstream coho habitat. Also, the use of fire retardants may adversely affect salmonid habitat if used in a manner that does not sufficiently protect streams causing the potential for coho to be exposed to lethal amounts of the retardant. This exposure is most likely to affect summer rearing juvenile coho. As wildfires are stochastic events, NMFS cannot determine the extent to which suitable coho habitat may be removed or modified by these activities.

Construction, Reconstruction, Maintenance, and Use of Roads

Within the action area there are thousands of miles of surface roads used to provide access to timber or private residences. As the road networks in the action area are already fairly well established, NMFS does not anticipate significant new miles of roads to be built during the proposed action permit term. We do however anticipate that efforts will continue to upgrade and or decommission existing roads to make them less inclined to road failures (landslides) and/or be a chronic source of sediment discharge to adjacent stream networks. Improvement of environmental conditions on private and state lands related to roads throughout the action area is expected over the permit term due to an increasing emphasis on watershed-scale inventory, assessment and treatment of road networks as regulatory sediment reduction requirements are implemented in the action area (e.g., TMDLs). However, funding for such efforts is limited and the thousands of miles of existing roads in total is expected to continue to adversely affect salmonids and their habitat throughout the 10 year permit term.

Mining, Rock Quarrying and Processing

Although mining activity is a relatively minor land use within the action area as compared to timber management, NMFS anticipates that upland mining and quarrying will continue to be conducted by non-federal parties within the action area. The effects of upland mines and quarries on aquatic resources in the action area depend on the type of mining, the size of the quarry or mine, and distance from waters. Mining can cause increased sedimentation, accelerated erosion, increased streambank and streambed instability, and changes to substrate. Surface mining may result in soil compaction and loss of the vegetative cover and humic layer, thereby increasing surface runoff. Mining may also cause the loss of riparian vegetation. Chemicals used in mining can be toxic to aquatic species if transported to waters. Because the effects of mines and quarries depend on several variables, NMFS cannot determine the extent of the effects of mines and quarries and other commercial rock operations on Pacific salmonids during the permit term within the action area. Commercial rock quarrying will continue to be under the regulations of local municipalities within the action area.

In 2009 the State of California imposed a moratorium on suction dredge mining throughout the State. This action affects the Klamath River in that gold miners who utilized suction dredges to extract gold out of streambed substrate are now prevented from lawfully doing so. Suction dredge mining in systems that support salmonids was known to cause locally significant adverse impacts on salmonids and their habitat. The moratorium is in effect until June 30, 2016. During this moratorium, CDFG is performing an environmental review of the impacts associated with this instream activity and any needed offsetting mitigation. NMFS expects that the moratorium will allow for improved habitat conditions in the Klamath mainstem and larger tributaries, and will reduce the direct and indirect effects of this activity on SONCC ESU coho salmon in both the short and long term.

Habitat Restoration Projects

NMFS anticipates that, as monitoring information accumulates on past projects, the focus of stream restoration projects will gradually shift toward more effective restoration actions. Because such activities are usually coordinated with one or more of the resource agencies, we anticipate that all applicable laws will be followed. Restoration activities conducted through CDFG's Fisheries Habitat Restoration Program are covered by a consultation under ESA Section 7 with the U.S. Army Corps of Engineers, and are therefore not considered a cumulative effect. Restoration activities that are not conducted pursuant to CDFGs program may cause temporary increases in turbidity, alter channel dynamics and stability, and injure or scare salmonids if equipment is used in the stream. Properly constructed stream restoration projects may increase habitat complexity, stabilize channels and streambanks, increase spawning gravels, decrease sedimentation, and increase shade and cover for salmonids. These projects often focus on identifying source problems in an area (i.e., roads) and apply corrective measures to eliminate or minimize the adverse effects to aquatic resources. We do not know how many restoration projects will be completed outside of CDFG's program; therefore, the effects of these projects cannot be predicted.

Agricultural Activities

Agricultural activities in the action area include grazing, dairy farming, and the cultivation of crops. The impacts of this land use on aquatic species is anticipated to be locally intense, but the longevity of the impact depends on the degree of grazing pressure on riparian vegetation, both from dairy and beef cattle. Grasses, willows, and other woody species can recover quickly once grazing pressure is reduced or eliminated (Platts 1991) through fencing, seasonal rotations, and other measures. Assuming that appropriate measures are not taken to improve practices over time and reduce grazing pressure, impacts to aquatic species are expected to continue. Grazing impacts include decreased bank stability, loss of shade- and cover-providing riparian vegetation, increased sediment inputs, and elevated nutrient levels.

NMFS has determined that the completion of the mainstem Klamath River TMDL in California will result in requirements for agricultural, municipal, and industrial entities contributing to the degradation of water quality in the Klamath basin to develop and implement water quality management plans that reduce nutrient loading and aid in the improvement of water quality. Nutrient inputs in addition to naturally alkaline soils may be producing higher pH levels in the Klamath mainstem than would occur under an unaltered environment; high pH is also found in tributaries not influenced by the Project (e.g. Shasta River). High pH, in combination with high water temperatures, can precipitate elevated ammonia levels during summer months (FERC 2006). Between IGD 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). Figure 23 shows data on pH levels collected by the Karuk Tribe during summer/early fall downstream of IGD. As shown, pH below IGD can reach levels close to 8.5 pH during the early parts of summer. Goldman and Horne (1983) note that at pH of over 9.5 that all ammonium ions would be converted to dissolved ammonia, which is highly toxic to salmonids. Additional studies report effects of pH on salmonids of levels above 8.5 being stressful and pH 9.6 being lethal (Wilkie and Wood 1995). Adverse effects of high pH include ammonia toxicity (U.S. EPA 1999), decreased activity levels, stress responses, decrease or cessation in feeding, and loss of equilibrium (Murray and Ziebell 1984, Wagner et al. 1997). If pH reaches extremely low or high levels, death can occur (Wagner et al.1997). The high pH values found in the Klamath mainstem alone are likely not chronically or acutely lethal to coho juveniles exposed to these conditions, but in combination with high water temperatures, may cause some level of impairment to the fitness of juveniles residing in these conditions. At this time, the effect of high levels of pH on coho salmon in the basin is not well understood.

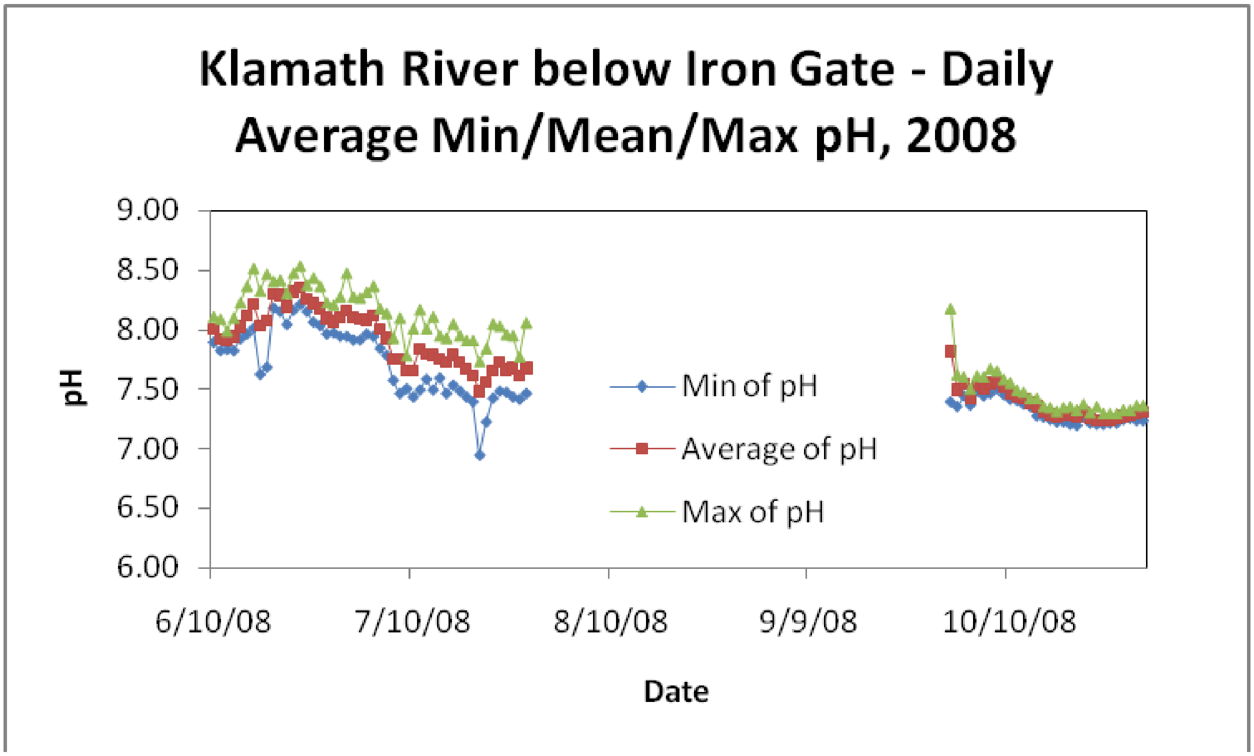

Figure 25. Daily maximum, mean and minimum pH values on the Klamath River below Iron Gate from June to October, 2008 (from Karuk 2008).

NMFS is also aware that the completion of the water adjudication process for the Klamath basin in Oregon is expected in the near future. The adjudication process may provide for more efficient water management in the Oregon side of the Klamath River basin, and result in increased water availability for resource needs

Residential Development and Existing Residential Infrastructure

Human population growth in the action is expected to remain relatively stable over the next 10 years as California's economy continues to recover from a long-lasting nationwide recession. The recesses ion has had significant economic impacts at both the statewide and local scales with widespread impacts to residential development and resource industries such as timber and fisheries. However, some development will continue to occur which, on a small-scale, can impact coho habitat. Once development and associated infrastructure (roads, drainage, water development, *etc*.) are established, the impacts to aquatic species are expected to be permanent. Anticipated impacts to aquatic resources include loss of riparian vegetation, changes to channel morphology and dynamics, altered hydrologic regimes (increased storm runoff), increased sediment loading, and elevated water temperatures where shade-providing canopy is removed. The presence of structures and/or roads near waters may lead to the removal of LWD in order to protect those structures from flood impacts. The anticipated impacts to Pacific salmonids from continued residential development are expected to be sustained and locally intense. Commonly, there are also effects of home pesticide use and roadway runoff of automobile pollutants, introductions of invasive species to nearby streams and ponds, attraction of salmonid predators due to human occupation (e.g., raccoons), increased incidences of poaching, and loss of riparian habitat due to land clearing activities. All of these factors associated with residential development can have negative impacts on salmon populations.

A subset of this development may occur for the purposes of marijuana cultivation. Watersheds within the action area have been utilized to produce marijuana crops both legally and illegally. California law allows for the production of marijuana for medicinal purposes under Proposition 215 which establishes limits to the production of marijuana by patients or their designated growers. NMFS does not expect that cultivation of marijuana under Proposition 215 limits will result in adverse effects to coho habitat. However, illegal marijuana production within the action area can at times result in grow operations of over 100,000 plants; often these illegal grows occur on federal lands. During the proposed action permit term, NMFS expects these illegal grow operations to continue on isolated parcels within the action area. These grow operations can adversely affect coho habitat by diversion of water for irrigation, resulting in the drying of streams or draining of pools that provide rearing habitat for coho juveniles. The operations can also contaminate nearby streams by the discharge of pesticides, rodenticides, and fertilizers to nearby streams. Such influx of contaminants can be lethal to exposed coho, or result in the alteration of stream habitats via eutrophication.

Recreation, Including Hiking, Camping, Fishing, and Hunting

Expected recreation impacts to salmonids include increased turbidity, impacts to water quality, barriers to movement, and changes to habitat structures. Streambanks, riparian vegetation, and spawning redds can be disturbed wherever human use is concentrated. Campgrounds can impair water quality by elevating nutrients in streams. Construction of summer dams to create swimming holes causes turbidity, destroys and degrades habitat, and blocks migration of juveniles between summer habitats. Impacts to salmonid habitat are expected to be localized, mild to moderate, and temporary. Fishing within the action area, typically for steelhead or Chinook salmon, is expected to continue subject to CDFG regulations. Fishing for coho directly is prohibited in the Klamath River. The level of impact to coho within the action area from angling is unknown, but is expected to remain at current levels.

Water Withdrawals

An unknown number of permanent and temporary water withdrawal facilities exist within the action area. The nature of their impacts was discussed in the environmental baseline section. These include diversions for urban, agricultural, commercial, and residential use, along with temporary diversions, such as drafting for dust abatement. Approximately 81,070 acre feet of water is diverted from the Scott River annually (Van Kirk and Naman 2008). Numerous other water diversions in the systems that feed the Klamath River decrease the quantity of mainstem flows on the Klamath River mostly during the summer months, when juvenile access to cooler tributaries and cooler mainstem water temperatures is essential.

In the fall of 2009, the CDFG released a Final Environmental Impact Report (FEIR) on the Scott River Watershed-Wide Permitting Program (WWPP). The FEIR accompanied a process by which agricultural operators in the Scott River watershed could receive incidental take coverage for coho salmon under state law if the operator diverts water from a stream by means of an active diversion for an agricultural purpose, or is involved in an agricultural operation on property in the WWPP area through which or adjacent to which a stream flows. Recently, the EIR for the program was challenged in court, and it was ruled to be insufficient. We are unsure whether the WWPP will be reinstated, and if so, within what timeframe. An active diversion is defined as a surface water diversion that has operated at least one out of the last five years. The WWPP also implements certain stream restoration projects in the Scott River watershed identified in the California Fish and Game Commission's (Commission) *Recovery Strategy for California Coho Salmon* (February 2004) as key coho recovery projects. Under the WWPP, the Siskiyou County Resource Conservation District (RCD) will be responsible for implementing those recovery projects. One of CDFG's objectives for this program is to eliminate unauthorized take of coho salmon caused by water diversions in the Scott River watershed and avoid, minimize, and fully mitigate take of coho salmon incidental to diverting water with a valid water right, recovery actions, and other lawful activities.

We do not expect the number or quantity of diversions to increase in the action area given the already high levels of water withdrawals and the issues surrounding limited water resources at the present time. Given the complexities of the WWPP, it is possible more landowners will transition from instream diversion for their water needs to off channel wells and pumps. Although there would be a benefit to salmonids from ending adverse effects of instream pumping and diversions, such as entrapment and impingement of younger salmonid life stages within pump systems, there is currently a poor understanding of how groundwater withdrawals could affect near stream surface flows. A greater reliance on groundwater withdrawals could lead to similar reductions in streamflows and still result in localized dewatering of reaches, and depleted flows necessary for migration, spawning, rearing, flushing of sediment from the spawning gravels, gravel recruitment, and transport of LWD. We are currently unsure if the WWPP will be reinstated and, if reinstated, we are unsure of the benefits the WWPP will provide to salmonids in the Scott River watershed, but expect they are likely to be minimal.

Climate Change

Climate change is postulated to have a negative impact on the SONCC coho salmon ESU. The impact of climate change on the SONCC coho salmon ESU includes the coho population units in the Klamath basin, whose freshwater habitat is detrimentally affected by alterations in river flows and water temperature as a result of climate change.

The hydrologic characteristics of the Klamath River main stem and its major tributaries are dominated by seasonal melt of snowpack (NRC 2004). Van Kirk and Naman (2008) found statistically significant declines in April 1 Snow Water Equivalent (SWE) since the 1950s at several snow measurement stations throughout the Klamath basin, particularly those at lower elevations (<6000 ft.). Mayer (2008) found declines in winter precipitation in the upper-Klamath basin. The overall warming trend that has been ubiquitous throughout the western united states (Groisman et al. 2004), particularly in winter temperatures over the last 50 years (Feng and Hu 2007, Barnett et al. 2008), has caused a decrease in the proportion of precipitation falling as snow (Feng and Hu 2007). Basins below approximately 1800-2500 m in elevation appear to be the most impacted by reductions in snowpack (Knowles and Cayan 2004, Mote 2006, Regonda et al. 2005). Some of the largest declines in snowpack over the Western U.S. have been in the Cascade Mountains and Northern California (Mote et al. 2005, Mote 2006). These declines in snowpack are expected to continue in the Klamath basin and increase the demand for water by humans (Doll 2002, Hayhoe et al. 2004) and decrease water availability for salmonids (Battin et al. 2007). These decreases in water supply and increases in irrigation demand are likely to negatively impact coho salmon in the Klamath basin.

Bartholow (2005) found that the Klamath River is increasing in water temperature by 0.5°C/decade, which may be related to warming trends in the region (Bartholow 2005) and/or alterations of the hydrologic regime resulting from the Project, logging, and water utilization in Klamath River tributary basins. Particularly, changes in the timing of peak spring discharge, and decreases in water quantity in the spring and summer may affect salmonids of the Klamath River. Most life history traits (e.g., adult run timing, juvenile migration timing) in Pacific salmon have a genetic basis (Quinn et al. 2000, Quinn 2005) that has evolved in response to watershed characteristics (e.g., hydrograph) as reflected in the timing of their key life-history features (Taylor 1991, NRC 2004). In their natural state, anadromous salmonids become adapted to the specific conditions of their natal river like water temperature and hydrologic regime (Taylor 1991, NRC 2004). Therefore, the extent and speed of changes in water temperatures and hydrologic regimes of the Klamath River and associated tributaries will determine whether or not coho salmon of the Klamath River are capable of adapting to changing river conditions.

The most recent information on estimated climate change effects in the Klamath basin are discussed in Reclamation's 2011 SECURE Water Act Report (Reclamation 2011). The Reclamation (2011) report estimates the following climate changes in the Klamath River basin:

- Climate change models indicate temperatures throughout the Klamath River basin may increase by approximately 5–6 °F over the 21st century, with a projected increase of from 2.2 to 2.7% in precipitation by 2050.
- Increased warming is expected to reduce snowpack and snowmelt, resulting in less runoff during the late spring through early autumn. Snowpack decreases are projected to be more substantial in the warmer parts of the basin.
- Mean annual runoff is projected to increase by from 2.9 to 9.6% by 2050.
- Projected warming might also change runoff timing, with more rainfall-runoff during the winter and less runoff during the late-spring and summer.

Reclamation (2011) indicates that these historical and projected climate changes have the following potential impacts for the basin:

- Warmer conditions might result in increased fishery stress, reduced salmon habitat, increased electricity demand, increased water demands for instream ecosystems and increased likelihood of invasive species infestations.
- Water demands for endangered species and other fish and wildlife could increase due to increased air and water temperatures and runoff timing changes.
- Spring and early summer runoff decreases likely translate into water supply reductions for meeting irrigation demands, adversely impacting hydropower operations and increasing wintertime flood control challenges.
- Adequate and safe water supplies are fundamental to the health, economy and ecology of the United States and global climate change poses a significant challenge to the protection of these resources.

Climate change may at best complicate recovery of coho salmon, or at worst hinder their persistence (Beechie et al. 2006, Van Kirk and Naman 2008). By negatively affecting freshwater habitat for Pacific salmonids (Mote et al. 2003, Battin et al. 2007), climate change is expected to negatively impact one or more of the VSP criteria for the interior Klamath population units. Climate change can reduce the spatial structure by shrinking the amount of freshwater habitat available to coho salmon. Diversity could also be impacted if one specific life history strategy is disproportionately affected by climate change. Population abundance can also be reduced if fewer juveniles survive to adulthood. Climate change affects critical habitat by decreasing water quantity and quality, and limiting the amount of space available for summer juvenile rearing. In terms of climate change effects on coho in the Klamath River basin during the term of the ITP, NMFS does not believe climatological changes will occur within the next decade that would have noticeable effects on coho abundance, productivity, or spatial distribution. Although we believe climate change is likely going to result in increased stressors on coho viability, we believe these stressors are likely to manifest at time-scales much longer than the ITP term.

IX. INTEGRATION AND SYNTHESIS

As we discussed in Chapter III of this Opinion, *Analytical Approach*, once we have established the environmental baseline for SONCC ESU coho salmon in the action area, determined the anticipated effects to coho in the action area from the proposed action (issuance of an ITP and implementation of the PacifiCorp HCP), and considered effects to coho in the action area from future cumulative effects, we must then integrate and synthesize these effects to determine whether the additive effects of the proposed action (either adverse or beneficial or both in this case), in consideration of baseline and future effects, are likely to appreciably reduce the likelihood of both the survival and recovery of the SONCC coho salmon ESU in the wild or are likely to result in the destruction or adverse modification of its designated critical habitat. An important tool we use in this step of the assessment is a consideration of the life cycle of the species. The consequences on a population's probability of extinction as a result of impacts to different life stages are assessed within the framework of this life cycle and our current knowledge of the transition rates (essentially, survival and reproductive output rates) between stages, the sensitivity of population growth to changes in those rates, and the uncertainty in the available estimates or information. In this Opinion, we integrate and synthesize these combined effects on various life stages for each coho population likely affected by the proposed action. We then evaluate these population level effects on the diversity strata affected, and finally how strata level effects are expected to affect the viability of the ESU as a whole. We conduct a similar analysis for effects to the conservation value of critical habitat. In essence, we evaluate effects of the conservation value of habitat at the population scale, then at the scale of affected diversity strata, and finally at the ESU scale.

SONCC Coho Salmon ESU Environmental Baseline Summary

The SONCC coho salmon ESU appears to be susceptible to continued population declines. Most data across the ESU and within individual watersheds show a steady decline in coho abundance. Over the last several decades, data indicates the number of streams where coho salmon are present continues to decrease, and in many of those stream systems still supporting coho, abundance and distribution are on a declining trend and face a high risk of extinction due to low abundance, spatial structure, and diversity.

Effects of Proposed Action on Watershed Processes

Our analysis of effects was organized around the following physical or biological watershed processes which are critical to coho growth and survival in the freshwater phase of their life cycle:

1. Barriers and Limited Habitat Access
2. Hydrology
3. Water Quality
4. Disease
5. Gravel and LWD Transport and Recruitment Processes

Since these processes control the quality and distribution of freshwater habitat, we assumed that coho populations will respond to changes in these processes because declines in the quality and distribution of freshwater habitat appears to be a significant factor in the decline and current status of salmonids in the action area. Since salmonid populations are influenced by freshwater habitat in the action area, our determination of effects is focused on anticipated changes to stream habitat and how habitat changes are expected to influence individuals; specifically, we discuss effects on specific life history functions (i.e., salmonid spawning, emergence, juvenile rearing and out-migration) to better understand the life-stage specific responses to the proposed action.

9.1 Upper Klamath Population Unit

Life Stage Response- Adult Migration and Spawning

As discussed throughout this Opinion, coho adults from this population have been blocked from spawning above IGD since the early 1960's, and adverse effects to this population are principally due to hydroelectric and agricultural development in the upper basin. The blockage above IGD will not change with implementation of the proposed action, nor is this condition expected to change within the next decade. The blockage of 58 miles of habitat above IGD has resulted in a significant negative effect on the Upper Klamath adult population. Below IGD, the Project, and thus the proposed action, is not believed to negatively affect the ability of adults to reach currently available spawning grounds. The proposed action will, however, continue to result in the interruption of gravel recruitment processes downstream of IGD, limiting the formation of spawning gravels within the Klamath mainstem for the duration of the proposed action. In summary, the adverse effects of the proposed action is the continued blockage of 58 miles of habitat above IGD, and the retention of spawning gravels within Project reservoirs which, absent the Project, could be available to provide additional mainstem spawning habitat for Upper Klamath coho, however limited that may have been. This limitation on gravel recruitment likely affects the majority of the population unit.

To mitigate, or compensate, for the proposed action effects on adult migration and spawning, implementation of the HCP will result in benefits to the adult life stage and spawning opportunities by taking direct actions to maintain and improve access to existing spawning and rearing habitat in approximately 60 miles of Upper Klamath tributaries between April and November of each year. In addition, direct actions will be taken to remove existing passage barriers to create permanent access to at least one mile of potential spawning and rearing habitat in Upper Klamath tributaries. Providing new or improved access to spawning and rearing areas will enhance the opportunity for colonization, and potentially establish new sub-populations. Since there are numerous sites being targeted, they span a broad area in the upper basin, providing access to a wide spectrum of new habitat types. This enhances the opportunity to establish more unique adult spawning units, contributing to diversity in population structure over the 10 year permit duration. Furthermore, these access improvement actions expand the geographic distribution of SONCC ESU coho salmon, enhancing the currently limited spatial structure of the population. The removal of existing permanent barriers to suitable spawning habitat can benefit adult abundance and spatial structure long after the ITP has expired, and in the case of permanently opening new habitat, perhaps into perpetuity.

Additionally, the proposed action will mitigate for the interruption in the recruitment of potential spawning gravels by Project reservoirs by augmenting gravel downstream of IGD. Significant quantities of gravel will be placed annually within the Upper Klamath unit with one of the purposes to be the addition of suitable spawning gravels in a location determined to contain characteristics suitable for spawning, yet lacking gravels. For example, this action could occur in reaches where instream mining resulted in the removal of spawning gravels. As described previously, gravel augmentation proposed in the HCP would also serve the purpose of contributing to scour events in areas within the Upper Klamath reach susceptible to the formation of disease conditions. NMFS does not anticipate infection of coho adults is contributing to the decline of the Upper Klamath population, therefore we do not anticipate reduction in disease outbreaks via gravel augmentation will have an effect on adults per se. However, increases in the rates of juvenile to smolt survival can result in the indirect benefit of increasing adult abundance as healthier, more robust smolts enter the ocean environment. If these smolts encounter favorable ocean conditions, NMFS expects more fit smolts will equate to higher rates of survival into adulthood.

The HCP would also add LWD to the Klamath mainstem, or provide LWD for tributary projects such as complex wood jams. Large wood added to the Klamath mainstem, if placed in a floating raft-like structure, has the potential to provide cover habitat for migrating adults. Such instream cover has the potential to reduce predation on migrating adults from fish-eating birds such as osprey and bald eagle that can prey on average sized-adult coho.

Implementation of the HGMP will assist in the maintenance of genetically diverse adults in the population, helping to ensure that adverse consequences of small population size on the genetic composition of the population is minimized to the maximum extent. Although hatcheries can produce individual adults that stray into non-natal streams and spawn with other natal adults resulting in potential for genetic cross-contamination, an HGMP can help to minimize this potential. NMFS expects that implementation of an HGMP will aid in maintaining genetic diversity of adults in the Upper Klamath population, allowing for diversity to be improved or maintained throughout the duration of the ITP.

In summary, although the Project itself will continue to have adverse effects on adults of the Upper Klamath population, the conservation measures outlined in the PacifiCorp HCP will aid in the viability of this population unit by taking direct actions which will benefit adult migration and spawning. This will occur as a result of the expansion of accessible spawning habitat, maintaining accessibility to existing habitat, improvement or creation of spawning habitat where it currently doesn't exist through the placement of spawning gravels in suitable habitat, and maintenance of genetic diversity in the adult population via implementation of an HGMP. Without these actions, the adult population would continue to have limited access to spawning habitat under normal conditions and be subject to adverse genetic consequences via hatchery releases which do not have conservation of genetic resources as one of its principal objectives.

Life Stage Response- Egg to Smolt Survival

By far, past and ongoing operations of the Project have had the largest adverse effect on the Upper Klamath population, most significantly adverse effects below IGD on the egg-to-smolt life stages of this population. Therefore, the conservation strategy outlined in PacifiCorp's HCP targets these life-stages for direct actions which are intended to result in increased survival rates from egg through smoltification and ocean entry. It is also these life stages which have been most adversely affected from other non-Project past and reasonably foreseeable future stressors occurring in the Upper Klamath freshwater environment (e.g., Reclamation's Klamath Project). Other non-Project stressors on these life stages of the population include tributary barriers which can seasonally or permanently block access to suitable summer rearing habitat.

As discussed in the *Effects of the Action* section of this Opinion, altered hydrologic flow of the Klamath mainstem has likely had the largest effect on these life stages of coho. Altered flows have led to conditions where abnormally high water temperatures are experienced throughout the Upper Klamath reach during summer months, and have contributed to reductions in suitable summer and winter rearing habitat. These conditions have contributed to lethal and sub-lethal outbreaks of disease, particularly near the Trees of Heaven reach, that have negatively impacted survival rates for juveniles infected with disease agents. These effects have occurred in the past, and are likely to continue for the next decade as the network of dams and reservoirs in the upper basin, which contribute to the formation of these conditions, will remain in place while it is decided whether some of them should be removed or, if not removed, the dams are modified to allow for volitional fish passage. As such, NMFS expects that, as compared to an unaltered system, reductions in egg to smolt survival rates for the Upper Klamath population unit will continue to occur to some degree throughout the proposed permit term. NMFS expects this reduction will largely be due to periods of disease outbreak which can vary in terms of extent and severity on the coho juvenile population.

As described throughout this Opinion, Project dams and reservoirs have impeded the rivers ability to "flush" itself with pulse flows and bedload transport. Lack of gravels contributing to scour is believed to play a significant role in disease outbreaks discussed above. Thus, Project effects on bedload transport have and will continue to contribute towards reductions in egg to smolt survival rates throughout the permit term, as compared to an unaltered system.

In order to combat disease outbreaks in the Upper Klamath reach, the HCP proposes to take direct actions which are intended to interrupt or reduce habitat conditions that lead to disease outbreaks. The HCP proposes that PacifiCorp will actively participate in a Flow Variability Team that will develop fall/winter and spring flows. Fall and winter flows will be designed to redistribute spawned-out adult salmonid carcasses which may be concentrated in the upper basin causing the potential for disease outbreaks to occur, and will also be designed to scour channel bottom redistributing fine sediment and organic matter. These actions will help reduce the prevalence of *P. minibicornis* and *C. shasta*, the organisms tied to health related impacts on coho. Increased spring flows are expected to aid in maintaining or expanding summer rearing habitat for juveniles occupying the Upper Klamath reach. Based on analyses presented in NMFS (2010), we conclude that the availability of rearing habitat will increase substantially with PacifiCorp's cooperation in implementing RPA flows and increase juvenile survival though the smolt stage. Spring flow objectives will also include timing release of flows to spur downstream emigration in an attempt to reduce smolt transit time through disease prone areas. The relationship between increasing discharge and faster smolt migration has been identified for salmonid species in other regulated rivers (Berggren and Filardo 1993, Giorgi et al. 1997). Increased migration speed may also reduce exposure time predators, thereby improving smolt survival.

Other actions proposed in the HCP to offset Project effects on these life-stages include improvements in dissolved oxygen concentrations downstream of IGD for an approximately six mile reach. Dissolved oxygen concentrations from releases from Iron Gate reservoir associated with Project operations in summer and early fall have been found to drop to levels which may cause periods of stress on juveniles residing in this reach. With implementation of turbine venting and blower operations at Iron Gate, PacifiCorp has been able to demonstrate improvements in DO which may reduce these stressful conditions for juvenile coho residing in the Upper Klamath reach. PacifiCorp will also fund additional disease research in the Klamath basin to better understand why disease occurs and more importantly, what actions seem to be most effective at controlling or reducing disease. As juvenile coho appear to be the most susceptible life-stage to infections acquired in the Klamath mainstem, this additional research, if tied back to direct management actions, can result in more suitable habitat conditions for these life stages.

Implementation of the HCP would also target 28 coldwater refugia sites along the mainstem Klamath River for improvement and maintenance of habitat complexity and cover. There are seven (7) refugia sites identified in the Upper Klamath reach and 21 refugia sites identified in the Middle Klamath reach (see Figures 2 and 3). These actions will be taken to maintain these sites as cover for rearing juveniles and to also enhance these sites through the addition of habitat features such as brush bundles or large woody debris. Other actions to be taken include increasing the extent and/or duration of nine coldwater refugia sites along the Klamath River (4 in the Upper Klamath and 5 in the Middle Klamath). These would include actions such as channel re-alignment, increasing flow to the refugia sites, or adding structures to the refugia sites. Although the HCP must contain flexibility in where actual project work will occur over the permit term, these refugia sites have been preliminarily identified as having the greatest potential for habitat improvements. All of these actions can result in enhanced survival from the juvenile to smolt life stage. These actions can result in improvements to currently marginal habitat for coho, making them more suitable for rearing (e.g., better protected, cooler, and less temporary in nature). Other actions in the HCP that are targeted to increase connectivity in Upper Klamath tributaries will result in habitat being available to juvenile coho which might not otherwise occur. Such connectivity actions can include channel reconstruction, floodplain connection, or beaver introductions to restore tributary floodplain processes (e.g. pool development). Although some of these actions are slated to occur in the Middle Klamath mainstem or tributaries, Upper Klamath coho juveniles can benefit from the actions in the

Middle Klamath as they emigrate downstream and gain access to quality habitat that previously did not exist, or temporarily utilize this habitat during their residence time in the upper basin. Opening new habitat and expanding or enhancing existing habitat throughout the Middle and Upper Klamath reaches can provide new foraging opportunities to juveniles, as well as provide new cover from high water temperatures, low DO conditions, or predators.

The numerous and assorted habitat access and improvement actions implemented throughout this geographic zone will improve different facets of ecosystem function. Although it is difficult to quantify survival gains associated with habitat restoration and improvement projects, the strategy is widely applied and is a foundation block for many recovery plans for salmon. Most notably, tributary habitat restoration has been adopted as a building block for improving survival of threatened and endangered anadromous salmonid populations in the Snake-Columbia River System (NOAA 2010). Analyses by Paulsen and Fisher (2005) provide general support for juvenile survival benefits associated with habitat restoration actions. They analyzed eleven years of PIT tag data from 33 Snake River basin sites. They found that parr-to-smolt survival was generally higher for sites where past tributary habitat remediation or enhancement actions occurred.

In summary, the Upper Klamath population is currently significantly depressed as compared to pre-Project conditions, it is not considered viable, and it is far from low-risk spawner thresholds established in Williams et al. (2008). However, NMFS believes the proposed action will for the next decade result in a reduction in Project adverse effects on SONCC coho salmon ESU, and will improve the viability of the Upper Klamath population. In addition, NMFS expects tangible improvement in the conservation value of critical habitat in the Upper Klamath reach, particularly for juvenile-to-smolt rearing and migration corridors. Such reductions in Project adverse effects and improvements in population viability and critical habitat will occur through improved connectivity and increased access to thermal refugia and productive tributary rearing and spawning sites, increased dissolved oxygen levels below IGD, replenishment of gravel and LWD at strategic locations, and diminishment of disease prevalence. The proposed action should most significantly improve the survival probability of coho salmon in the Upper Klamath population across the spectrum of life history stages. Importantly, these combined effects of the assorted conservation actions are likely to result in returns of Upper Klamath population adults at higher rates and increase productivity above current levels. On balance, the collective effects on the four primary VSP parameters will be positive. This should produce a more robust, diverse and resilient population to recolonize the habitats above IGD once fish passage is restored. Importantly, we expect that these beneficial population level effects will persist for decades well beyond 2020. These actions will contribute to increasing overall population diversity and resiliency. Such benefits would likely persist long after the period of this Opinion. Collectively, this suite of population-level improvements increases the viability of this population unit, in accordance with VSP guidelines currently adopted by NMFS (McElhany et al. 2000).

9.2 Shasta River Population Unit

Life Stage Response- Adult Migration and Spawning

Because adults and juveniles from the Shasta River Population utilize the mainstem Klamath River for migration and rearing (NMFS 2010), they can be affected by stressful conditions in the mainstem that are expected to continue to some degree during the ITP term as described for the

Upper Klamath coho population. We do not anticipate the continued operations of the Project will result in adverse population effect on the adult life stage of Shasta River coho. There is no indication that the Project adversely affects the ability of Shasta River adults to reach their spawning grounds and successfully spawn. Project effects for this population are limited to effects on juveniles residing in the Upper and Middle Klamath reaches. Impacts to juveniles can translate however to reductions in adult returns for the Shasta population. These impacts are discussed below.

As noted with the Upper Klamath population, implementation of an HGMP at the IGH can benefit the Shasta River adult population by assisting in the maintenance of genetically diverse adults in the population, helping to ensure that adverse consequences of a very small population size on the genetic composition of the Shasta population is minimized to the maximum extent. Although hatcheries can produce individual adults that stray into non-natal streams and spawn with other natal adults resulting in potential for genetic cross-contamination, an HGMP can help to minimize this potential. NMFS expects that implementation of an HGMP will aid in maintaining genetic diversity of adults in the Shasta River population, allowing for diversity to be improved or maintained throughout the duration of the ITP. As with the Upper Klamath population adults, wood added to the Klamath mainstem, if placed in a floating raft-like structure, has the potential to provide cover habitat from predation for migrating Shasta adults.

Life Stage Response- Egg to Smolt Survival

As noted with the Upper Klamath population life stage response discussion, throughout the ITP term Shasta River coho juveniles are expected to experience degraded water quality conditions and incidences of disease outbreaks during the time juveniles take up residency in the Upper Klamath reach. A substantial proportion of the annual coho salmon fry and parr leave the Shasta River and enter the Upper Klamath River reach of the mainstem Klamath River near the Trees of Heaven study site during the months of April and May as irrigation diversions commence (Chesney and Yokel 2003). Because we expect the Shasta River will continue to suffer from degraded habitat conditions during the ITP term, we anticipate there will be continued reliance of Shasta River Population unit coho on the Klamath River mainstem and associated non-natal tributaries for rearing will continue to be an important component of the life history strategies expressed by this population.

As described for the Upper Klamath population, to combat adverse Project related effects, the HCP proposes to implement a wide range of conservation measures to increase and enhance habitats for the juvenile to smolt life stage of coho. Although, the conservation measures are primarily targeted to improve the viability of the Upper Klamath population, Shasta juveniles should experience benefits from these actions as well. Improving connectivity and increasing access to thermal refugia and productive tributary rearing sites, increasing dissolved oxygen levels below IGD, replenishing gravel and LWD at strategic locations, and diminishing disease prevalence is expected to collectively improve the survival probability of coho in the Shasta River population across the juvenile to smolt life history stages.

Among other reasons, to further mitigate for adverse Project effects on Shasta River population juveniles residing in the Upper Klamath reach, PacifiCorp will fund actions that address currently limiting factors for abundance and productivity in the Shasta River itself. The HCP sets as biological objectives the restoration of connectivity in the Shasta River basin and the funding of a water transaction program to provide flow augmentation in key reaches in the Shasta River basin for spawning and juvenile rearing. Sites preliminarily targeted in the Shasta include Little Shasta Creek, Parks Creek, and sites within the Shasta mainstem. These measures are intended to protect and enhance the limited rearing habitat currently occurring in the Shasta basin. Maintaining connectivity between rearing habitats through the prevention or reduction in seasonal fish passage barriers due to water diversions should result in increased foraging opportunities, improved water quality, increased cover habitat, and ultimately increased rates of juvenile survival. The current state of poor connectivity and resultant poor water quality conditions during summer months in the Shasta mainstem and important tributaries is likely a significant cause for the large decline in this population, as high rates of juvenile mortality are experienced. Examples of restorative projects include fish screening of diversions and riparian fencing. These types of actions will improve water quality conditions and increase habitat availability, albeit at a size and scale that is relatively small compared to the magnitude of habitat problems existing in the Shasta basin.

Efforts to protect and enhance suitable rearing habitat in the Shasta River basin are highly needed at this time. The Shasta River coho salmon population size is currently low and unstable, currently all three brood years are significantly less than the 531 spawners that are necessary to avoid the effects of low population sizes (depensation) (CDFG 2003). Based on the criteria set forth by Williams et al. (2008), the Shasta River population is at a high risk of extinction. This conclusion is based on the extremely small population size of the population (below depensation), declines in population abundance over the past 50 years (precipitous decline), and a spawner density below threshold levels (<1 per IP km).

As we have discussed in this and the Upper Klamath population synthesis, numerous and assorted habitat access and improvement actions implemented throughout this geographic zone are intended to improve different facets of ecosystem function in the Shasta River basin as well as the Klamath mainstem. Improving connectivity and increasing access to thermal refugia and productive tributary rearing and spawning sites, increasing dissolved oxygen levels below IGD, replenishing gravel and LWD at strategic locations, and diminishing disease prevalence is expected to collectively improve the survival probability for coho in the Shasta River population across the spectrum of life history stages, most particularly juveniles to smolt. Importantly, these combined effects of the assorted conservation actions are likely to result in returns of Shasta River adults at higher rates and increase productivity above current levels. The increase in survival probability across many life stages will compound benefits at the population level, with an expectant increase in population size of the coho emanating from the Shasta River. Overall, the conservation actions affecting the Shasta River Population unit will result in a net positive population level effect, and reduce extinction risk relative to current levels.

9.3 Scott River Population Unit

Life Stage Response- Adult Migration and Spawning

Because adults and juveniles from the Scott River Population utilize the mainstem Klamath River for migration and rearing (NMFS 2010), they can be affected by stressful conditions in the mainstem that are expected to continue to some degree during the ITP term as described for the Upper Klamath coho population. We do not anticipate the continued operations of the Project will result in adverse population effect on the adult life stage of Scott River coho. There is no indication that the Project adversely affects the ability of Scott River adults to reach their spawning grounds and successfully spawn. Project effects for this population are limited to effects on juveniles residing in the Upper and Middle Klamath reaches as described above for the Shasta River population. For reasons described for the Upper Klamath and Shasta River populations, implementation of an HGMP at the IGH can benefit the Scott River adult population by assisting in the maintenance of genetically diverse adults in the population, helping to ensure that adverse consequences of a very small population size on the genetic composition of the Scott River population is minimized to the maximum extent. Finally, as previously mentioned, wood added to the Klamath mainstem has the potential to provide cover habitat from predation for migrating Scott River population adults.

Life Stage Response- Egg to Smolt Survival

As noted with the Upper Klamath and Shasta River population life stage response discussion, throughout the ITP term Scott River coho juveniles are expected to experience degraded water quality conditions and incidences of disease outbreaks during the time juveniles take up residency in the Upper Klamath reach. Because we expect the Scott River will continue to suffer from degraded habitat conditions during the ITP term, we anticipate there will be continued reliance of Scott River coho on the Klamath River mainstem and associated non-natal tributaries for rearing. Like the Shasta River, a substantial proportion of the annual coho salmon fry and parr leave the Scott River and enter the Upper Klamath River reach of the mainstem Klamath River in the spring as irrigation diversions commence and sub-basin conditions become inhospitable (Chesney and Yokel 2003).

As described for the Upper Klamath population, to combat adverse Project related effects, the HCP proposes to implement a wide range of conservation measures to increase and enhance habitats for the juvenile to smolt life stage of coho. Although the conservation measures are primarily targeted to improve the viability of the Upper Klamath population, Scott River juveniles should experience benefits from these actions as well. Improving connectivity and increasing access to thermal refugia and productive tributary rearing sites, increasing dissolved oxygen levels below IGD, replenishing gravel and LWD at strategic locations, and diminishing disease prevalence is expected to collectively improve the survival probability of coho in the Scott River population across the juvenile to smolt life history stages.

Among other reasons, to further mitigate for adverse Project effects on Scott juveniles residing for periods of time in the Upper Klamath reach, PacifiCorp will fund actions that address currently limiting factors for abundance and productivity in the Scott River itself. Sites preliminarily targeted in the Scott for improvements to rearing habitat include Shackleford Creek, Mill Creek, French Creek, East Fork, and the mainstem of the Scott River. These tributaries have been known to support coho spawning activity, but are also known to suffer from disconnection during summer and early fall, resulting in unsuitable rearing conditions for juveniles. As described for the Shasta River life stage response discussion, the conservation measures outlined in the HCP to maintain connectivity and improve the quality of rearing habitat should result in increased foraging opportunities, improved water quality, increased cover habitat, and ultimately increased rates of juvenile survival. As with the Shasta River, the current state of poor connectivity and resultant poor water quality conditions during summer months in the Scott River mainstem and important tributaries is likely a significant cause for the large decline in this population, as high rates of juvenile mortality are experienced.

Efforts to protect and enhance suitable rearing habitat in the Scott River basin are highly needed at this time. The Scott River coho salmon population size is currently very low and overall unstable, currently only one brood year appears to be somewhat viable with adult returns nearing 1000, with the other two brood years significantly below the 441 spawners that are necessary to avoid the effects of low population sizes. At times, returns for these two brood years number below 100. Based on the criteria set forth by Williams et al. (2008), the Scott River population is at a high risk of extinction.

As we have discussed in the Upper Klamath population synthesis, numerous and assorted habitat access and improvement actions implemented throughout this geographic zone are intended to improve different facets of ecosystem function in the Scott River basin as well as the Klamath mainstem. Improving connectivity and increasing access to thermal refugia and productive tributary rearing and spawning sites, increasing dissolved oxygen levels below IGD, replenishing gravel and LWD at strategic locations, and diminishing disease prevalence are expected to collectively improve the survival probability for coho in the Scott River population across the spectrum of life history stages, most particularly juveniles to smolt. Importantly, these combined effects of the assorted conservation actions are likely to result in returns of Scott River adults at higher rates and increase productivity above current levels. The increase in survival probability across many life stages will compound benefits at the population level, with an expectant increase in population size of the coho emanating from the Scott River. Overall, the conservation actions affecting the Scott River population unit will result in a net positive population level effect and reduce extinction risk relative to current levels.

9.4 Middle Klamath River Population Unit

Life Stage Response- Adult Migration and Spawning

As described previously, gravel augmentation proposed in the HCP would also serve the dual purpose of contributing to scour events in areas within the Upper Klamath reach susceptible to the formation of disease conditions. NMFS does not anticipate infection of coho adults is contributing to the decline of the Middle Klamath population, therefore we do not anticipate reduction in disease outbreaks via gravel augmentation or flow variability will have an effect on Middle Klamath adults per se. The HCP would also add LWD to the Klamath mainstem, or provide LWD for tributary projects such as complex wood jams. Wood added to the Klamath mainstem, if placed in a floating raft-like structure, has the potential to provide cover habitat for migrating adults. Such instream cover has the potential to reduce predation on migrating adults from fish-eating birds such as osprey and bald eagle that can prey on average sized-adult coho.

Implementation of the interrelated HGMP will assist in the maintenance of genetically diverse adults in the population, helping to ensure that adverse consequences of small population size on the genetic composition of the population is minimized to the maximum extent practicable. Although hatcheries can produce individual adults that stray into non-natal streams and spawn with other natal adults resulting in potential for genetic cross-contamination, an HGMP can help to minimize this potential. NMFS expects that implementation of an HGMP will aid in maintaining genetic diversity of adults in the Middle Klamath population, allowing for diversity to be improved or maintained throughout the duration of the ITP.

Life Stage Response- Egg to Smolt Survival

Implementation of the HCP would target 28 coldwater refugia sites along the mainstem Klamath River for improvement and maintenance of habitat complexity and cover. There are seven (7) refugia sites identified in the Upper Klamath reach and 21 refugia sites identified in the Middle Klamath reach (see Figs. 2 and 3). These actions will be taken to maintain these sites as cover for rearing juveniles and to also enhance these sites through the addition of habitat features such as brush bundles or large woody debris. Other actions to be taken include increasing the extent and/or duration of nine coldwater refugia sites along the Klamath River (4 in the Upper Klamath and 5 in the Middle Klamath). These would include actions such as channel re-alignment, increasing flow to the refugia sites, or adding structures to the refugia sites. Although the HCP must contain flexibility in where actual project work will occur over the permit term, these refugia sites have been preliminarily identified as having the greatest potential for habitat improvements. In the Middle Klamath River reach, thermal refugia are considered habitat features that are critical to support coho salmon during the summer and early fall. Juvenile coho salmon rely on thermal refugia in summer and early fall when the Klamath River mainstem temperature is 19 $^{\circ}$C or warmer. During this period, refugia sites can be 2 to 6° C cooler than the mainstem (NRC 2004, Sutton et al. 2004). NMFS (2007) indicated that warmer temperatures in the summer and early fall reduce the ability of coho juveniles to use habitat in the mainstem during those periods. This may reduce growth or survival of juvenile coho redistributing into habitats in the mainstem.

All of these actions can result in enhanced survival from the juvenile to smolt life stage. These actions are expected to result in improvements to currently marginal habitat for coho, making them more suitable for rearing (e.g., better protected, cooler, and less temporary in nature). Other actions in the HCP targeted to increase connectivity in Middle Klamath tributaries will result in habitat being available to juvenile coho which might not otherwise occur. Such connectivity actions can include channel reconstruction, floodplain connection, or beaver introductions to restore tributary floodplain processes (e.g., pool development). Opening new habitat and expanding or enhancing existing habitat throughout the Middle Klamath reach can provide new foraging opportunities to juveniles, as well as provide new cover from high water temperatures, low DO conditions, or predators.

Effects of water management actions implemented in the mainstem Klamath River at IGD are expected to have minimal effect on individuals comprising the Middle Klamath Population unit. Inflow from tributaries downstream from Portuguese Creek dilutes the hydraulic signal produced by implementing the prescribed flow releases at IGD. We recognize that the Flow Variability Program and spring flow prescription will cause measurable physical effects into the upper portion of the Middle Klamath River reach, but these effects will be much less than occurs in the Upper Klamath River reach. Conditions allowing for the formation of habitat that supports disease conditions are not well understood in this reach as compared to the Upper Klamath reach where disease activity is highest. We anticipate the Flow Variability Program, particularly high winter flows, could help reduce conditions for disease outbreaks in the Middle Klamath reach should they form during the 10 year ITP term. Gravel augmentation efforts to scour channel substrate will occur in the Upper Klamath reach so gravel augmentation will likely not affect disease prevalence in the Middle Klamath reach.

Improving connectivity and increasing access to thermal refugia and productive tributary rearing sites, replenishing LWD at strategic locations, and reducing potential formation of disease conditions are expected to collectively improve the survival probability of coho in the Middle Klamath population across these life history stages. Importantly, over the permit term these combined effects of the assorted conservation actions are likely to result in returns of Middle Klamath population adults at higher rates and increase productivity above current levels. Further population level benefits are expected to accrue with the expansion of the population distribution afforded by providing access to productive habitats.

The mainstem habitat improvement and enhancement actions, including improvement of thermal refugia, will improve survival of juveniles while residing in the Middle Klamath River reach. At the population level, this will yield some level of increased juvenile abundance. Correspondingly, the number of smolts and returning adults will increase relative to production potential under current conditions. Furthermore, increased abundance is linked to increased population growth. However, we expect the increases in these population parameters to be modest for three reasons. First, the geographic scope of the actions is limited. Second, only the rearing juvenile life stage will benefit given the types of actions being implemented. Finally, due to the low abundance of this population, and generally favorable over-summer rearing habitat in the tributaries, relatively few juveniles are expected to rear in the mainstem Middle Klamath River (NMFS 2010). For these reasons, we do not expect substantive responses in any VSP parameter, and as a result we do not expect a measurable change in the extinction risk for this population unit with the proposed action.

9.5 Lower Klamath River Population Unit

We conclude that the proposed action will likely have a negligible effect on habitat availability and conditions for coho salmon within the Lower Klamath River reach. We also conclude that coho salmon will experience sufficient flows and water quality to meet their life history needs while in this reach. We therefore anticipate no adverse effects to the Lower Klamath River Population unit of coho salmon as a result of the Proposed Action.

Adverse effects associated with the continued operation of PacifiCorp’s Project will persist, but likely have no measurable effect on the Lower Klamath Population unit. Because the population resides so far from IGD, the signal from any hydrologic changes associated with Project operations (e.g., implementation of flow releases from IGD) will be diluted by tributary flow infusion over the Klamath River’s course.

The conservation actions that are implemented under the proposed action in this Lower Klamath River reach are directed at improving mainstem corridor habitat conditions for coho juveniles in this reach. Although the effects of the Project are negligible on adults, juveniles, and habitat conditions in the Lower Klamath River reach, these actions were selected to augment a strategy of improving rearing conditions for juvenile coho throughout the mainstem Klamath River. Although the HCP will target conservation actions to occur in the upper basin, funding for projects in the Lower Klamath reach may be necessary during the permit term if opportunities become limited in the upper basin for implementation. The mainstem habitat improvement and enhancement actions under the proposed action are expected to help improve survival of juveniles while residing in the Lower Klamath River reach. At the population level, this will yield some level of increased juvenile abundance. Correspondingly, the number of smolts and returning adults should increase relative to production potential under current conditions. Furthermore, increased abundance is linked to increased population growth. However, we expect the increases in these population parameters to be modest for two reasons. First, the geographic scope of the actions is limited. Second, only the rearing juvenile life stage will benefit given the types of actions being implemented. For these reasons, we do not expect substantive responses in any VSP parameter or a change in the extinction risk for this population unit with the proposed action.

9.6 Summary of Effects to the Interior-Klamath Diversity Stratum

The PacifiCorp HCP contains a strategy to minimize and mitigate Project adverse effects by implementing the *Coho Salmon Conservation Strategy*. The conservation strategy will both improve hydrologic dynamics in the mainstem Klamath River by more closely mimicking natural flow regimes, and improve a broad assortment of habitat conditions in the mainstem Klamath River and in select tributaries. The multifaceted array of habitat-based actions are expected to, in varying degrees, primarily increase survival across the egg-to-smolt life stages for coho salmon populations residing downstream from IGD. Those actions include: implementation of mainstem water management actions prescribed by the RPA in the NMFS 2010 Opinion; gravel and LWD augmentation; disease abatement actions; rearing habitat enhancements; actions to improve thermal refugia access and conditions; actions to reduce passage impediments to improve connectivity; actions to improve dissolved oxygen conditions below IGD; and interrelated actions to increase the number (due to increased survivability) and fitness of hatchery fish through the HGMP.

NMFS believes that the continued interim operation of PacifiCorp's Project under the proposed action, which will continue adverse effects on diversity stratum, in combination with the HCP conservation actions implemented under the proposed action, will result in a net positive effect on the affected populations' viability, and lower the risk of extinction for the Interior diversity stratum as the permit term progresses. We note that the improvements in VSP parameters will accrue to population units in the upper portion of the Klamath basin, e.g., the Upper Klamath, Shasta and Scott River population units. We expect that the Middle Klamath population unit will experience some improvement in early life stage growth and survival with targeted actions. However, we do not expect implementation of the HCP would result in substantive improvements to the overall viability of the Middle Klamath population. We do not anticipate significant improvements for Lower Klamath River population viability as the Project is not believed to adversely affect these populations, nor is there high likelihood that many conservation actions will take place in this population unit as there is little connection between the Project and the need to minimize and mitigate for Project effects.

9.7 Effects on SONCC Coho Salmon Evolutionarily Significant Unit Critical Habitat

9.7.1 Condition of Critical Habitat at the Evolutionarily Significant Unit Scale

Section 4 of this Opinion, *Status of the Species and Critical Habitat*, details the condition of critical habitat at the ESU scale. In summary, the current function of critical habitat of the SONCC coho salmon ESU has been degraded relative to its unimpaired state. Although there are exceptions, the majority of streams and rivers in the ESU have impaired habitat.

Additionally, critical habitat in the ESU often lacks the ability to establish essential features due to ongoing human activities. For example, large dams, such as IGD on the Klamath River, stop the recruitment of spawning gravels, which impacts both an essential habitat type (spawning areas) as well as an essential feature of spawning areas (substrate). Water utilization in many regions throughout the ESU reduces summer baseflows, which limits the establishment of several essential features such as water quality and water quantity.

9.7.2 Critical Habitat Condition within the Action Area

9.7.2.1 Current Condition and Function of Critical Habitat in the Upper Klamath River Reach

Section 5.4 of this Opinion, *Critical Habitat of Klamath Population Units*, describes our current understanding of the condition and functions of critical habitat for the Upper Klamath River population and will not be repeated here.

9.7.2.2 Consequences of Proposed Action on Critical Habitat Function in the Upper Klamath River Reach

The Proposed Action has the potential to affect the following four essential habitat types within the Upper Klamath River reach: juvenile rearing habitat, juvenile and adult migration corridors, and spawning habitat.

<u>Juvenile Rearing Habitat</u>

Generally, an abundance of habitat with velocities and depth suitable for coho salmon juveniles is predicted throughout the entire Upper Klamath River reach under flow releases as prescribed in the NMFS 2010 Opinion. NMFS (2010) concludes that, even during flow exceedence levels where habitat availability is not anticipated to be abundant (i.e., less than 80 percent), these flow management measures generally result in either similar or greater abundance of habitat with velocities and depth suitable for coho salmon juveniles than would occur in the absence of these measures.

The numerous and assorted habitat access and improvement actions implemented under the Proposed Action will improve several other facets of coho juvenile rearing habitat. Improving connectivity and increasing access to thermal refugia and productive tributary rearing sites, increasing dissolved oxygen levels below IGD, and replenishing gravel and LWD at strategic locations, will collectively improve rearing habitat conditions. The combined effects of the assorted conservation actions on rearing habitat conditions will increase the conservation value of critical habitat in the Upper Klamath reach and result in coho juvenile productivity above current levels.

<u>Adult and Juvenile Migration Corridors</u>

Both coho salmon adults and juveniles utilize the mainstem Klamath River as a migration corridor during the fall, with adults traveling upstream to natal spawning tributaries and coho salmon parr moving both upstream and downstream as they redistribute into winter habitat. Additionally, NMFS (2010) concludes that flow releases from IGD as prescribed by the 2010 Opinion will increase water depth and velocity during March, April, May and June (important periods for smolt emigration to the estuary) during most exceedence types. Water velocity is a critical factor likely influencing the speed at which coho salmon smolts move through the mainstem channel, and higher more natural velocities likely raise the conservation value of the mainstem Klamath River juvenile migration corridor. Water depth is an essential feature of migratory habitat with greater depths generally allowing easier access into tributary habitat. While higher water depths can enhance juvenile fish migration between mainstem and tributary habitat, the extent of this effect within the Klamath mainstem is uncertain at this time.

NMFS (2010) anticipates that RPA flows also will reduce juvenile transit time through areas of high disease infectivity as a result of increased flows below IGD. Higher velocities resulting from these flow releases are also expected to degrade the function and formation of slow "dead zones" within the channel that can harbor disease pathogens (Hardy et al. 2006), thereby reducing the overall impact of disease infection on coho salmon.

Habitat protection and enhancement projects implemented under the Proposed Action will improve connectivity and increase access to thermal refugia and productive tributary rearing and spawning sites. Little migration occurs within the coho salmon population during the months of July, August and September. The one exception is the observed migration between mainstem habitat and thermal refugia located near tributary confluences and within the lower sections of some creeks. Flow management measures implemented under the Proposed Action will result in greater water volumes during the summer, which will improve access by coho juveniles to thermal refugia and tributary rearing habitats.

Spawning Habitat

Gravel augmentation implemented under the proposed action will enhance spawning habitat in the Upper Klamath River reach, particularly in the reach between IGD and the confluence with the Shasta River where gravel augmentation is targeted to occur. NMFS (2010) indicates that coho salmon are predominantly tributary spawners and limited coho salmon spawning occurs in the Upper Klamath River reach, and that where spawning habitat occurs, gravel quality is suitable for successful spawning and egg incubation. The proposed action will expand these suitable spawning areas.

Water quantity is another essential feature that influences coho salmon spawning habitat. NMFS (2010) concludes that flow releases from IGD as prescribed by the RPA in the 2010 Opinion during the coho spawning period of November through January will ensure adequate water velocities and depths to support spawning. These flow management measures (to be implemented under the Proposed Action) also will ensure adequate water velocities and depths to support subsequent egg incubation within mainstem redds.

9.7.2.3 Current Condition and Function of Critical Habitat in the Middle Klamath River Reach

Section 5.4 of this Opinion, *Critical Habitat of Klamath Population Units*, describes our current understanding of the condition and functions of critical habitat for the Middle Klamath River population and will not be repeated here.

9.7.2.4 Consequences of Proposed Action on Critical Habitat Function in the Middle Klamath River Reach

The proposed action has the potential to affect the following four essential habitat types within the Middle Klamath River reach: juvenile rearing habitat, juvenile and adult migration corridors, and spawning habitat.

Juvenile Rearing Habitat

NMFS (2010) concludes that the flow releases from IGD as prescribed by implementation of the RPA will result in either similar or greater abundance of habitat with velocities and depth suitable for coho salmon juveniles than would occur in the absence of these measures. Juvenile rearing habitat within the Middle Klamath River reach is affected in much the same way as habitat within the Upper Klamath River reach, except the overall magnitude of effect is generally diminished because a higher percentage of the flow volume within the Middle Klamath River reach originates from tributaries and not IGD.

The habitat protection and enhancement projects implemented within the Middle Klamath River reach under the proposed action will improve different facets of coho juvenile rearing habitat. Improving connectivity to and conditions within thermal refugia and mainstem corridor rearing sites will collectively improve rearing habitat conditions. The combined effects of these conservation actions on rearing habitat conditions will increase coho juvenile productivity above current levels.

Adult and Juvenile Migration Corridors

As in the Upper Klamath River reach, habitat protection and enhancement projects implemented in the Middle Klamath River reach under the proposed action will improve connectivity and increase access to thermal refugia and productive tributary rearing and spawning sites. Little migration occurs within the coho salmon population during the months of July, August and September. The one exception is the observed migration between mainstem habitat and thermal refugia located near tributary confluences and within the lower sections of some creeks. Flow management measures implemented under the proposed action will result in greater water volumes during the summer, which also will improve access by coho juveniles to thermal refugia and tributary rearing habitats.

Spawning Habitat

NMFS (2010) concludes that mainstem coho salmon spawning is likely limited within most of the Middle Klamath River reach, the exception being a small number of coho salmon redds observed downstream of Indian Creek within the upper portion of the reach. Gravel augmentation implemented under the Proposed Action is not expected to enhance spawning habitat in the Middle Klamath River reach because gravel augmentation is targeted to occur mainly in the Upper Klamath River reach between IGD and the confluence with the Shasta River. In any event, NMFS (2010) indicates that spawning gravel composition is not limiting redd function with the Middle Klamath River reach, and that where spawning habitat occurs, gravel quality is suitable for successful spawning and egg incubation.

During the coho spawning period, NMFS (2010) concludes that flow releases from IGD as prescribed by the RPA will ensure adequate water velocities and depths to support spawning in the Middle Klamath River reach.

9.7.2.5 Current Condition and Function of Critical Habitat in the Shasta River Reach

Section 5.4 of this Opinion, *Critical Habitat of Klamath Population Units*, describes our current understanding of the condition and functions of critical habitat for the Shasta River population and will not be repeated here.

9.7.2.6 Consequences of Proposed Action on Critical Habitat Function in the Shasta River Reach

The proposed action has the potential to affect the following two essential habitat types within the Shasta River sub-basin: juvenile rearing habitat, and juvenile migration corridors.

<u>Juvenile Rearing Habitat</u>

The assorted habitat access and flow actions implemented in the Shasta River sub-basin under the Proposed Action will improve connectivity and increase access to productive tributary rearing sites, and improve habitat cover and complexity at rearing sites. These actions will collectively improve juvenile rearing habitat conditions. The combined effects on rearing habitat conditions of the assorted conservation actions should increase coho juvenile productivity above current levels.

<u>Juvenile Migration Corridors</u>

Habitat protection and enhancement projects implemented in the Shasta River sub-basin under the Proposed Action will improve connectivity and increase access to productive tributary rearing sites. The proposed action will not implement measures to improve adult migration corridors in the Shasta River sub-basin. The combined effects on migration corridor conditions of the assorted conservation actions will increase coho juvenile and spawning productivity above current levels.

9.7.2.7 Current Condition and Function of Critical Habitat in the Scott River Reach

Section 5.4 of this Opinion, *Critical Habitat of Klamath Population Units*, describes our current understanding of the condition and functions of critical habitat for the Scott River population and will not be repeated here.

9.7.2.8 Consequences of Proposed Action on Critical Habitat Function in the Scott River Reach

The Proposed Action has the potential to affect the following two essential habitat types within the Scott River sub-basin: juvenile rearing habitat, and juvenile migration corridors.

<u>Juvenile Rearing Habitat</u>

The numerous and assorted habitat access and flow actions implemented in the Scott River sub-basin under the Proposed Action will improve connectivity and increase access to productive tributary rearing sites, and improve habitat cover and complexity at rearing sites. These actions will collectively improve juvenile rearing habitat conditions. The combined effects on rearing habitat conditions of the assorted conservation actions will increase coho juvenile productivity above current levels.

Juvenile Migration Corridors

Habitat protection and enhancement projects implemented in the Scott River sub-basin under the Proposed Action will improve connectivity and increase access to productive tributary rearing sites. The proposed action will not implement measures to improve adult migration corridors in the Scott sub-basin. The combined effects on migration corridor conditions of the assorted conservation actions will increase coho juvenile productivity above current levels.

The Proposed Action improves the condition of several essential habitat types in the action area. Depending on the location of the action, mainstem or tributaries, essential habitat features will improve or be expanded. Habitat types that will improve include juvenile rearing habitat in the summer-winter and juvenile migration corridor in the spring.

Critical Habitat Analysis Not Applicable to the Lower Klamath River Reach

An assessment of current conditions of critical habitat and effects of the proposed action on critical habitat is not applicable to the Lower Klamath River reach. Because tribal land borders both banks of the Klamath River downstream of the Trinity River confluence, SONCC coho salmon ESU critical habitat is not designated within the Lower Klamath River reach.

9.7.3 Critical Habitat Response from Proposed Action at the Diversity Stratum and Evolutionarily Significant Unit Level

9.7.3.1 Condition of Critical Habitat of the Interior-Klamath Diversity Stratum

The current function of critical habitat in the Interior-Klamath Diversity Stratum is degraded relative to its unimpaired state. Sedimentation, low stream flows, poor water quality, stream habitat simplification, and habitat loss from poorly designed road crossings plague coho salmon streams in this stratum. Additionally, critical habitat in the Interior Diversity stratum often lacks the ability to establish essential features due to ongoing human activities. For example, IGD on the Klamath River stops the recruitment of spawning gravels, which impacts both an essential habitat type (spawning areas) as well as an essential feature of spawning areas (substrate). Water utilization in many regions throughout the diversity stratum (*e.g.,* Shasta and Scott Rivers) reduces summer baseflows, which limits the establishment of several essential features such as water quantity and water quality.

Given the continuance of Project related adverse effects on critical habitat during the permit, the diverse suite of habitat-related actions prescribed under the Proposed Action improves the condition of or access to juvenile rearing habitat, juvenile and adult migration corridors, and spawning habitat. We recognize the magnitude of beneficial effects varies across population units. The proposed action is designed to target specific problems identified in specific locales;

this dictates the number and types of conservation efforts implemented within the bounds of each population unit. NMFS expects that, on balance, the magnitude of the collective effect across all actions is sufficiently positive to improve the function of rearing, migration and spawning habitat for this diversity stratum. Furthermore, because the Interior diversity stratum is a critical component of the SONCC coho salmon ESU, we expect the improvements to critical habitat associated with the proposed action will contribute to the conservation of this ESU over the permit term.

X. CONCLUSION

After considering the best available scientific and commercial information, the current status of the SONCC coho salmon ESU, and its designated critical habitat, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects in the action area, it is NMFS' biological opinion that issuance of an ITP to PacifiCorp for the implementation of the PacifiCorp HCP as proposed, is not likely to jeopardize the continued existence of the SONCC coho salmon ESU and is not likely to result in the destruction or adverse modification of SONCC coho salmon ESU critical habitat.

XI. 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.

Section 7(b)(4)(i) of the ESA provides that an incidental take statement must specify the impact of such incidental taking on the species [16 U.S.C. § 1536(b)(4)(i)]. The joint consultation regulations further provide that the incidental take statement must specify the impact, *i.e.*, the amount or extent of incidental taking that would occur under the Federal action [50 CFR § 402.14(i)(1)(i)]. In order to monitor the impacts of the incidental take, the applicant must report to NMFS on the progress of the action and its impacts on covered species, as specified in the incidental take statement [50 CFR § 402.14(i)(3)]. If during the course of the action, the impact on the species contemplated in the biological opinion is exceeded, reinitiation of consultation must occur [50 CFR § 402.14(i)(4) and 50 CFR § 402.16].

Under section 10(a)(1)(B) of the ESA, habitat conservation plans are developed and incidental take permits are approved under criteria similar to those addressed by an incidental take statement following consultation under ESA section 7. A habitat conservation plan must, among other things, specify the impact of the take on covered species and minimize and mitigate the impacts of such take so that, ultimately, such taking will not appreciably reduce the likelihood of survival and recovery of the species in the wild [16 USC §§ 1539(a)(2)(A) and (a)(2)(B)]. The proposed HCP and its associated documents clearly identify the anticipated impacts to affected species likely to result from incidental taking and the measures that are necessary and appropriate to minimize and mitigate those impacts. The proposed action, issuing the ITP, does not cause incidental take, nor does it permit the underlying activities that cause the incidental take. The ITP only authorizes the incidental take that occurs as a result of conducting the otherwise lawful covered activities that are described in the ITP and conducted according to the conditions required by the ITP.

11.1 Amount or Extent of the Take

The incidental take that is the subject of the proposed permit and addressed in the HCP occurs mostly in the form of harm, where habitat modification from continued Project operations and maintenance activities, despite minimization and mitigation measures implemented via the HCP, will impair normal behavior patterns of SONCC ESU coho salmon to an extent that actually injures or kills them at some point in time. The activities that cause the habitat modification and the extent of anticipated habitat modification from implementation of the proposed HCP is summarized below.

NMFS is unable to accurately predict how many individuals of a particular life stage will be taken via habitat modification or impairments from HCP covered activities throughout the action area for the entire permit term. The natural variability in salmonid population parameters (*e.g.*, abundance, productivity, *etc.*) make it impractical to attribute or determine the numbers of individuals taken arising from the remaining covered activities given their scale, both temporally and spatially, and the indirect and cumulative nature of their effects on salmonids. For example, (1) it can be difficult to separate the impact on the species arising from human-induced habitat modification from the impact on the species arising from naturally-occurring, and often stochastic, watershed processes that form a wide distribution of habitat conditions; (2) salmonids possess complex life histories, with multiple life stages that rely on a broad range of habitat conditions, both spatially and temporally; (3) salmonids exhibit high natural mortality rates in the wild, and it is exceedingly difficult to first detect distinct instances of mortality, and then attribute mortality to specific actions affecting habitat conditions; and (4) habitat conditions vary over time and space due to natural and human-induced factors, and it is difficult to predict where and when salmonids may experience such habitat conditions and whether those conditions will lead to take. In view of these complexities, NMFS relies on habitat-based surrogates to identify the amount or extent of anticipated take associated with the proposed action and known Project effects which could indicate an exceedance in authorized take and trigger the need to reinitiate consultation for this proposed action.

NMFS will use habitat-based surrogates to address the stressors that NMFS identified in the Opinion as likely to result in take: (1) Project contributions to altered flow in the Klamath mainstem affecting mainstem rearing habitat, (2) Project contributions to poor water quality conditions downstream of IGD affecting juvenile growth and survival, and (3) Project contributions to formation of habitat causing disease outbreaks. Although continued blockage of suitable spawning and rearing habitat upstream of IGD was identified as a stressor in this Opinion, any incidental take resulting from this stressor would occur downstream from IGD. Under the terms of the ITP, the Project will continue to contribute to altered habitat conditions downstream of IGD as described and discussed in Section VI *Effects of the Action* in this Opinion. As mentioned in this Opinion, HCP projects funded by the coho enhancement fund that will involve instream work where coho may be exposed to project stressors will undergo separate permitting actions as project plans become finalized and authorized for funding. At that time, any anticipated take associated with such projects would undergo separate consultation with corresponding analysis of the expected amount and extent of take. NMFS cannot express the amount or extent of any take associated with implementation of HCP conservation measures funded by the coho enhancement fund as numbers of individuals exposed to conservation measure stressors (e.g., instream modification of habitat) cannot be adequately predicted due to the nature of projects occurring in as yet to be determined final project sites, as well as the nature of coho distribution varying in space and time with currently unknown project-related stressors. The authorized take associated with the Project's effect on habitat downstream of IGD is presented below.

1. Extent of authorized take for harm to habitat associated with an altered springtime flow regime:

    a. Even with PacifiCorp's cooperation in implementing RPA flows from the NMFS 2010 Opinion, NMFS expects the reach between IGD and the confluence with the Scott River will be affected by Reclamation's Project from an altered flow regime during March-June flows. As was described in the NMFS 2010 Opinion, we expect that implementation of RPA flows will continue to affect smolt travel times in the affected reach making travel times slower as compared to an unaltered system (NMFS 2010). NMFS expects that PacifiCorp will achieve estimated travel times contained in Table 20 of the 2010 Opinion below IGD, to the extent that Reclamation provides sufficient flows under the terms of the NMFS 2010 Opinion, or the requirements of any future consultations between NMFS and Reclamation during the ITP term. NMFS monitors compliance with the 2010 NMFS Opinion via coordination with Reclamation on flows to ensure that RPA requirements are being achieved. This coordination, to include PacifiCorp, will continue during the proposed action permit term in order to monitor the achievement of target flows. The extent of authorized take will be exceeded if PacifiCorp fails to achieve estimated travel times contained in Table 20 of the 2010 Opinion below IGD, except for short-term deviations due to required maintenance actions, safety concerns, operational limitations, or other similar short-term interruptions.

    b. PacifiCorp's cooperation with Reclamation in the implementation of the NMFS 2010 RPA flows in the March-June period will result in improvements in habitat availability during select average and wetter hydrologic periods. We expect that PacifiCorp will achieve estimated habitat levels contained in Table 19 of the 2010 Opinion below IGD, to the extent that Reclamation provides sufficient flows under the terms of the NMFS 2010 Opinion, or the requirement of any future consultations between NMFS and Reclamation during the ITP term. The extent of authorized take will be exceeded if PacifiCorp fails to achieve estimated habitat levels contained in Table 19 below IGD, except for short-term deviations due to required maintenance actions, safety concerns, operational limitations, or other similar short-term interruptions.

2. Extent of authorized take for harm to habitat associated with impaired water quality:

   NMFS expects that the Project will continue to periodically contribute to lower DO conditions for a distance of up to six (6) miles downstream of IGD. We expect that in the time period between June 15 and September 30 in any given year of the permit, DO in this reach of the mainstem could fall to levels as low as 5.5 mg/L and drop below 85% saturation. We expect this low DO condition could occur for up to 7 days prior to the achievement of improved DO conditions with implementation of conservation measures. The conservation measures to improve DO are expected to increase DO levels to above 7.0 mg/L and greater than 85% saturation. We do not expect low DO beyond September 30th in most years of the permit term to result in harmful conditions for exposed juveniles as fall precipitation is expected to result in river mixing and increasing DO concentrations. Therefore, the extent of authorized take will be exceeded if DO in the reach from IGD to six miles below IGD remains below 85% saturation for longer than 7 consecutive days during the period of June 15-September 30. This period reflects when coho salmon are expected to be present and likely to be adversely affected by Project Operations.

3. Extent of authorized take for harm to habitat associated with impaired water temperatures:

   NMFS anticipates the "thermal lag" conditions downstream of IGD will continue throughout the permit term. The thermal lag effect is expected to ameliorate by the time flows reach the Shasta River confluence. Of primary concern for adverse effects on juvenile coho are elevated water temperatures during the summer period. The extent of authorized take will be exceeded if the Project is determined to be a primary cause in increases in mean weekly minimum water temperatures (MWMT) below Iron Gate dam of more than 4ºC during the period of June 15-September 1 throughout the permit term. This period reflects when coho salmon are expected to be present and likely to be adversely affected by Project Operations. The increases in temperature will be evaluated through comparisons of the MWMT at the monitoring station upstream of the hatchery bridge and selected down-river reference sites as described in the HCP.

4. Extent of authorized take for harm to habitat that leads to disease forming conditions and disease outbreaks:

NMFS expects the Project will continue to contribute to the formation of habitat conditions downstream of IGD that lead to disease outbreaks within juvenile coho residing in the upper basin. NMFS expects the area of potential disease outbreaks to occur in the reach from IGD to the confluence with the Shasta River. Our expectation is that, with implementation of conservation measures designed to reduce the extent and severity of disease outbreaks, the zone prone to disease formation conditions will diminish as the permit term progresses. Physical and biological mechanisms influencing disease dynamics within the Klamath River are myriad and complex. Thus, it is difficult to estimate the amount or extent of take resulting from this stressor expected to remain following implementation of conservation actions intended to diminish the habitat conditions that lead to disease outbreaks. However, the higher flow and habitat quantity, combined with the implementation of the Fall/Winter Flow Variability Program required through the RPA in NMFS (2010) are expected to directly address and lower disease incidence within the Klamath River juvenile coho salmon population from IGD to the confluence with the Shasta River. The fish disease research conducted with funds from the HCP may also help guide river management decisions to alleviate the incidence of fish disease in the Klamath River. Therefore, NMFS has provided a habitat surrogate for the amount or extent of authorized take of coho salmon as a result of disease forming conditions and disease outbreaks through the use of flow habitat indicators described in 1a and 1b above, which have a direct effect on this source of incidental take.

11.2 Effect of the Take

As previously described, NMFS expects that habitat conditions will gradually improve as implementation of the HCP and its conservation strategy to minimize and mitigate Project effects on coho occurs, and that watershed processes important for the survival and recovery of SONCC ESU coho salmon will gradually improve leading to improvements in suitable spawning and rearing habitat. In this Opinion, NMFS has determined that this level of anticipated incidental take is not likely to result in jeopardy to the SONCC coho salmon ESU or destruction or adverse modification of its designated critical habitat.

11.3 Reasonable and Prudent Measures

The applicant will minimize the extent of incidental take by implementing the following Reasonable and Prudent Measures discussed below under Terms and Conditions.

11.3.1 Terms and Conditions

All conservation measures and monitoring and adaptive management measures described in the final HCP (PacifiCorp 2012), together with the terms and conditions described in the associated Implementation Agreement and the Section 10(a)(1)(B) permit issued with respect to the HCP, are hereby incorporated by reference as reasonable and prudent measures and terms and conditions within this Incidental Take Statement. Additional terms and conditions associated with the issuance of an ITP include the following:

1. Within one year of permit issuance, PacifiCorp shall submit to NMFS for review and approval a water quality monitoring plan. The water quality monitoring plan must include the following:

   A. For Turbine Venting and DO monitoring:

      a. Protocols for hourly monitoring of DO (in percent saturation) below Iron Gate dam (at the station upstream of hatchery bridge).
      b. Procedures to assess data relative to the surrogate level as described in 2a above.
      c. Protocol and procedures for steps to take if and when monitoring data indicate the DO target is not being met at the primary sampling station near the hatchery bridge, and steps that will be taken to assess whether and how coho may be affected based on a literature review of likely coho sensitivities to DO concentrations.
      d. Preliminary identification of additional sampling locations within a six mile reach downstream of IGD to determine the extent of DO conditions that fail to meet the DO 85% saturation take threshold described in 2a above. The Plan should be explicit on how and when additional sampling efforts will be initiated to determine the extent of low DO.
      e. Procedures to be implemented to assess whether and how exceedences of the take surrogate may be related to Project operations, including if applicable a determination of potential operations/technical adjustments needed (e.g., changes to venting/blower settings; reservoir drawdown, spill patterns).
      f. Procedures for reporting annual monitoring results to NMFS.

   B. For water temperature monitoring:

      a. NMFS and PacifiCorp will jointly determine a down-river reference sampling location (e.g. Orleans) that is considered outside the influence of the Project for MWMT comparisons.
      b. Procedures used for hourly monitoring of water temperature below Iron Gate dam (at the station upstream of hatchery bridge) and at the selected down-river site.
      c. Procedures used to assess data relative to the surrogate level in 3A above.
      d. Procedures to be used to determine if and when monitoring data indicates the surrogate is not being met, and steps that will be taken to assess whether and how coho may be affected based on literature review of known coho sensitivities to water temperature, and assessment of potential extent and duration of habitat effects.

e. Procedures used to assess whether and how exceedances of the surrogate may be related to Project operations (based on coincident reservoir and powerhouse operations information; modeling information).
f. The steps to be taken to confer with NMFS on changes to priorities of HCP actions, including additional funding for actions, if needed.
g. Procedures for reporting annual monitoring results to NMFS.

2. In addition to funding disease research as outlined in the HCP, PacifiCorp will provide an annual summary report to NMFS on the upcoming research projects anticipated to be funded through the HCP conservation strategy, a synopsis of any significant findings from previously funded research, and any preliminary conclusions which may be drawn from research findings on how and where disease outbreaks may be affected by implementation of the HCP conservation strategy (e.g., effects of improved flows or gravel augmentation).

3. NMFS has determined the Gravel Augmentation Program will result in conservation benefits to coho salmon and its designated critical habitat. However, NMFS expects that while the Gravel Augmentation Program will mitigate, in part, Project effects on gravel transport, the Project will continue to have a net adverse effect and continue to retain gravel that would otherwise provide spawning habitat downstream of IGD as well as provide an ecological role in scour flows that can disrupt the formation of bedload conditions downstream of IGD that lead to disease outbreaks. NMFS is not capable of quantifying the extent of these effects as there are limited data to indicate the volume of gravel likely to be retained over the period of the HCP. In addition, given the dynamic nature of the riverine environment downstream from IGD, it is not possible to establish a habitat-based surrogate for any potential take from such effects. However, to minimize the potential for take associated with blockage of gravel at IGD, NMFS has developed the following term and condition to ensure mitigation for gravel effects occurs to the maximum extent practicable:

   a. Within one year of permit issuance, PacifiCorp shall submit to NMFS for review and approval, a draft gravel augmentation plan. The gravel augmentation plan must provide preliminary locations of sites determined to be suitable for gravel augmentation, including an assessment of existing bedload conditions, the objectives for specific gravel placement projects, the amount of gravel to be placed in the location (s), and procedures to be implemented to ensure gravel placement has been placed according to project plans and specifications.

4. PacifiCorp will provide to NMFS an annual report that describes how much LWD was trapped at Project facilities and how the transport of the LWD was in compliance with the HCP. Included in this report should be a synopsis of the size of LWD transported, and where and when it was placed downstream of IGD.

Such terms and conditions are nondiscretionary and must be undertaken for the exemptions under section 10(a)(1)(B) and section 7(o)(2) of the ESA to apply. If the permittee fails to adhere to these terms and conditions, the protective coverage of the section 10(a)(1)(B) permit and section 7(o)(2) may lapse. The associated reporting requirements and provisions for disposition of dead or injured animals are as described in the HCP and its accompanying section 10(a)(1)(B) ITP.

XII. 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 the 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, or to develop additional information. NMFS has not identified any additional conservation recommendations at this time in view of the measures contained in the proposed conservation plan.

XIII. REINITIATION OF CONSULTATION

This concludes formal consultation on the actions and processes described in the proposed HCP and Chapter II, *Description of the Proposed Action*, of this Opinion. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the extent of incidental take (described in Section 11.1 of this Opinion) is exceeded, (2) new information reveals effects of the agency action may affect listed species or critical habitat in a manner or to an extent not considered in the Opinion, (3) the agency action is modified in a manner that causes an effect to the listed species or critical habitat not considered in the Opinion, or (4) a new species (not a covered species) is listed or critical habitat designated that may be affected by the action. In instances where the extent of incidental take is exceeded, consultation shall be reinitiated immediately.

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APPENDIX A

HCP MONITORING AND ADAPTIVE MANAGEMENT

VIII. Monitoring and Adaptive Management

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

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

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

Compliance Monitoring

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Effectiveness Monitoring

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

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

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

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

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

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

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

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

Adaptive Management

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

Technical Review Team

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

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

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

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

Adaptive Responses Process

Circumstances Triggering Adaptive Responses

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

1. A particular objective cannot be implemented as planned

2. Effectiveness monitoring indicates that an objective is not effective

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

Guidelines for Types of Adaptive Responses

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

Adaptive Response Decision-Making

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

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

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

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

Costs for Implementing Adaptive Management Actions

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

APPENDIX B

ESSENTIAL FISH HABITAT ASSESSMENT

ESSENTIAL FISH HABITAT ASSESSMENT

Action Agency

National Marine Fisheries Service (NMFS)

Project Name

Authorization for Incidental Take and Implementation of the PacifiCorp Klamath Hydroelectric Project Interim Operations Habitat Conservation Plan for Coho Salmon

Essential Fish Habitat Background

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended, requires Federal agencies, including NMFS itself, to consult with NMFS on activities that may adversely affect Essential Fish Habitat (EFH).

The objective of this EFH assessment is to determine whether or not the proposed action “may adversely affect” designated EFH for relevant commercially, federally-managed fisheries species within the proposed action area. Designated EFH for both Chinook and Coho salmon exist in the action area. It also describes conservation measures proposed to avoid, minimize, or otherwise offset potential adverse effects to designated EFH resulting from the proposed action.

Description of the Project/Proposed Activity

NMFS’ proposed action in this intra-service EFH consultation is the issuance of an Incidental Take Permit (ITP) by NMFS under Section 10(a)(1)(B) of the Endangered Species Act (ESA) of 1973, as amended, to PacifiCorp Energy (PacifiCorp) for PacifiCorp’s implementation of the Klamath Hydroelectric Project Interim Operations Habitat Conservation Plan (HCP) for Coho Salmon (PacifiCorp 2011), for a period of 10 years. The Southern Oregon/Northern California Coast (SONCC) coho salmon evolutionarily significant unit (ESU) is listed as threatened under the ESA, and Project operations are likely to result in incidental take of coho salmon during the 10-year period under consideration.

Hydroelectric generation is the primary activity conducted at Project facilities, with the exception of the Keno development, which does not include power-generating equipment. Iron Gate Dam (IGD) is the Project dam furthest downstream on the Klamath River, and it blocks anadromous fish migration to spawning and rearing habitat in the Upper Klamath River. Activities covered under the ITP ("Covered Activities") that may result in the incidental take of SONCC coho include those activities that are necessary to operate and maintain Project facilities during the interim 10-year period of Project operations, as well as certain mitigation and conservation measures identified in the HCP (PacifiCorp 2011). Detailed descriptions of Project facilities and their operations and HCP coho conservation measures are provided in Chapter IV (Current Conditions) of the HCP (PacifiCorp 2011) and have been summarized in section II *Description of the Proposed Action* of the Biological Opinion associated with this proposed action.

The HCP, developed with technical assistance from NMFS, includes a series of conservation measures to minimize and mitigate the effects of operations and maintenance of the Project on listed coho salmon during the 10-year period of the ITP. Projects and actions that will be implemented over the term of the ITP at selected locations in the Upper and Middle Klamath River reaches, and the Scott and Shasta Rivers (major tributaries to the Klamath River), are targeted at meeting the following biological goals to offset Project effects on coho salmon:

- Goal I: Offset biological effects of blocked habitat upstream of IGD by enhancing the viability of the Upper Klamath coho salmon population.
- Goal II: Enhance coho salmon spawning habitat downstream of IGD.
- Goal III: Improve instream flow conditions for coho salmon downstream of IGD.
- Goal IV: Improve water quality for coho salmon downstream of IGD.
- Goal V: Reduce disease incidence and mortality in juvenile coho salmon downstream of IGD.
- Goal VI: Enhance migratory and rearing habitat for coho salmon in the Klamath River mainstem corridor.
- Goal VII: Enhance and expand rearing habitat for coho salmon in key tributaries.

Section II of the Biological Opinion details project objectives and targets to meet these goals, and Section VI *Effects of the Action* in the Opinion describes how HCP projects are expected to beneficially affect coho salmon populations in the Klamath River. In summary, most conservation projects are targeted to improve juvenile survival (the life stage most impacted by the Project) in the Upper Klamath, Middle Klamath, Scott and Shasta River independent populations of coho during the 10-year permit term. These populations are included in the Interior diversity stratum, one of seven diversity stratum that comprises the ESU. Currently, none of the diversity stratum is considered viable by NMFS.

Improvements in juvenile survival are expected to primarily occur through improvements in river flow management, improvement in water quality through reductions in low dissolved oxygen conditions, protection and enhancement of critical summer juvenile refugia habitat, actions taken to reduce the extent and severity of disease outbreaks that infect juveniles, improvements in hatchery practices at Iron Gate Hatchery, actions to gain access to currently blocked habitat, and efforts to restore and maintain connectivity between juvenile rearing habitat in systems suffering from the effects of inadequate summer flow.

Potential Adverse Effects of Proposed Project/Action

Designated EFH for both Chinook and coho salmon occurs in the following five watersheds, which overlap with the Action Area described in the Biological Opinion: Upper Klamath River, Middle Klamath River, Shasta River, Scott River, and Lower Klamath River. Adverse effects to Salmon EFH occur in some, but not all of these watersheds and are discussed below.

Adverse Effects to GroundFish EFH

Project related effects (adverse and beneficial) are not expected to affect the Klamath River estuary or offshore benthic habitat, therefore, NMFS anticipates no adverse effects to groundfish EFH. A complete list of the species covered under the Groundfish EFH can be found at http://marinehabitat.psmfc.org/.

Adverse Effects to Coastal Pelagics EFH

Project related effects (adverse and beneficial) are not expected to affect the Klamath River estuary or nearshore coastal habitat, therefore, NMFS anticipates no adverse effects to Coastal Pelagics EFH. A complete list of species covered under the Coastal Pelagics EFH can be found at http://www.psmfc.org/efh/pelagic_efh.html.

Adverse Effects to Salmon EFH

Adult Migration Pathways

Adverse effects to coho adult migration pathways have been described in the Biological Opinion in Section VI *Effects of the Action*. Essentially, Iron Gate Dam will continue to block access to approximately 58 miles of coho habitat in the Upper Klamath River reach during the 10-year permit term. Below IGD, NMFS expects that issuance of an ITP to PacifiCorp for the implementation of the HCP is expected to improve adult migration pathways for coho, and likely also Chinook salmon, whose migration corridors overlap with coho in the Klamath mainstem. Improvements of the flow regime as expected to occur with HCP implementation, are expected to be adequate for Chinook and coho migration in the mainstem of the Klamath. Opening of new habitat currently blocked by anthropogenic causes (e.g. culverts, excessive sedimentation, etc…) have the potential to expand migratory habitat to new spawning grounds. Although coho is the target species for such actions, in low gradient watersheds, Chinook may also benefit.

The continued presence of reservoirs upstream of IGD for the 10-year permit term will continue to cause a “thermal lag” of water temperatures released from Iron Gate dam. The natural seasonal trend of cooling temperatures in the fall is expected to be “lagged” about 2 to 4 weeks. This thermal lag may affect the timing (or periodicity) of migrating adult fall Chinook salmon below Iron Gate dam and could cause habitat conditions to be less than suitable for Chinook migration. As such, continued operations of the Project may result in continued adverse effects on designated EFH for this species. NMFS believes that the extent of Project related temperature effects during Chinook migration is generally confined to the mainstem above the confluence with the Shasta River. Below the point, tributary inputs to the mainstem ameliorate Project effects. However, for coho NMFS does not conclude that the temperature-related effects of the Project adversely affect coho migration as coho migrate later in the season when fall precipitation has been sufficient enough to cool water temperatures to suitable conditions.

The Project does not affect the Shasta and Scott Rivers, nor does NMFS believe Project effects extend to the Lower Klamath River reach. Implementation of the HCP will result in beneficial actions in these systems and NMFS concludes that Chinook and coho EFH for migration pathways in the Shasta, Scott, and Lower Klamath River will not be adversely affected by the proposed action.

Spawning and Incubation

Adverse effects to coho spawning and incubation habitat has been described in the Biological Opinion in Section VI *Effects of the Action*. Chinook and coho salmon are known to spawn in the Klamath River mainstem where suitable spawning habitat exists (e.g., clean and appropriately sized gravels for redd building). Spawning and incubation habitat in the mainstem Klamath River will continue to be adversely affected by the trapping of sediment and spawning gravels behind IGD during the permit term. However, this adverse Project related effect will be mitigated for by gravel augmentation efforts planned in the HCP. Gravel will be placed in suitable locations downstream of IGD to not only improve the availability of mainstem spawning habitat but to also attempt to reduce the extent and severity of disease outbreaks caused by altered flows and lack of gravels that can contribute to bedload scour disturbing river bed conditions that lead to disease outbreaks. The HCP conservation measures in combination are expected to improve spawning and incubation habitat above baseline conditions throughout the permit term below IGD. Besides short-term adverse effects to EFH which may occur when gravels are placed in the mainstem (e.g. turbidity), NMFS expects as a result implementation of the HCP EFH below IGD will be improved for coho and Chinook spawning and incubation.

As explained in section VI of the Opinion, implementation of the HCP would result in primarily beneficial effects from conservation measures carried out in the Scott and Shasta Rivers, therefore, NMFS does not anticipate adverse effects to spawning and incubation EFH habitat in the Scott and Shasta Rivers, nor do we anticipate adverse effects to EFH in the Lower Klamath River reach.

Stream Rearing Habitat

Section VI of the Opinion details NMFS' analysis of proposed action effects on stream rearing habitat in EFH reaches. In summary, although continued adverse effects from the Project will occur over the interim permit period, as compared to baseline conditions, NMFS anticipates implementation of the HCP will result in overall improvements to stream rearing habitat in the Upper and Middle Klamath mainstem reaches, as well the Scott and Shasta Rivers. Protection, enhancement, and restoration of rearing habitat as proposed in the HCP are expected to increase the conservation value of habitats currently in conditions that are likely not properly functioning for the conservation of coho. Although Chinook juveniles have much less residence time in the Klamath River, as compared to coho, improvements to rearing conditions for coho can also provide benefits to Chinook that may utilize the same habitat at some point in their early life stage.

There may be short term adverse effects associated with the construction phase of the proposed restoration projects, but anticipated improvements in habitat are expected to improve EFH for stream rearing overall.

Smolt Migration Pathways

NMFS believes the continued adverse Project effects on summer rearing can also affect smolt habitat in many of the same ways. However, as with summer rearing habitat, NMFS believes that overall, there will be improvements to smolt migration habitat with implementation of the HCP. See the discussion above for summer rearing habitat. Most importantly, reducing disease outbreaks is expected to have the most benefits for Chinook and coho smolts utilizing the Klamath mainstem in its upper reaches.

Estuarine Habitat

There are no adverse effects to Salmon EFH Estuarine Habitat from the Project. Adverse effects from Project activities are ameliorated to an undetectable level before reaching any estuarine habitat.

Marine Habitat

There are no adverse effects to Salmon EFH Marine Habitat from the Project. Adverse effects from Project activities are ameliorated to an undetectable level before reaching any marine habitat.

EFH Conservation Measures

Proposed conservation measures described in the HCP will minimize the potential adverse effects to EFH by improving rearing habitat, improving spawning habitat, increasing dissolved oxygen concentrations, and continuing to improve flow variability through the implementation of the RPA flows in NMFS' 2010 BiOp for Reclamation's Klamath Project operations. These activities and effects are described in detail in the 2012 NMFS Opinion for this Project. Therefore, at this time NMFS is not proposing additional conservation measures.

Conclusion

With issuance of an ITP there will continue to be adverse Project effects to spawning and incubation habitat, smolt migration pathways and rearing habitat in the Klamath mainstem during the 10-year permit term. However, implementation of the HCP and associated conservation measures will mitigate and minimize adverse effects resulting in improved EFH habitat in the Upper and Middle Klamath, Scott and Shasta Rivers as compared to baseline (no ITP) conditions.