RECLAMATION

Managing Water in the West

Final Biological Assessment and Essential Fish Habitat Determination on the Proposed Removal of Four Dams on the Klamath River

U.S. Department of the Interior
Bureau of Reclamation

August 2012

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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Abbreviations and Acronyms

Abbreviation/Acronym	Definition
ac	acres
AFA	*Aphanizomenon flos-aquae*
AMPA	aminomethyl phosphonic acid
ASR	Aquatic Scientific Resources
BA	Biological Assessment
BKD	bacterial kidney disease
BLM	Bureau of Land Management
BMIs	Benthic Macroinvertebrates
BMP	Best Management Practice
BO	Biological Opinion
BOD	Biological Oxygen Demand
BRTs	Biological Review Teams
C	Celsius
CAS	California Academy of Sciences
CDFG	California Department of Fish and Game
CDWR	California Department of Water Resources
CEQA	California Environmental Quality Act
cfs	Cubic feet per second
Chl-a	Chlorophyll-a
CHU	Critical Habitat Unit
CI	Confidence Interval
CINWCC	California Interagency Noxious Weed Coordinating Committee
cm	centimeter
cms	Cubic meters per second
CNDDB	California Natural Diversity Database
COLD	cold freshwater habitat
CWA	Clean Water Act
CWQG	Canadian Water Quality Guidelines
D16	the substrate particle diameter where 16% of the material is finer than
DEQ	Department of Environmental Quality
Detailed Plan	Detailed Plan for Facilities Removal
DOI	United States Department of the Interior
DPS	Distinct Population Segment
DRE	Dam Removal Entity
EDRRA	Evaluation of Dam Removal and Restoration of Anadromy
EEZ	Exclusive economic zone
EFH	Essential Fish Habitat
EIS/EIR	Environmental Impact Statement/Environmental Impact Report

Abbreviation/Acronym	Definition
ENSO	El Niño Southern Oscillation
EOG	electro-olfactogram
EPA	United States Environmental Protection Agency
EPIC	Environmental Protection Information Center
ESA	Endangered Species Act
ESA	Federal Endangered Species Act
ESU	Evolutionary Significant Unit
F	Fahrenheit
FERC	Federal Energy Regulatory Commission
Four Facilities	J.C. Boyle, Copco 1, Copco 2, and Iron Gate dams
FR	Federal Register
ft	feet
ft/day	foot per day
ft^2	Square feet
GEC	Gatherd Engineering Consultants
GIS	Geographic information system
ha	hectares
Ich	*Ichthyophthirius*
IGH	Iron Gate Hatchery
IHN	Infectious Haematopoietic Necrosis
IM	Interim Measure
in	inch
IOD	Immediate Oxygen Demand
IPCC	Intergovernmental Panel on Climate Change
ISAB	Independent Scientific Advisory Board
KBRA	Klamath Basin Restoration Agreement
kg	kilogram
KHP	Klamath Hydroelectric Project
KHSA	Klamath Hydroelectric Settlement Agreement
km	kilometer
KPSIM	Klamath Project Simulation Model
KRTT	Klamath River Technical Team
KRWQM	Klamath River Water Quality Model
kV	kilovolt
KW	kilowatts
lb/yd^3	pounds per cubic yard
lbs	pounds
LC50	lethal concentration at which 50% of test animals die in 96 hours
LRD	Lost River Diversion
LRD	Lost River Diveristy
LRS	Lost River suckers
LWD	Large woody debris

Abbreviation/Acronym	Definition
m	meters
m^2	square meters
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation and Management Reauthorization Act
MDN	marine-derived nutrients
mg	milligram
mg/L	milligram per liter
µg/L	micrograms per liter
mi	mile
min	minute
mm	millimeters
MMPA	Marine Mammal Protection Act
MMPA	Marine Mammal Protection Act
mph	miles per hour
MW	Megawatts
MWMT	Maximum Weekly Maximum Temperature
NCRWQCB	North Coast Regional Water Quality Control Board
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPGO	North Pacific Gyre Oscillation
NRC	National Research Council
NSO	Northern Spotted Owl
ODFW	Oregon Department of Fish and Wildlife
OEHHA	Office of Environmental Health and Hazard Assessment
PCBs	polychlorinated biphenyls
PCEs	Primary Constituent Elements
PDO	Pacific Decadal Oscillation
PECDF	penta-chlorodibenzofuran
PIT	Passive Integrated Transponder
PP&L	Pacific Power and Light
ppt	parts per thousand
Proposed Action	Full Facilities Removal of Four Dams Alternatives
psi	Pound per square inch
PUC	Public Utilities Commission
RBDD	Red Bluff Diversion Dam
Reclamation	Bureau of Reclamation
RM	River Mile
ROD	Record of Decision
RT	Round trip
RWS	River Water Surface
SE	Standard Error

Abbreviation/Acronym	Definition
Secretary	Secretary of the Interior
SERA	Syracuse Environmental Research Associates
SEV	Severity
SNS	shortnose suckers
SONCC	Southern Oregon Northern California Coast
SPCC	Spill Prevention, Control, and Countermeasure
SRH-1D	one dimensional sedimentation and river hydraulics model
SSCs	suspended sediment concentration
SSRT	Shasta–Scott Recovery Team
SWE	Snow Water Equivalent
SWRCB	California State Water Resources Control Board
TMDL	Total Maximum Daily Load
TN	total nitrogen
TN:TP	ratios of total nitrogen to total phosphorus
TP	Total Phosphorous
TSS	Total Suspended Solids
UKL	Upper Klamath Lake
USACE	United States Army Corp of Engineers
USDA	United Stated Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VSP	Viable salmonid population
WDFW	Washington Department of Fish and Wildlife
WHO	World Health Organization
WQMP	Water Quality Management Plan
WURP	Water Use Retirement Program
WY	Water year
yd^3	cubic yards
yr	year
YTEP	Yurok Tribe Environmental Program

1 INTRODUCTION

This Biological Assessment (BA) and Essential Fish Habitat (EFH) Determination for the Proposed Removal of Four Dams on the Kamath River has been revised from the October 3, 2011 version due to new information being made available, clarification of the proposed federal action, and recommended edits from the United States Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS). More specifically, the main revisions made to this BA include: 1) clarification that the Klamath Basin Restoration Agreement (KBRA) is not a part of the Proposed Action and therefore, is not analyzed as such in this BA; 2) include section on Standard Operating Procedures (SOPs) and Best Management Practices (BMPs); 3) include information from the May 24, 2012 Technical Memorandum for the Evaluation of Dam Removal and Restoration (EDRRA) model runs on Klamath Chinook abundance forecast and subsequent revisions to Steller sea lion and Southern Resident Distinct Population Segment (DPS) killer whale analysis; 4) revision of determination of effects analysis on marbled murrelet; 5) revisions to Southern DPS eulachon, bull trout, and shortnose and Lost River suckers effects analysis; and 6) add language for proposed revision of northern spotted owl critical habitat.

1.1 Purpose of the Biological Assessment

The United States Department of Interior (DOI), through the Bureau of Reclamation (Reclamation), has prepared an Environmental Impact Statement/Environmental Impact Report (EIS/EIR) to evaluate the potential effects of the proposed removal of four PacifiCorp dams (J.C. Boyle, Copco 1, Copco 2, and Iron Gate – collectively referred to as the Four Facilities) on the Klamath River (Klamath Facilities Removal EIS/EIR – [DOI and CDFG 2012]).

The Klamath Facilities Removal EIS/EIR will inform a determination by the Secretary of the Interior (Secretary) on whether dam removal will advance salmonid restoration and is in the public interest. Reclamation is also preparing the Detailed Plan for Facilities Removal (Detailed Plan [Reclamation 2012b]), which contain the preliminary engineering designs and cost estimates for removal of the four dams. To evaluate the potential effects to Federally threatened or endangered species and designated or proposed critical habitat which could result from implementation of the Proposed Action, Reclamation has prepared this BA pursuant to Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.), and its implementing regulations (50 CFR 402). Reclamation has concluded that the Proposed Action may affect listed species; therefore, formal ESA consultation is required.

This BA provides information on the potential effects of the Proposed Action on listed species and critical habitat for use by the USFWS and Department of Commerce's NMFS in preparation of their Biological Opinion (BO). The Preferred Alternative from the Klamath Facilities Removal EIS/EIR, which is the Proposed Action and the subject of this consultation, is the full removal of all four dams and appurtenant facilities (refer to Section 2 for a project description of the Proposed Action). For the purposes of effects analysis only, hydrological data was required and the best available modeled hydrology incorporated an assumed parameter based on changes to the current hydrology as an outcome of certain KBRA programs. However, the KBRA modeled hydrology itself and KBRA programs are not a part of this Proposed Action and Reclamation is not seeking ESA Section 7(a)(2) consultation on these actions at this time. Much of the KBRA programs envisioned to be implemented require development of specific plans, additional collection of data, the identification of the responsible party(s), and funding source(s) before further decisions can be made. Thus, the KBRA programs do not contain enough detail for Reclamation to assess their potential impacts on listed species at this time.

1.2 Background

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 and to Reclamation’s Klamath Project and by several hydroelectric dams operated by a private company, currently known as PacifiCorp. PacifiCorp’s Klamath Hydroelectric Project (KHP) was constructed between 1911 and 1962. It includes eight developments: The East and West Side power facilities, Keno, J.C. Boyle, Copco1, Copco 2, Fall Creek, and Iron Gate Dams. Link River Dam and Upper Klamath Lake (UKL) are not part of the hydroelectric project. PacifiCorp operated the KHP under a 50-year license issued by the Federal Energy Regulatory Commission (FERC) until the license expired in 2006. Although Reclamation’s Link River Dam and PacifiCorp’s Keno Dam currently have fish ladders, none of the mainstem dams were constructed with fish ladders sufficient to pass anadromous fish and, as a result, fish have been blocked from accessing the upper reaches of the basin for close to a century. Beginning in 1956, Iron Gate Dam (IGD) (the lowest dam in the system) flow releases were generally governed by guidelines outlined within the FERC license, commonly referred to as “FERC minimum flows.” FERC’s original license to operate the KHP was issued prior to enactment of the ESA.

The 1980s and 1990s witnessed continued declining fish populations and closure of Lost River and shortnose sucker fisheries as well as the federal listing under the ESA of both sucker species and coho salmon.

In 2008 and 2010, the USFWS and the NMFS, respectively, issued BOs on Reclamation’s Klamath Project operations to better protect listed suckers and coho salmon. Project operations have since been governed in part by both opinions. To protect listed fish, the BOs recommend surface water elevations in UKL and river flows. Meeting the needs of ESA listed fish results in insufficient irrigation water delivery for Reclamation’s Klamath Project contractors during low water years. Other non-Reclamation irrigation diversions also occur within the Klamath Basin. (The Proposed Action and the subject of this BA consultation do not include Klamath Project operations, which is a separate and distinct action. As noted in Section 1.4 of this BA and specified in Section 22.1.2 of the KBRA, Reclamation will request ESA consultation on Klamath Project operations consistent with the limitations on diversion of water as provided in Appendix E-1 of the KBRA prior to implementation of the On-Project Plan [KBRA 2010]).

Competing needs for water between fisheries, irrigators, municipal users, and others resulted in conflict among the various communities and Tribal Governments. In 2006, with the expiration of the FERC license, PacifiCorp began to phase in higher power rates for irrigators so within six years irrigators will pay the same tariff rates as residential and commercial power users.

Combined with measures to protect fish, Reclamation’s Klamath Project irrigators faced more water shut-offs and curtailments. In 2002, at least 33,000 returning adult salmon perished in the mainstem Klamath River due to high water temperatures, crowded conditions, and disease. In 2005, commercial salmon ocean harvest was heavily restricted and in 2006 over 700 miles of Oregon and California coast was closed to salmon fishing to protect weak stocks. The likelihood that such widely traumatic cycles would continue, coupled with changes PacifiCorp would need to make in order to continue operating the KHP, led basin stakeholders and American Indian Tribes to begin collaborative discussions with the goal of developing a mutually beneficial agreement as a sustainable option for solving the basin's natural resource derived problems.

While stakeholders began efforts to reach agreement on the multifaceted issues in the basin in the 1990s, the efforts to reach a settlement increased in 2001 and 2002 following the water-related farming and fisheries crises experienced in those years. Official negotiations leading to the Klamath Hydroelectric Settlement Agreement (KHSA) and KBRA began in 2005. The KHSA was an outcome of FERC's Alternative Dispute Resolution Procedures as outlined in the Energy Policy Act of 2005[1] (18 C.F.R. 385.601, et seq.) wherein the parties elected to set aside differences to reach resolution on a settlement that is in furtherance of the interests of all of the parties. As established in Section 1.2 of the KHSA, many of the parties to the settlement maintained that facilities removal would help restore basin resources and all Signatory Parties agreed that settlement would help reduce conflicts among Klamath Basin communities. The KHSA and KBRA were finalized in February 2010[2].

The vision for the removal of the Four Facilities as contemplated in the KHSA and implementation of the KBRA programs is to provide bargained for benefits to all the involved parties. Removing the Four Facilities would provide for a free-flowing river and would optimize the efficiency of fish migration to and from the Upper Basin as well as through the entire Hydroelectric Reach. The entire river from Keno Dam to the Pacific Ocean would become a connected, free-flowing river and would provide new fish habitat in the reach currently upstream of IGD. Dam removal would maximize the recruitment of gravel within the Four Facilities' reach and below IGD, which would benefit fish spawning. Additionally, removal of the Four Facilities would create a more natural flow pattern and a more mobile stream bed. Both of these conditions are hypothesized to reduce the occurrence of juvenile salmon fish disease and would likely create better conditions for fish migration, rearing, and spawning.

1.3 Listed Species and Critical Habitat

Information on federal ESA-listed species that may be affected by the Proposed Action was obtained from the following sources:

- USFWS and NMFS list of all federal ESA-listed endangered and threatened species identified as having the potential to be affected by the Proposed Action (USFWS and NMFS, 2011);
- The California Native Plant Society (CNPS) online Inventory of Rare and Endangered Vascular Plants of California (CNPS 2011), as searched for the United States Geological Survey (USGS) 7.5-minute quadrangles that fall within the Affected Area (i.e., the Klamath River corridor and the UKL) and the surrounding quadrangles;
- Results of plant and wildlife surveys conducted by PacifiCorp in 2002–2004 (PacifiCorp 2004a);
- Biological opinions developed by the USFWS and NMFS for the Klamath River Basin including:
  - NMFS (2002)—Biological opinion for the Klamath Project operations,
  - NMFS (2010)—Biological opinion for operation of the Klamath Project between 2010 and 2018
  - USFWS (2008a)—Formal consultation on the Bureau of Reclamation's proposed Klamath Project from 2008 to 2018;
- Species profiles developed by NMFS (http://www.nmfs.noaa.gov/pr/species/) and the USFWS (http://www.fws.gov/arcata/);
- Klamath Facilities Removal EIS/EIR and appendices; and
- Numerous scientific studies, assessment, and surveys.

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[1] Section 442 of the Energy policy Act of 2005, Pub. L. 109-58, SS 241, 119 Stat, 594, 67475 (Aug. 8, 2005) ("EPAct") (codified in 16 U.S.C. SS 797 (e) and 811), and the underlying procedural regulations codified in 50 C.F.R. Part 221.

[2] The KHSA and KBRA are available at http://www.klamathrestoration.gov

Table 1-1 lists all the federally threatened and endangered species and designated and proposed critical habitat that may be present in the Action Area. The potential effects on these species are discussed in further detail in Section 4.

Table 1-1. Federally Threatened and Endangered Species and Designated and Proposed Critical Habitat within the Action Area that may be Affected by the Proposed Action (USFWS and NMFS 2011)

Scientific name	Common name	Listing[1]	Critical habitat[2]
Astragalus applegatei	Applegate's milk-vetch	E	N
Fritillaria gentneri	Gentner's fritillary	E	N
Phlox hirsuta	Yreka phlox	E	N
Salvelinus confluentus	bull trout	T	Y
Chasmistes brevirostris	shortnose sucker	E	P
Deltistes luxatus	Lost River sucker	E	P
Eucyclogobius newberryi	tidewater goby	E	Y
Acipenser medirostris	Southern DPS green sturgeon	T	Y
Oncorhynchus kisutch	SONCC coho salmon	T	Y
Thaleichthys pacificus	Southern DPS eulachon	T	Y
Caretta caretta	loggerhead turtle	T	N
Chelonia mydas (incl. agassizi)	green turtle	T	N
Dermochelys coriacea	leatherback turtle	E	Y
Lepidochelys olivacea	olive (=Pacific) ridley sea turtle	T	N
Brachyramphus marmoratus	marbled murrelet	T	Y
Charadrius alexandrinus nivosus	western snowy plover	T	Y
Phoebastris albatrus	short-tailed albatross	E	N
Strix occidentalis caurina	northern spotted owl	T	Y, P
Balaenoptera borealis	sei whale	E	N
Balaenoptera musculus	blue whale	E	N
Eubalaena japonica	North Pacific right whale	E	Y
Balaenoptera physalus	fin whale	E	N
Eumetopias jubatus	Steller sea lion	T	Y
Orcinus orca	Southern Resident killer whale	E	Y
Megaptera novaengliae	humpback whale	E	N
Physeter macrocephalus	sperm whale	E	N

Key:

[1] Listing

E	Endangered; Listed in the Federal Register as being in danger of extinction
T	Threatened; Listed as likely to become endangered within the foreseeable future

[2] Critical Habitat

Y	Yes
N	No
P	Proposed

1.4 Consultation History

This is a new action; therefore no consultation has taken place previously.

The following is a record of the consultation milestones:

- On January 26, 2011, the DOI notified the USFWS and NMFS that Reclamation would be developing a BA in accordance with the ESA to determine if the Proposed Action may adversely affect listed species and/or their critical habitat. Reclamation also included a list of endangered, threatened, proposed, and candidate species and their designated and proposed critical habitat that may be present in the Action Area. Reclamation requested that the USFWS and NMFS review the list and either concur that it was complete and correct, or provide any additional species or critical habitat that should be included in the BA.
- On February 15, 2011, NMFS sent a clarification list of species to the DOI.
- On March 7, 2011, Reclamation received a letter from the USFWS (dated March 4, 2011) that included a new list of ESA-listed species that were likely to occur within the Action Area.
- On May 6, 2011, Reclamation received a letter (dated May 2, 2011) from the USFWS that amended the March 4, 2011 ESA list of species that were likely to occur within the Action Area.
- Reclamation, USFWS, NMFS, and consultants met on May 12, 2011 to discuss information needs for the BA. Agreement was reached during this meeting that an assessment of impacts on ESA candidate species was not appropriate for the BA. Discussion ensued regarding the scope of the Proposed Action.
- Reclamation, USFWS, NMFS, and consultants met on May 18, 2011 to discuss development of a draft BA template that would meet the informational and analytic needs of the USFWS and NMFS. An agreement was reached that specific mitigations from the EIS/EIR would be part of the proposed action for purposes of ESA consultation as they are part of the preferred alternative in the EIS/EIR. Reclamation, USFWS, NMFS, and consultants met on May 25, 2011 to discuss policy determination that Reclamation, and not the DOI, would be the Action Agency.
- Reclamation, USFWS, NMFS, and consultants met on June 7, 2011and a decision was made that the BA would use the modeled hydrology from the EIS/EIR in the analysis of potential effects to listed species. Reclamation staff clarified that this consultation is a separate and different action than that of the operations of Reclamation's Klamath Project, and it is important to keep the two consultations separate and distinct. NMFS advised that analysis in the BA should deconstruct the Proposed Action down to its incremental parts and identify stressors to life history stages of listed species so it would be most useful in preparation of any future BO.
- Reclamation, USFWS, NMFS, and consultants met on June 14, 2011. During that meeting, Reclamation's consultant, Stillwater Sciences, was directed to focus the BA on the KHSA while policy decisions on how to treat the connected action of KBRA were on-going.
- Reclamation, USFWS, NMFS, and consultants met on June 29, 2011. Working backwards from the due date of the Final BO, the team developed milestone dates for the BA. Reclamation later developed a detailed schedule and communicated to Stillwater through the contracting process. The recommended deliver dates were Administrative draft of the BA: on or about August 19, 2011; Final BA: on or about September 16, 2011.
- On September 22, 2011, Reclamation sent a letter to the USFWS and NMFS requesting a modification and update to the May 2, 2011 ESA list of species that were likely to occur within the Action Area.
- On September 28, 2011, Reclamation received a new list of species that were likely to occur in the Action Area from the USFWS and NMFS.

- In a letter dated October 6, 2011, Reclamation requested formal consultation with the USFWS and NMFS, respectively, and attached the BA.
- On December 13, 2011, Reclamation sent an email correspondence to the USFWS and NMFS to clarify the proposed action and subject of ESA consultation in the BA.
- On January 18, 2012, Reclamation sent a letter to the USFWS requesting conference on Proposed Critical Habitat for the Lost River and Shortnose sucker as part of the consultation.
- On February 2, 2012, Reclamation participated in the USFWS and NMFS' briefing for the Yurok, Karuk, Resighini, and Hoopa tribe staff on the status and analytical approaches of this consultation at the USFWS office in Arcata, California. The Quartz Valley and Klamath tribes were invitied but were unable to attend the meeting.
- On Februrary 13, 2012, Reclamation attended the USFWS and NMFS' briefing for Quartz Valley Indian Reservation staff on the status and analytical approaches of this consultation over the phone and through a web-based powerpoint presentation.
- On March 6, 2012, Reclamation sent a letter to the NMFS regarding classification of aspects of Reclamation's BA including clarification on the use of modeled hydrology, and transmittal of errata on the southern Distinct Population Segment (DPS) eulachon critical habitat and Best Management Practices (BMPs) portion of the Proposed Action.
- On March 7, 2012, John Bezdek and staff from Reclamation, USFWS, and NMFS met with the Hoopa Valley Tribal Council to respond to questions concerning Reclamation's BA.

1.5 Compliance with the ESA and Magnuson-Stevens Act

The ESA requires federal agencies to ensure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of listed species, or result in the destruction or adverse modification of critical habitat. To fulfill this requirement, Reclamation, as the action agency, must prepare a BA in accordance with 50 CFR § 402 of the implementing regulations for ESA. If Reclamation determines that the Proposed Action may affect a proposed or listed species, or destroy or modigy designated or proposed critical habitat, then pursuant to Section 7(a)(2) of the ESA, Reclamation must consult with the USFWS on terresterial species and inland fish, and with NMFS on marine species and anadromous fish, if they intend to proceed with the project. Reclamation found that the Proposed Action may affect listed species and will therefore transmit this BA to the USFWS and NMFS requesting formal Section 7(a)(2) consultation. If USFWS and NMFS concur that the Proposed Action may adversely affect proposed or listed species, or proposed or designated critical habitat, they will develop a BO for the project. The BO analyzes the effects of the proposed action to determine if they are likely to jeopardize listed species or destroy or adversely modify critical habitat.

The Essential Fish Habitat (EFH) provisions of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (Magnuson-Stevens Act) (P.L. 94-256 or 10 U.S.C 1801 et seq.) require heightened consideration of habitat for commercial fish species in resource management decisions. EFH is defined in the Magnuson-Stevens Act as "those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity." NMFS interprets EFH to include aquatic areas and their associated physical, chemical, and biological properties used by fish that are necessary to support a sustainable fishery and the contribution of the managed species to a healthy ecosystem. The Magnuson-Stevens Act and its implementing regulations (50 CFR § 600.92(j)) require that before a federal agency may authorize, fund, or carry out any action that may adversely affect EFH, it must consult with NMFS. The purpose of the consultation is to develop conservation recommendations that address reasonably foreseeable adverse effects on EFH. Freshwater EFH for Pacific salmonids includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically, accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers, and long-standing impassable natural barriers. EFH for Pacific coast groundfish includes all waters from the mean higher high water line, and the upriver extent of saltwater intrusion in river mouths, along the coasts of Washington, Oregon, and California seaward to the boundary of the U.S. exclusive economic zone (EEZ). EFH for coastal pelagic species includes all marine and estuarine waters from the shoreline along the coasts of California, Oregon, and Washington offshore to the limits of the EEZ.

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2 PROJECT DESCRIPTION

2.1 Action Area

The Proposed Action is located in the Klamath River Basin of northern California and southern Oregon. The Upper Klamath Basin lies within Jackson, Lake, and Klamath counties in Oregon and Siskiyou and Modoc counties in California. The Lower Klamath River flows through Trinity, Humboldt, and Del Norte counties in California.

For the purposes of this BA, the Action Area consists of the geographic extent anticipated for potential effects. Effects within the Action Area will vary according to species, because the population distribution and the specific effects may vary between species. In general, the Action Area includes UKL and its fishbearing tributaries, the Klamath River between Keno Dam and IGD, the Lower Klamath River from IGD downstream to the mouth of the Klamath Estuary, and the nearshore marine environment of the Pacific Ocean (Figure 2-1). Specifically, the Action Area consists of the following:

- All fish bearing streams above UKL;
- UKL to full pool;
- The 100-year flood plain between Link River Dam and J.C. Boyle Dam;
- The area within 1.5 miles of the overall project footprint in the hydroelectric reach (Four Facilities and their reservoirs) which contains the 4 dams proposed for removal;
- The 100-year flood plain from IGD to the mouth of the Klamath River; and,
- The Pacific Ocean one mile north, south, and west of the mouth of the Klamath River.

The Four Facilities and their appurtenant structures are located in the Action Area and are central to the Proposed Action are listed below.

- J.C. Boyle Dam, which is located at River Mile (RM) 224.7, is a concrete and earthfill embankment that is 68 ft high, 692 ft long along its crest, and impounds a reservoir of 420 acres with a storage volume of 2,629 acre-feet. Associated appurtenant structures include, but are not limited to, spillway gates, fish ladder, canal intake structure, power canal (flume), forebay spillway control structure, tunnel inlet portal structure, surge tank, penstocks, tynnel portals, powerhouse gantry crane and substructure, tailrace, switchyard, warehouse, suport buildings, 64-kV transmission lines, and recreation structures.
- Copco 1 Dam, which is located at RM 198.6, is a concrete structure that is 135 ft high, 410 ft long along its crest, impounds a reservoir of 1,000 acres with a storage volume of 40,000 acre-feet. Associated appurtenant structures include, but are not limited to, diversion tunnel intake, penstocks, spillway gates, powerhouse intake structure, diversion control structure, powerhouse, switchyward, warehouse and residences, 69-kV transmission lines, and recreation structures.
- Copco 2 Dam, which is located at RM 198.3, is a concrete structure that is 35 ft high, 335 ft long along the crest, and has minimal reservoir capacity of 73 acre-feet. Associated appurtenant structures include, but are not limited to, spillway, penstock intake structure, wood-stave penstock, powerhouse, tail race, and 69-kV transmission lines.
- IGD, which is located at RM 190, is an earthfill embankment that is 189 ft high, 740 ft long along the crest, and impounds a reservoir of 944 acres with a storage volume of 53,800 acre-feet. Associated appurtenant structures include, but are not limited to, fish spawning facilities, powerhouse and penstock, spillway, diversion/outlet shaft/tower structure, water supply pipes, fish facilities, switchyard, 69-kV transmission line, and recreation structures.

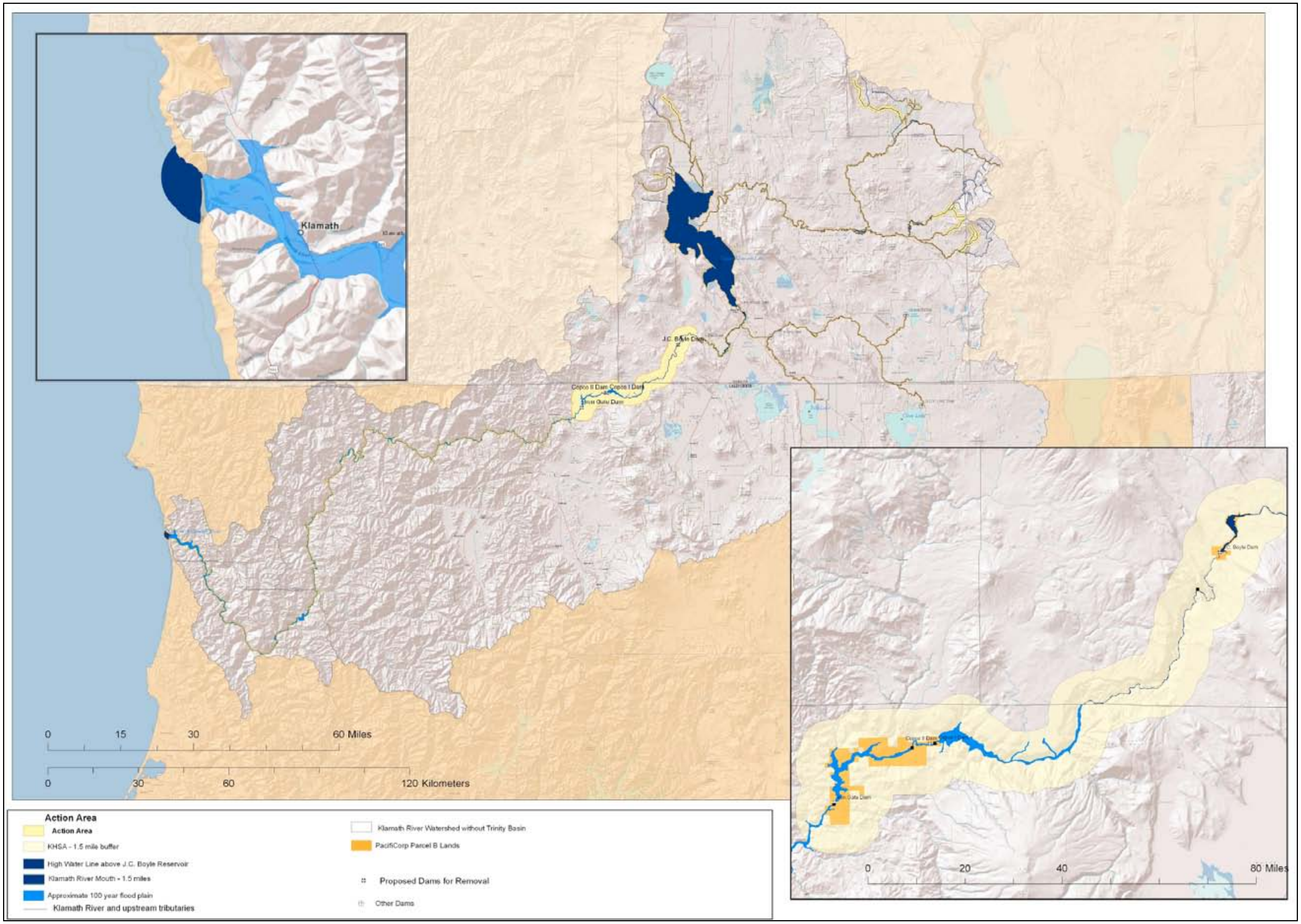

Figure 2-1. Action Area.

2.2 The Proposed Federal Action: Full Facilities Removal of Four Dams

The Proposed Action includes the removal of the Four Facilities and related appurtenances as described in the EIS/EIR and contemplated in the KHSA. This would include the complete removal of dams, power generation facilities, water intake structures, canals, pipelines, ancillary buildings, and dam foundations.. The result of the Proposed Action would be that the Klamath River would have no dams downstream from Keno Dam.

The following project description was taken from Detailed Plan (Reclamation 2012b). Some edits have been made to remove content unrelated to the Proposed Action. The Detailed Plan in its entirety is available at the Klamath Restoration website.[3]

Modification of water intake structures and diversion tunnels at Copco 1 and Iron Gate dams would begin in mid-2019. Reservoir drawdown at Copco 1 Dam would begin in November of 2019. However, the following dam removal plans assume that the natural release of sediment to the Klamath River from the three larger reservoirs (J.C. Boyle, Copco, and IGD) would be initiated no earlier than January 1, 2020 by regulated releases from available gated spillways, powerhouse bypass facilities, and modified low-level outlets. A conservative assumption has been made that power production would cease once reservoir drawdown begins. Facilities removal as defined by the KHSA to produce a free-flowing river through the Hydroelectric Reach (the reach extending from the upstream end of the J.C. Boyle reservoir downstream to IGD) would be completed prior to the specified December 31, 2020 completion date. Figure 2-2 provides an anticipated schedule for the Proposed Action based on construction requirements for removal of the four PacifiCorp dams. See the Detailed Plan for a more detailed reservoir drawdown and dam demolition schedule (Reclamation 2012b).

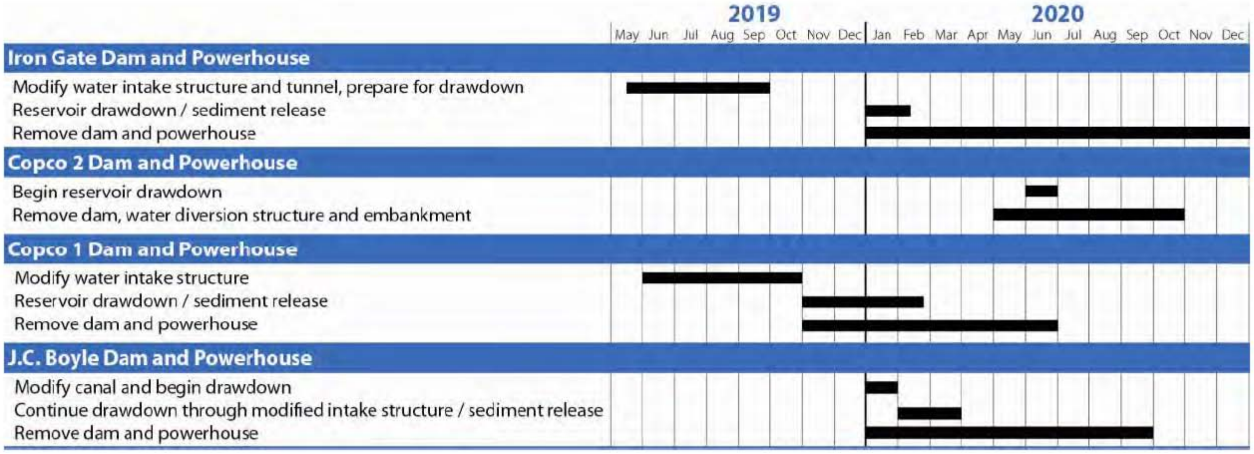

Figure 2-2. Anticipated Schedule for Full Removal of the Four PacifiCorp Dams and Facilities

Quantity estimates for all features to be removed, including concrete volumes and weights of mechanical and electrical equipment, have been carefully prepared using detailed engineering drawings provided by PacifiCorp, which are believed to represent current, as-built conditions. Each dam site has been examined by members of the Reclamation engineering design team to confirm the existence of project features for which quantities have been prepared for this level of design. However, no independent surveys or measurements of dam embankments, concrete structures, or equipment have been taken to confirm the PacifiCorp data. Additional surveys and measurements would be performed for final design. All elevations are in project datum, unless otherwise noted.

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[3] http://klamathrestoration.gov/

The following sections define the removal limits, reservoir drawdown and streamflow diversion requirements, proposed demolition methods and schedules, and waste disposal requirements for each dam. Drawings have been prepared for each dam to clearly define the proposed removal limits for the dam and for each appurtenant feature, and are included in the Detailed Plan (Reclamation 2012b). Reservoir storage-elevation and discharge capacity data for each dam are provided in the Detailed Plan (Reclamation 2012b). Summary level construction schedules for each dam are provided in the Detailed Plan (Reclamation 2012b) and have been prepared for the work at each dam to occur independently.

2.2.1 J.C. Boyle Dam and Powerhouse

2.2.1.1 Removal Limits

J.C. Boyle Dam is located within a relatively narrow canyon on the Klamath River at RM 224.7 (Figure 2-3). Minimum requirements for a free-flowing condition and for volitional fish passage on the Klamath River through the J.C. Boyle damsite would require the complete removal of the embankment section and concrete cutoff wall to the bedrock foundation, to ensure long-term stability of the site and to prevent the development of a potential fish barrier at the site in the future. The lower portion of the fish ladder would be removed to prevent potential stranding of fish during future flood events. The spillway gates, deck, piers, and crest structure would be removed to facilitate reservoir drawdown, and to ensure sufficient discharge capacity during dam removal to prevent a potential overtopping failure of the embankment. With the removal of the embankment and spillway sections, the left abutment wall (between the embankment and spillway) and the upper portion of the fish ladder could become unstable and would also be removed. The 14-ft-diameter steel pipeline would be used to provide additional low-level release capacity to the canal during dam removal, and could be retained for use as a footbridge across the Klamath River for the Partial Removal alternative, although long-term maintenance issues related to the steel pipeline and supports (which are assumed to include coatings containing heavy metals) should be addressed. The pipeline supports would remain within the 100-year floodplain.

The concrete headgate structure, completed in 2002 on PacifiCorp property, could be retained for modification as an observation point, with access from the 14-ft-diameter pipeline, for the Partial Removal alternative. However, the 2.2-mile-long power canal (or flume) located on Bureau of Land Management (BLM) property would be expected to collect rockfall and sustain structural damage over time, and would require some additional openings for drainage and for animal escape or migration, as would the forebay area. Therefore, the reinforced concrete walls for the power canal and forebay would be completely removed, with the concrete floor slabs and shotcrete slope protection left in place. Retention of portions of the back wall only, where provided, could be considered to further reduce project costs, but is not included in the current plans. The communications equipment, engine-generator building, and propane tank at the forebay site would probably be removed by PacifiCorp. Other structures at the site, including the tunnel inlet portal structure and forebay spillway control structure, would be removed to avoid long-term maintenance issues, and the upstream tunnel portal would be plugged with reinforced concrete to avoid unauthorized entry. Extensive headcutting erosion has occurred within the forebay spillway discharge channel since construction, and this channel could be backfilled and stabilized to restore most of the preconstruction slope on the right bank of the river channel if necessary, provided the site can be used for concrete waste disposal. Any concrete rubble disposed on site would be compacted by equipment travel and covered with a minimum of 2 ft of soil.

The 78-ft-tall steel surge tank and the 150-ton gantry crane would be removed to prevent a potential future stability problem during a large seismic event, to avoid long-term maintenance issues, and for aesthetic reasons. The two penstocks would be removed to avoid long-term maintenance issues related to the steel, which is assumed to include exterior coatings containing heavy metals, and to facilitate wildlife migration across its alignment. The downstream tunnel portal would be plugged with reinforced concrete to avoid unauthorized entry. The large warehouse building would be removed to avoid future security and maintenance issues. The switchyard and any unused transmission lines would be removed, including fencing, poles, and transformers, to avoid long-term maintenance issues. The existing transmission lines cross over steep terrain in some areas and may be difficult to access.

Removal of the J.C. Boyle powerhouse would involve the following major mechanical and electrical equipment: two vertical-shaft Francis-type hydraulic turbine units, two turbine governor hydraulic control systems with oil storage reservoir and pressure tank, two turbine runner spiral casings and head covers/operating rings, four turbine gate hydraulic servomotors, two vertical turbine shafts, two turbine draft tubes, two electric oil sump pumps and tank, two draft tube bulkhead gates, two vertical sump pumps, bearing oil storage tank(s), and other miscellaneous mechanical equipment, piping, and valves; plant transformers, distribution equipment, unit breakers, two generators, conduit and cable, plant control equipment, and other miscellaneous electrical equipment. Removal of the J.C. Boyle switchyard would involve the removal of all transformers, breakers, switches, and take-off structures. Other potentially hazardous materials, such as batteries, would also be removed. The tailrace channel between the powerhouse and the river channel could be backfilled to the pre-construction contours if necessary, which would eliminate the need to remove the concrete training walls.

Figure 2-3. J.C. Boyle Dam and Powerhouse (Images from Klamath Riverkeeper)

Features to be removed or retained for the J.C. Boyle Dam removal are summarized in Table 2-1.

Table 2-1. J.C. Boyle Dam and Powerhouse Removal Requirements

Feature	Action
Embankment Dam, Cutoff Wall	Remove
Spillway Gates and Crest Structure	Remove
Fish Ladder	Remove
Steel Pipeline and Supports	Remove
Canal Intake (Screen) Structure	Remove
Left Concrete Gravity Section	Remove
Power Canal (Flume)	Remove
Shotcrete Slope Protection	Remove
Forebay Spillway Control Structure	Remove
Tunnel Inlet Portal Structure	Remove
Surge Tank	Remove
Penstocks, Supports, Anchors	Remove
Tunnel Portals	Concrete Plug
Powerhouse Gantry Crane	Remove
Powerhouse Substructure/Slab	Remove
Powerhouse Hazardous Materials (transformers, batteries, insulation, petroleum products)	Remove
Tailrace Flume Walls	Remove
Tailrace Channel Area	Backfill
Canal Spillway Scour Area	Backfill
69-kV Transmission Line, 0.24 mi	Remove
Switchyard	Remove
Warehouse, Support Buildings	Remove All

2.2.1.2 Reservoir Drawdown

The following reservoir drawdown and streamflow diversion plan is proposed to facilitate the removal of J.C. Boyle Dam, while minimizing flood risks and downstream impacts due to the release of impounded sediments. Refer to the Hydrology section of the Detailed Plan (Reclamation 2012b) for historical daily and monthly streamflow data and frequency floods for this site. There are no upstream reservoirs to be drawn down during dam removal. The proposed plan assumes power generation at J.C. Boyle Dam would end on January 1, 2020, as specified by the KHSA. Reservoir drawdown would not commence until that time.

Because there are no structures around the reservoir rim that could be damaged by potential slope failures, the maximum drawdown of J.C. Boyle Reservoir would be controlled by the rate that would be safe for the embankment dam. A nominal drawdown rate of 1 ft/day for the reservoir water surface (RWS) would be very unlikely to cause a rapid drawdown failure, especially since the embankment shells are a mixture of compacted sand and gravel which should have a high strength and adequate permeability. A drawdown rate of 3 ft/day should be acceptable considering the relatively flat upstream slope and low height of the embankment; although the upstream shell material may not drain as quickly as for IGD. Faster drawdown rates could result in some pore pressure development and slope instability, although probably shallow, and would increase the total streamflow at downstream sites. The proposed streamflow diversion plan could result in rapid drawdowns of approximately 10 ft (between RWS elevations 3,780 and 3,770) and 8 ft (between RWS elevations 3,770 and 3,762) within less than 24 hours, but would each be followed by a sustained hold period of a week or more before any further drawdown for the dissipation of any high pore pressures within the embankment. Slope stability analyses of these conditions would be performed for final design to confirm acceptable performance of the embankment during the proposed reservoir drawdown. A preliminary assessment of the maximum drawdown rate for J.C. Boyle Dam was prepared by PanGEO (2008).

Sufficient freeboard would have to be maintained at all times between the elevation of the excavated embankment surface and the reservoir to prevent flood overtopping and potential embankment failure. The freeboard would be dictated by the amount of flood protection that is desired (in terms of flood return period) during the removal operation. The proposed plan described below does not permit any excavation of the embankment section at J.C. Boyle Dam until after July 1, 2020 and requires completion by September 30, 2020 to minimize hydrologic risk. Seasonal frequency floods for this period have been developed to help assess this risk.

Initiate reservoir drawdown and sediment release (January 2, 2020)

a. Make controlled releases through gated spillway (crest elevation 3,781.5) and power canal (intake invert elevation 3768) for drawdown from normal RWS elevation 3,793 to about RWS elevation 3,774 for a dry (90% exceedance) year, to about RWS elevation 3,780 for a median (50% exceedance) year, or to about RWS elevation 3,784 for a wet (10% exceedance) year. This assumes historical inflows and an average drawdown rate of about 1.3 ft/day, for an additional drawdown release of approximately 100 cfs to the downstream channel. Power canal releases after decommissioning the powerhouse would be passed through the canal forebay spillway to the river at the existing scour location, which may require some additional stabilization measures for sustained releases. The existing siphon spillway at the concrete headgate structure is of limited capacity and would not be sufficient for this purpose.

b. With reservoir at the lowest possible level (depending upon inflow), remove the concrete stoplogs from one 9.5- by 10-ft diversion culvert (invert elevation 3,751.5) by blasting if necessary. Releases would rapidly increase by between 2,200 and 3,000 ft^3/s, and reservoir would draw down to about RWS elevation 3,762 for a dry (90% exceedance) year, to about RWS elevation 3,770 for a median (50% exceedance) year, or to about RWS elevation 3,771 for a wet (10% exceedance) year. Suspend power canal flows by closing upstream gate for 14-ft pipeline (intake invert elevation 3,768) to reduce total reservoir releases and rate of reservoir drawdown as needed.

c. With reservoir stabilized at lower level (depending upon inflow) and after a sufficient hold period to ensure slope stability (assumed one week), remove the concrete stoplogs from the other 9.5- by 10-ft diversion culvert (invert elevation 3,751.5) by blasting if necessary. Releases would rapidly increase by between 1,000 and 2,500 ft^3/s, and reservoir would draw down to about RWS elevation 3,758 for a dry (90% exceedance) year, to about RWS elevation 3,762 for a median (50% exceedance) year, or to about RWS elevation 3,776 for a wet (10% exceedance) year. This would provide the maximum reservoir drawdown possible prior to removal of the dam embankment section, except for the natural drawdown resulting from the subsequent reduction of streamflow, and should be completed by January 31, 2020 to minimize potential impacts at the downstream dam removal sites. The potential formation of reservoir ice in January at this site is assumed to not impact reservoir drawdown significantly during this period. Reservoir releases at the dam would be maintained below any ice cover.

d. With reservoir drawn down below the spillway crest (for any water year) remove all three spillway gates and operators, spillway bridge deck, and spillway piers in the dry. Continue removal of the concrete spillway crest structure in lifts to the lowest practical level (approximate elevation 3,762.5, or 1 ft above crown of diversion culverts) for additional drawdown, by notching below the reservoir level, or to avoid potential reservoir refill if the reservoir is already low (i.e., no additional reservoir release). Complete this work by March 15, 2020. Retain embankment dam crest and left abutment wall with fish ladder for flood protection until after spring runoff.

e. The downstream powerhouse can be removed as required any time after decommissioning by constructing a cofferdam in the tailrace channel for removal operations in the dry. Use sump pumps to unwater area as required. Retain cofferdam as partial backfill for tailrace channel. Remove penstocks and plug tunnel openings. Remove switchyard and warehouse building.

2.2.1.3 Dam Removal (July 1, 2020)

a. Begin excavation of embankment dam section. As reservoir inflows decrease for the summer months, reservoir level would reduce to between RWS elevation 3,758 and 3,760 by August (regardless of water year), or below crown of diversion culverts (elevation 3,761.5). Complete removal of pipeline and downstream water conveyance features and place concrete rubble and soil cover materials in scour hole below canal forebay spillway structure (up to 80,000 yd^3) as required.
b. Remove dam embankment to about elevation 3,760 (over 100,000 yd^3) in July and August (about 23 ft above bedrock at upstream toe), or as low as reservoir level would allow, to create an upstream cofferdam to ensure flood protection for flows through left abutment. Remove embankment materials downstream of required cofferdam limits to final channel grade, including concrete cutoff wall. Haul excavated materials to disposal area on right abutment. Place excavated rockfill (from stockpile) on downstream face of upstream cofferdam for controlled breach of cofferdam embankment to streambed elevation 3,737 by notching below reservoir level. Final reservoir drawdown would be achieved by natural erosion of the armored cofferdam and impounded sediments to the original streambed level. Much of the reservoir between RWS elevations 3,737 and 3,760 is filled with sediment and would be released with the cofferdam breach. The cofferdam breach at J.C. Boyle could release up to 5,000 cfs and should be delayed until after the Iron Gate cofferdam has been breached, to minimize potential downstream impacts.
c. Remove left abutment wall with fish ladder during dam removal. Remove any remaining embankment materials from river channel in the wet, during low flow period, as required. Remove all other features as required. Restore dam site and waste disposal areas as required, including the placement of topsoil and seeding. Demobilize from site.

Demolition methods and schedule

The following demolition methods and sequence, construction equipment requirements, workforce requirements, and construction activity durations have been assumed for planning, scheduling, and cost estimating purposes, based on engineering judgment. Alternative methods, sequence, equipment, and durations which would also meet project requirements are possible.

The contractor would have to mobilize construction equipment to the site by October 2019, and improve existing access roads between the dam and on-site waste disposal areas for two-way traffic where required. The delivery of off-road construction equipment, including cranes, large excavators, loaders, and large capacity dump trucks would be by special tractor-trailer vehicles operating under “wide load” restrictions and at appropriate speeds. Equipment staging areas would include both abutments of the dam and in the vicinity of the downstream powerhouse. The reservoir log boom would be removed. The spillway gates and traveling hoists would be removed by a large crane for loading onto highway trucks and heavy-haul trailers, with the reservoir drawn down below the spillway crest. The reinforced concrete spillway bridge deck and piers could be removed in pieces by hydraulic excavators, or in sections by conventional or diamond-wire sawcutting. The upstream concrete stoplogs for the diversion culvert would be removed by blasting if they cannot be pulled out of their slots by a crane under reservoir head. The construction of a temporary cofferdam upstream of the diversion culvert would permit the replacement of the concrete stoplogs with single concrete bulkheads to facilitate removal under reservoir head at a controlled rate if required, but is not included as a specific item of work in the cost estimate. The design contingency allowance should be sufficient to cover potential additional items such as this.

The lower portion of the concrete spillway section would be removed by hoe-ramming or by drilling and blasting, working behind a temporary cofferdam if necessary for a wet year (left side first, with flows through diversion culvert). Drilling for blasting would include small- to mid-sized hydraulic track drills and perhaps air-track drills supported by 850 to 1,200 ft^3/min air compressors. Considerable jack-leg and similar hand drilling would supplement the machine drilling for special shots. Reinforced concrete in deck, wall, and floor slabs for remaining features to be removed (including fish ladder, canal intake structure, power canal, forebay structures, and powerhouse) would be excavated by mechanical methods (e.g., hydraulic shears or hoe-ramming), or possibly in sections by conventional or diamond-wire sawcutting. Concrete rubble would be hauled in 25 to 30 ton articulated off-road trucks to an on-site disposal area, either near the dam or forebay. Mechanical and electrical equipment, and miscellaneous items would be hauled in a mixture of 12 to 15 ton tandem-axle highway trucks, 25 ton rock trailers, and conventional heavy-haul trailers to approved off-site disposal areas.

Conventional earthmoving equipment required to remove the embankment is assumed to consist of up to eight 25 to 30 ton articulated off-road trucks with two 4 yd^3 excavators to reach the required average production rate of 400 yd^3 per hour, or 16,000 yd^3 per week (five days per week, single shift) for removal of the dam embankment within 8 to 9 weeks. An average haul distance to the on-site disposal area of 1 mile was assumed for construction scheduling purposes, with an average speed for the haul units of 20 mph empty and 10 mph loaded. Dozers are expected to be used for knockdown and grading at the disposal areas as well as to support higher production, mass excavation operations. Higher production rates would be required within the middle two-thirds of the embankment by height, to compensate for lower production rates near the crest and foundation. Some rockfill from the outer surfaces would be stockpiled for later use as slope protection for the upstream cofferdam. The upstream cofferdam would be breached and flushed downstream under a reservoir head of around 20 ft. Some removal of breached cofferdam materials may be required in the wet to restore the downstream channel.

Assumed equipment for the removal of J.C. Boyle Dam and Powerhouse and for restoration of the reservoir area includes:

- Crawler-mounted lattice boom crane, 150 to 200 ton, 160- to 200-ft boom
- Rough terrain hydraulic crane, 35 to 75 ton
- Hydraulic track excavators, 65,000 to 120,000 lb, with Cat H120 hoe-ram, thumb and shear attachments
- Cat 966 or Cat 988 wheel-loaders, 4 yd^3 bucket
- Cat 740 articulated rear dump trucks, 30 ton (22 yd^3)
- D-6 or D-8 standard crawler dozers
- Front-end wheel loader, integrated tool carrier, 25,000 lb
- Cat TL943 rough terrain telescoping forklift
- Rough terrain telescoping manlift
- Truck-mounted seed sprayer, 2,500 gallon
- On-highway, light-duty diesel pickup trucks, ½-ton and 1-ton crew
- On-highway flatbed truck with boom crane, 16,000 lbs
- On-highway truck tractors, 45,000 lbs
- Off-highway water tanker, 5,000 gallon
- Engine generators, 6.5 KW to 40 KW, diesel or gasoline
- Air compressors, 100 psi, 185 to 600 cfm, diesel
- Hand-held drilling, cutting, and demolition equipment

- Portable welders and acetylene torches
- 4-inch submersible trash pumps, electric

Imported materials that may be required for construction would include gravel surfacing for temporary haul roads (approximately 2,800 tons), soil cover for concrete waste disposal (approximately 13,000 yd^3, from required excavation), seed and mulch materials, and minor quantities of ready-mix concrete from local commercial sources for tunnel plugs.

An estimated average workforce of 25 to 30 people would be required for the construction activities, for an estimated duration of 12 months from site mobilization to construction completion for either alternative. The peak workforce required during excavation of the dam embankment could reach 40 to 45 people.

Waste disposal

Estimated waste quantities for the removal of J.C. Boyle Dam and Powerhouse include nearly 170,000 yd^3 of earthfill, nearly 8,000 yd^3 of concrete, an estimated 500 tons of reinforcing steel, and nearly 700 tons of mechanical and electrical items at the dam (upstream of the concrete headgate structure at the power canal); and nearly 32,000 yd^3 of concrete, an estimated 1,900 tons of reinforcing steel, and over 2,300 tons of mechanical and electrical items from the power canal to the powerhouse. There are also a total of ten buildings at both sites with a combined area of over 12,000 ft^2 and estimated waste volume of 2,000 yd^3, and over 3.5 mi of 69-kV transmission lines.

It has been assumed that the original borrow pits, located on the right abutment of the dam, would be used as waste concrete and earth disposal areas. Embankment materials would be hauled along existing routes to the larger of two potential disposal sites along the cleared transmission line corridor, covering an area of approximately 10 acres, and placed within a ravine well below the transmission lines. Some initial clearing and improvements to the existing unpaved access roads and disposal areas would be required, including the stockpiling of excavated topsoil for later use. Special precautions would be required for work below the high voltage transmission lines, but adequate clearance should be available. The disposal site would be covered with topsoil, graded, and sloped for drainage upon completion. Compaction other than by equipment travel would not be necessary. Concrete rubble could also be buried at this site (with a minimum soil cover of 2 ft), after removal of reinforcing steel, or at an alternative (unidentified) site on the left abutment. A temporary riprap stockpile site may be located adjacent to the disposal site for use during construction.

Some waste concrete and earth materials would be placed within the eroded scour hole through the hillside below the forebay spillway structure, to restore the area to near pre-dam conditions if required. Reinforcing steel would be separated from the concrete rubble and hauled to a local recycling facility. All mechanical and electrical equipment would be hauled to a suitable dump site or salvage collection point outside the FERC project boundaries. The site assumed for this study is a Klamath County landfill facility located in Klamath Falls, Oregon, approximately 20 mi east from the damsite, and accessible by county road and state highway. The landfill accepts construction and demolition waste, asbestos, contaminated soils, and recyclables, and has an estimated remaining capacity of 435,000 yd^3. An alternative landfill is located in Dorris, California, approximately 20 mi south from the damsite, accessible by county roads.

Potential hazardous materials at J.C. Boyle Dam and Powerhouse include asbestos, batteries, bearing and hydraulic control system oils, treated wood, and coatings containing heavy metals in the powerhouse and on the exterior surfaces of the steel penstock pipes, surge tank, bulkhead gate, generator gantry crane, and other painted equipment, which would need specialized abatement and disposal requirements. Contaminated soils may exist at the locations of painted exterior equipment. Asbestos may be found in ceiling and floor tiles, roofing materials, and electrical wiring insulation. Although all transformers have tested negative for Polychlorinated biphenyl (PCB), some residual PCBs may exist in closed systems such as transformer bushings. Equipment containing over 37,500 gallons of various types of oils and fuels has been identified at the site. The Red Barn administration complex includes a hazardous materials building for the storage of materials regulated by the Environmental Protection Agency (EPA), and a fueling facility containing above-ground gasoline (1,000 gallon) and diesel (500 gallon) tanks which meet state and federal requirements. Underground septic systems are in use within the Red Barn complex of office and maintenance buildings and two residences.

All hazardous materials shall be shipped to disposal sites that are licensed to receive such materials. Established BMPs shall be followed to avoid or minimize accidental spills of hazardous materials into the Klamath River during demolition and shipping activities. The contractor shall have spill kits available in easily accessible locations at each of the dam and facilities removal sites. All hazardous material removal and transport activities shall also be subject to state and federal permit terms and conditions that regulate such activities. Federal law requires that owners/operators of facilities with large quantities of oils and fuels have spill prevention, control, and countermeasure plans (SPCCP) to address spills. The contractor(s) will be required to have an approved SPCC Plan prior to performing the dam removal work. Any accidental discharge or spill of hazardous materials will be reported immediately to the Dam Removal Entity (DRE)[4].

Estimated quantities, numbers of truck trips, proposed haul routes to disposal sites, and approximate haul distances for non-hazardous waste disposal are summarized in Table 2-2. This table assumes off-highway articulated rear dump trucks would be used for hauling earth and concrete materials on unpaved roads between the dam and proposed waste sites on PacifiCorp and BLM property, with a nominal load capacity of 20 cubic yards each, and truck tractor-trailers for hauling mechanical and electrical items, metals, and other waste materials on paved public roads (at posted speed limits), with a nominal load capacity of 12.5 tons, or 10 cubic yards each. A bulking factor of 30% for concrete rubble and 20% for earth materials has been assumed for determining the number of truck trips required for hauling loose materials. All values have been rounded. Miles shown are average for one round trip, from demolition site to disposal site and return. Total miles (not shown) would be computed from the estimated number of total trips shown multiplied by the average trip distance. Peak daily trips for each site are based on the number of vehicles (units) shown, operating within one 8-hour shift.

Table 2-2. Non-Hazardous Waste Disposal for Full Removal of J.C. Boyle Dam

Waste material	Bulk quantity*	Disposal site	Peak daily trips	Total trips
Earth	170,000 yd^3	Right abutment borrow area	5 units/160 trips (unpaved road)	8,500 trips (1 mile round trip [RT])
Concrete	52,000 yd^3	Forebay spwy scour hole	2 units/50 trips (unpaved road)	2,600 trips (3 mi RT)
Metal and Rebar	5,400 tons	Landfill near Klamath Falls	2 units/10 trips (Highway 66)	430 trips (44 mi RT)
Building Waste	2,000 yd^3	Landfill near Klamath Falls	2 units/10 trips (Highway 66)	200 trips (44 mi RT)

* Volumes increased 30% for concrete rubble, 20% for loose earth materials.

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[4] The DRE is the entity designated by the Secretary of the Interior that has the legal, technical, and financial capacities set forth in Section 7.1 of the Klamath Hydroelectric Settlement Agreement.

2.2.2 Copco No. 1 Dam and Powerhouse

2.2.2.1 Removal Limits

Copco No. 1 Dam is located within a narrow canyon on the Klamath River at RM 198.6 (Figure 2-4). Minimum requirements for a free-flowing condition and for volitional fish passage on the Klamath River through the Copco No. 1 damsite would require the complete removal of the concrete gravity arch dam between the left abutment rock contact and the concrete intake structure on the right abutment, to approximate elevation 2,476, or up to 5 ft below the existing streambed level at the dam, to prevent the development of a potential fish barrier at the site in the future. The spillway gates, bridge deck, and piers would first be removed from the dam crest, followed by removal of the remaining portion of the concrete dam in lifts. Notching below reservoir levels would be performed as required to help maintain reservoir drawdown requirements. The two concrete gate houses on the right abutment intake structure may have to be removed to provide construction access and workspace for a large crane. The downstream tunnel portal would be plugged with reinforced concrete for either alternative to avoid unauthorized entry. The switchyard, located above the dam on the right abutment, and any unused transmission lines would be removed, including fencing, poles, and transformers, to avoid long-term maintenance issues. The maintenance building and residence located on the right abutment would have to be removed from the site of the proposed concrete waste disposal area prior to dam demolition activities.

Removal of the Copco No. 1 powerhouse would involve the following major mechanical and electrical equipment: two horizontal-shaft, double-runner Francis-type hydraulic turbine units, four turbine runner spiral casings and head covers/operating rings, two horizontal turbine shafts, two turbine governor hydraulic control systems with oil storage reservoir and pressure tank, two turbine draft tubes, vertical sump pump(s), bearing oil storage tank(s), two 40-ton and one 15-ton overhead traveling cranes and structural members, and other miscellaneous mechanical equipment, piping, and valves; six plant transformers, distribution equipment, unit breakers, two 10 MW generators, conduit and cable, plant control equipment, and other miscellaneous electrical equipment. Removal of the Copco No. 1 switchyard would involve the removal of all transformers, breakers, switches, and take-off structures. Removal of the steel penstocks would involve two 10-ft-diameter (reducing to two 8-ft-diameter) and one 14-ft-diameter (reducing to two 8-ft-dimaeter) turbine penstock pipes from the intake structure to the powerhouse, including three vertical air vent pipes. The tunnel portion of the 14-ft-diameter penstock would be plugged with concrete. Features to be removed or retained for the Copco 1 Dam removal are summarized in Table 2-3.

Figure 2-4. Copco 1 Reservoir, Dam and Powerhouse (Images from Klamath Riverkeeper)

Table 2-3. Copco No. 1 Dam and Powerhouse Removal Requirements

Feature	Full removal
Concrete dam	Remove to 5 ft below channel
Spillway gates, deck, piers	Remove
Penstocks	Remove
Powerhouse intake structure	Remove
Gate houses on right abutment	Remove
Diversion control structure	Retain
Tunnel portals	Concrete plugs
Powerhouse	Remove
Powerhouse hazardous materials (transformers, batteries, insulation)	Remove
Two 69-kv transmission lines, 0.7 mi	Remove
Switchyard	Remove
Warehouse and residence	Remove

2.2.2.2 Reservoir Drawdown

The following reservoir drawdown and streamflow diversion plan is proposed to facilitate the removal of Copco No. 1 Dam, while minimizing flood risks and downstream impacts due to the release of impounded sediments. Additional releases due to the concurrent drawdown at J.C. Boyle Dam may affect the drawdown of Copco Reservoir. The proposed plan assumes that limited reservoir drawdown from

RWS elevation 2,606 to below the gated spillway crest at elevation 2,593.5 begins on November 1, 2019; however, no significant sediment release is anticipated until after January 1, 2020 when the reservoir is first drawn down below RWS elevation 2,590. Power generation at Copco No. 1 Dam would have to end after the reservoir reaches the minimum operating level at RWS elevation 2,601, which would be nearly two months before the January 1, 2020 date specified by the KHSA. This is necessary for removal of the concrete dam to near final grade before March 15, 2020 for environmental purposes, and would be more than offset by power generation at Copco No. 2 Dam for up to four months beyond the January 1, 2020 date. These operational changes would likely have to be approved by PacifiCorp and by the Public Utilities Commission (PUC).

The drawdown of Copco Reservoir should be controlled to the extent necessary to prevent potential problems with slope stability around the reservoir rim that could result in property damage, including the loss or damage of residential homes. A drawdown rate of between 1.0 and 1.5 ft/day would be unlikely to cause failure of any existing slopes and was assumed for this plan for the upper 50 ft of the reservoir, which would be sufficiently controlled by gated releases through the existing spillway (above RWS elevation 2,593.5) and through the modified diversion tunnel. Detailed studies of the geologic conditions and a slope stability analysis of the reservoir rim would be performed for final design. A greater drawdown rate should be acceptable for the lower portion of the reservoir where the rock types should be different and there would be limited control of reservoir releases. A maximum average drawdown rate of 3 ft/day was originally assumed for the lower portion of the dam for modeling purposes; however, an assessment of the probable demolition rate for the mass concrete in the dam suggested a lower average reservoir drawdown rate of 8 ft (or one lift) per week, or an average of about 1.1 ft/day, would be sufficient for as long as the modified diversion tunnel can accommodate the streamflow. Instantaneous drawdown rates at the time of notching would be greater, depending upon the size of the notch and the streamflow, unless diversion tunnel releases are reduced to offset the sudden increase in potential reservoir release capacity. A final notch would have to be excavated to drain the reservoir to RWS elevation 2,483 by March 15, 2020, matching the current tailwater level below Copco No. 1 Dam and the normal reservoir level at Copco No. 2 Dam (which would still be operating at that time). The final notch could potentially be 40 ft deep (between RWS elevations 2,513 and 2,473), but would require a drawdown of only 30 ft to the tailwater level. The final breach would be located at the bottom of the reservoir where there is very little storage, and only reservoir inflow and sediment would be passed.

The excavated concrete dam crest can safely accommodate overtopping flows during dam removal without concern for frequency floods and freeboard, although demolition operations would have to be suspended. Notching of a concrete dam crest for controlled drawdown in stages has been assumed previously by Reclamation for removal of Glines Canyon Dam on the Elwha River in Washington, having a similar annual average flow, and would be more economical than constructing one or more new gated outlets through the dam. A maximum notch depth for Copco No. 1 Dam would be established based more on practical and hydraulic considerations than on what is required to maintain structural stability of the excavated concrete gravity section. The proposed plan assumes a minimum notch depth of 16 ft (or twice the lift height), with variable notch widths depending upon the sill elevation and release requirements. Notch excavation is assumed to be performed in the dry from the downstream face until reaching an acceptable distance from the upstream face required for stability of the remaining plug section, which would then be blasted under reservoir head to complete the notch. Subsequent notches would alternate locations from side to side to permit excavation of a new, deeper notch while passing flow through the existing notch. These locations could either be completely separate as originally proposed for removal of Glines Canyon Dam, or within a single wider location as considered for removal of Condit Dam (also located in Washington) which was adopted for this study. In order to facilitate the removal of concrete rubble at the downstream toe, the notches would be located in the left half of the dam along the rock abutment and a temporary training wall would be constructed on the downstream face to separate the diversion flow from the concrete loading and hauling operations on the right side. Construction access would be provided by a large crane or by other means.

The proposed plan described below results in the complete drainage of Copco Reservoir by March 15, 2020, in order to minimize downstream environmental impacts resulting from the natural release of impounded sediments. The concurrent drawdown of both J.C. Boyle and Copco Reservoirs results in additional inflow to IGD at a time when the diversion release capacity at IGD is sufficiently high to accommodate it.

Modify diversion tunnel to restore release capacity (July 2019)

a. Mobilize barge-mounted crane from Iron Gate Reservoir (see 4.4.2) onto Copco Reservoir (assume normal RWS elevation 2,606 – but anything less would reduce the depth for divers). Remove sediment from diversion tunnel intake using clamshell or suction dredge, as required.
b. Remove three existing 72-inch flap (or “clack”) gates on upstream face of diversion intake structure (invert elevation 2,489) under balanced head and no flow conditions, using hard hat divers (117 ft depth). Upstream tunnel should be full of water (due to valve leakage since tunnel was plugged), but should be confirmed. Install three new 6- by 6-ft slide gates with hydraulic operators and remote controls at upstream face of diversion structure using divers. The removal of the dam is dependent upon the successful completion of these modifications to restore the discharge capacity of the diversion tunnel for low-level releases. The underwater work would be difficult and should be performed well in advance of the reservoir drawdown schedule to ensure completion and avoid any construction delay. No impacts on power generation are expected for this work.
c. With new upstream slide gates at diversion intake closed, drill drain and air vent holes through concrete tunnel plug from downstream side to unwater tunnel. Remove concrete tunnel plug in dry conditions. Inspect diversion tunnel for possible reinforcement or repairs (none assumed necessary). Remove (or open) three existing 72-inch butterfly valve disks from downstream side in dry conditions, after drilling drain and air vent holes through each disk. Determine need for air vent piping and provide as necessary for operation of upstream slide gates.
d. Retain barge-mounted crane as needed for removal of spillway gates and bridge deck.

Initiate reservoir drawdown to spillway crest (November 1, 2019)

a. Make controlled releases through gated spillway (crest elevation 2,593.5) and from modified diversion tunnel to draw down reservoir below spillway crest. Continue releases to powerhouse for power generation for as long as possible (minimum operating level elevation 2,601), although plant shutdown on November 1 has been assumed for this study. Limit reservoir drawdown to about 1 ft/day to maintain slope stability on reservoir, and hold at about elevation 2,590 (for any water year). No significant sediment release is expected for this upper range of reservoir levels and rate of drawdown.
b. With reservoir drawn down to approximate elevation 2,590, use barge-mounted crane to remove all 13 spillway gates and operators, spillway bridge deck, and spillway gate piers in the dry. Assume barge-mounted crane is then removed from the site, and a large crane is mobilized to the right abutment above the dam to provide construction support. (The left abutment would also be accessible from Ager-Beswick Road for mobilization of a crane for construction support, if necessary.)

Continue reservoir drawdown and initiate sediment release (January 1, 2020)

a. Make controlled releases from modified diversion tunnel. Assume predicted streamflow, plus drawdown releases from J.C. Boyle Reservoir in January up to 100 cfs (or about 200 acre-feet per day). Limit reservoir drawdown to between 1.0 and 1.5 ft/day, so as to maintain slope stability on reservoir and control drawdown releases from both upstream reservoirs to IGD.

b. Continue reservoir drawdown at between 1.0 and 1.5 ft/day until stabilizing at about RWS elevation 2,505 for a dry (90% exceedance) year, at about RWS elevation 2,529 for a median (50% exceedance) year, or at about RWS elevation 2,585 for a wet (10% exceedance) year, based on assumed streamflow (without further drawdown releases from J.C. Boyle after January 31, 2020) and modified diversion tunnel discharge capacity. (Note that this drawdown can range from 20 to 100 ft below the normal RWS—a major difference due to hydrologic variations).

c. As reservoir is drawn down, assume concrete dam is removed in 8-ft lifts between abutments in the dry, with rubble dropped to the toe of the dam and removed by truck on a temporary access road constructed within the river channel along the right bank at the powerhouse (assumed to remain in place until after dam removal for either alternative, for later demolition if required), or by using a large crane on the right abutment to deliver equipment and materials and to remove waste materials as required. Haul concrete rubble to concrete disposal area on right abutment (within one mile). As streamflow diversion capacity through tunnel decreases due to reduced reservoir head, blast minimum 16-ft-deep notches in concrete dam below reservoir levels for overtopping flow as needed (assume variable notch widths depending upon inflow, but with a minimum effective bottom width of 10 ft for a median year). Control instantaneous reservoir releases and drawdown rates during notching by excavating the notches in stages or by controlling the diversion tunnel discharge. The elevation of the first notch would depend upon the streamflow, but was assumed for a median year to be at RWS elevation 2,529. Notching operations and weather conditions are expected to slow the demolition rate during the winter months and spring rainy season. The elevation of the final notch would be at RWS elevation 2,513 (regardless of water year), and would extend up to 40 ft to the final channel grade, but reservoir storage at those elevations is negligible and reservoir releases would match inflow. The reservoir must be completely drained to RWS elevation 2483 (reservoir level to be maintained at Copco No. 2 Dam) by March 15, 2020 to minimize downstream impacts due to sediment release. Retention of Copco No. 2 Reservoir would limit the head on the final notch blast to no more than 30 ft, and would permit continued power generation at the Copco No. 2 Powerhouse.

Complete dam removal after spring runoff (May 15, 2020)

a. Remove remaining concrete in dam below elevation 2,513 to a level at or below elevation 2,476, or about 5 ft below bedrock to avoid a potential future barrier to fish passage. This requires the drawdown of Copco No. 2 Reservoir to minimize the water surface at the Copco No. 1 Dam site, and cessation of power generation at Copco No. 2 Powerhouse. Excavate concrete in 8-ft lifts and remove remaining rubble from river channel during low flow period. Remove concrete in right abutment intake structure in the dry after reservoir has been drained, or concurrent with dam demolition if no impact to overall schedule. The temporary access road to the dam toe may be extended upstream for removal of the concrete rubble from the intake structure.

b. Construct or maintain temporary cofferdams in the river channel as required for removal of the powerhouse and of the diversion control structure in the dry during low flow period. Demolish powerhouse if required and remove all rubble and equipment using trucks along access road, or using a large crane on the right abutment. Remove reinforcing steel, and mechanical and electrical items from site for disposal. Haul concrete rubble to concrete disposal area on right abutment (within one mile). Use sump pumps to unwater low areas as required. Remove cofferdams from river channel when no longer needed. Plug upstream intake and the downstream portal of the diversion tunnel. Restore dam site and concrete disposal areas as required. Place topsoil and seed where required. Demobilize from site.

Demolition methods and schedule

The following demolition methods and sequence, construction equipment requirements, workforce requirements, and construction activity durations have been assumed for planning, scheduling, and cost estimating purposes, based on engineering judgment. Alternative methods, sequence, equipment, and durations which would also meet project requirements are possible.

The concrete dam and powerhouse are situated in a steep, narrow canyon. The existing access roads would require significant upgrading to handle the hauling of the mechanical and electrical equipment and excavated materials. The contractor would have to mobilize construction equipment to the site by June 2019, and improve the existing access roads between the dam, powerhouse, and on-site waste concrete disposal area on the right abutment. The delivery of off-road construction equipment, including cranes, large excavators, loaders, and large capacity dump trucks would be by special tractor-trailer vehicles operating under “wide load” restrictions and at appropriate speeds. Equipment staging areas would include both abutments of the dam and in the vicinity of the powerhouse for both alternatives. One-way traffic with turnarounds is assumed for the primary haul roads, for an average haul distance of 1.25 mi from the dam to the disposal site. Barge access to the reservoir would be provided at an existing boat ramp located at either Mallard Cove on the southern shore (off of Ager-Beswick Road) or Copco Cove on the western shore (off of Copco Road). The log boom would be removed to permit access to the spillway structure. All work can be performed within the existing FERC project boundaries.

The spillway gates and traveling hoists would first be removed by a barge-mounted crane for loading onto trucks, with the reservoir drawn down below the spillway crest using the modified diversion tunnel. The reinforced concrete spillway bridge deck and piers could be removed in pieces by hydraulic excavators, or in sections by conventional or diamond-wire sawcutting. The barge-mounted crane would be removed from the site following removal of the spillway structure and modification of the diversion control structure. Early removal of the spillway structure is required to facilitate the removal of the dam necessary to breach the reservoir by March 15, 2020.

The concrete gravity arch dam was constructed with large (cyclopean) boulders placed in the concrete matrix, and reinforced throughout with 455 tons of 30-pound steel rails placed in horizontal mats and in vertical rows across construction joints (for an average density of 25 lb/yd^3, distributed as shown on project drawings), which would complicate demolition activities. Dam demolition would likely be performed in horizontal lifts using conventional drilling and blasting methods. High production rates with a minimum of weather delays would be required to meet the proposed construction schedule. Drilling was assumed for the construction analysis to control overall production, with up to five drill crews required for each of two 8-hour shifts, each capable of drilling 175 linear feet of production blast holes per shift, with a 6-day work week. A minimum of 9 effective working shifts per week was assumed for scheduling purposes. Over 90,000 linear feet of production drilling was estimated for blast holes spaced 3–4 ft apart, using small air track or hydraulic track drills. Redrilling would likely be required where rail steel is encountered. Drilling pre-split holes is assumed to be primarily limited to notching and would be concurrent with production drilling. Production blasting is assumed to include shots between 288 ft^2 (12- by 24-ft) and 800 ft^2 (20- by 40-ft) per round, with an average between 3 and 6 shots per day for up to 15 weeks, during daylight hours. Assuming similar blast planning to that developed by Revey and Associates for the planning of Glines Canyon Dam removal in Washington, an underground, pre-packaged, detonator-sensitive, water resistant, emulsion-type explosive such as Magnafrac (Orica Explosives Technology) could be used, assuming a weight of 1.25 to 1.75 lb/yd^3, with an approximate weight of explosives between 80 and 300 lb/round and from 35 to 80 lb/delay. The total weight of explosives required for removal of the concrete dam alone (having a volume of 36,000 yd^3) could range between 20 and 30 tons.

Quickly mucking and removing the shot rubble is important to achieving the production rates needed. Acetylene torches would be needed to cut rail steel in the dam. A large crawler-mounted crane could be used on the right abutment to help remove the concrete rubble and rail steel from the dam, or deliver equipment to the excavated surface. Crane access may also be available to the left abutment from Ager-Beswick Road. A sheet-pile or H-pile cofferdam could be constructed along the right bank of the river to isolate a portion of the dam toe and the powerhouse, providing an access road and a work pad to stage concrete rubble collection, loading, hauling, and plant demolition. Once the spillway structure has been removed and routine mass blasting is underway, cranes would no longer be used to support rubble removal. Depending upon the approach, the contractor may need to develop effective access around the notched areas during demolition and may need to alternate between active and under-construction notch alignments. Confining the notches to a single large slot at the left abutment may facilitate the demolition operations. Concrete rubble would be loaded into articulated off-road rock trucks having a haul capacity of 30 tons, using either a hydraulic track excavator with a 3.5 yd^3 bucket, or a front-end loader with a 5 to 6 yd^3 bucket. An average haul distance of 1.25 mi was assumed for construction scheduling purposes, with an average speed for the haul units of 12 mph. Over 700 tons of concrete rubble could be removed per day using two trucks making 12 rounds each during one 8-hour shift, with nearly 70,000 tons (or 36,000 yd^3 in-place volume) to be removed from the dam within approximately 16 weeks. Removal of the final concrete lifts may be delayed by up to two months for lower streamflow conditions and following reservoir drawdown at Copco No. 2 Dam.

Mass concrete in the right abutment intake structure would probably be removed in lifts as for the concrete in the dam, using similar methods but at a slower rate due to the embedded penstock pipes and mechanical equipment. The concrete rubble could be removed from the lift surface using a large crane, or from the bottom of the canyon using an extension of the lower haul road constructed for demolition of the dam, during the low flow period. Reinforced concrete in deck, wall, and floor slabs for remaining features to be removed (including powerhouse and diversion intake structure) would be excavated by mechanical methods (e.g., hydraulic shears and hoe-ramming).

Assumed equipment for the removal of Copco No. 1 Dam and Powerhouse and for restoration of the reservoir area includes:

- Crawler-mounted lattice boom crane, 200 ton, 160- to 200-ft boom
- Rough terrain hydraulic crane, 35 to 75 ton
- Mid-size hydraulic excavator, 28,000 to 60,000 lb, 1 to 2 yd^3 bucket
- Cat 336 hydraulic track excavator, 80,000 lb, 3.5 yd^3 bucket
- Hydraulic track excavators, 65,000 to 120,000 lb, with Cat H120 hoe-ram, thumb and shear attachments
- Cat 966 articulated wheel-loader, 52,000 lb, 5 yd^3 bucket, or
- Cat 980 articulated wheel-loader, 65,000 lb, 6 yd^3 bucket
- Cat 725 or Cat 730 articulated rear dump truck, 50,000 lb, 30 ton (20 yd^3)
- D-6 or D-7 standard crawler dozers
- Front-end wheel loader, integrated tool carrier, 25,000 lb
- Cat TL943 rough terrain telescoping forklift
- Rough terrain telescoping manlift
- Cat 140 motorgrader
- Flexifloat sectional barges
- Truck-mounted seed sprayer, 2,500 gallon

- On-highway, light-duty diesel pickup trucks, ½-ton, ¾-ton, and 1-ton crew
- On-highway flatbed truck with boom crane, 16,000 lb
- On-highway truck tractors, 45,000 lb
- Off-highway water tanker, 5,000 gallon
- On-highway water truck, 4,000 gallon
- Wheel-mounted asphalt paver (for most probable high estimate only)
- Self-propelled rubber tire and drum vibratory compactor, 5 to 15 ton
- Engine generators, 6.5 KW to 40 KW, diesel or gasoline
- Air compressors, 100 to 150 psi, 850 to 1200 cfm, diesel
- Airtrack drill or hydraulic track drill
- Hand-held drilling, cutting, and demolition equipment
- Portable welders and acetylene torches
- 4-inch submersible trash pumps, electric
- Light plants, 2000 to 6000 watt, 10 to 25 hp, diesel

Imported materials that may be required for construction would include gravel surfacing for temporary haul roads (approximately 320 tons), soil cover for concrete waste disposal (approximately 23,000 yd^3), seed and mulch materials, and minor quantities of ready-mix concrete from local commercial sources for tunnel plugs.

An estimated average workforce of 30 to 35 people would be required for the construction activities, for an estimated duration of 16 months from site mobilization to construction completion for either alternative. The peak workforce required during demolition of the concrete dam could reach 50 to 55 people.

Waste disposal

Estimated waste quantities for the Copco No. 1 Dam and Powerhouse include nearly 62,000 yd^3 of concrete, 900 tons of rail and reinforcing steel, and over 1,200 tons of mechanical and electrical items at the dam and powerhouse. There are two buildings at the site with a combined estimated area of 1,600 ft^2 and estimated waste volume of 300 yd^3, and over 3 mi of 69-kV transmission lines.

All concrete rubble is assumed to be buried on the right abutment within an on-site disposal area, covering an area of approximately 7 acres. Some initial clearing and improvements to the disposal area would be required, including the demolition of two structures (maintenance building and residence) and stockpiling of excavated topsoil for later use. Rail and reinforcing steel would be separated from the concrete and hauled to a local recycling facility. The on-site disposal areas would be covered with topsoil, graded, and sloped for drainage upon completion. Compaction other than by equipment travel would not be necessary.

All mechanical and electrical equipment would be hauled to a suitable dump site or salvage collection point outside the FERC project boundaries. A Class III sanitary landfill and medium volume transfer station is located in Yreka, California, in Siskiyou County, approximately 28 mi from the damsite, and is accessible by county road and federal highway (Interstate 5). The landfill accepts construction and demolition waste and mixed municipal waste, and has an estimated remaining capacity of 3,924,000 yd^3. The transfer station accepts metals and mixed municipal recyclable materials.

Potential hazardous materials at Copco No. 1 Dam and Powerhouse include asbestos, batteries, bearing and hydraulic control system oils, treated wood, and coatings containing heavy metals in the powerhouse and on the exterior surfaces of the steel penstock and air vent pipes, as well as on other painted equipment, which would need specialized abatement and disposal requirements. Contaminated soils may exist at the locations of painted exterior equipment. Asbestos may be found in electrical wiring insulation and possibly in other building materials. Mercury may exist in older light switches. Although all transformers have been tested negative for PCB, some residual PCB's may exist in closed systems such as transformer bushings. Equipment containing nearly 12,000 gallons of various types of oils has been identified at the site.

All hazardous materials shall be shipped to disposal sites that are licensed to receive such materials. Established BMPs shall be followed to avoid or minimize accidental spills of hazardous materials into the Klamath River during demolition and shipping activities. The contractor shall have spill kits available in easily accessible locations at each of the dam and facilities removal sites. All hazardous material removal and transport activities shall also be subject to state and federal permit terms and conditions that regulate such activities. Federal law requires that owners/operators of facilities with large quantities of oils and fuels have SPCC Plans to address spills. The Contractor(s) will be required to have an approved SPCC Plan prior to performing the dam removal work. Any accidental discharge or spill of hazardous materials will be reported immediately to the DRE.

Estimated quantities, numbers of truck trips, proposed haul routes to disposal sites, and approximate haul distances for non-hazardous waste disposal are summarized in Table 2-4. This table assumes off-highway articulated rear dump trucks would be used for hauling concrete materials on unpaved roads between the dam and proposed waste sites on PacifiCorp property, with a nominal load capacity of 20 cubic yards each, and truck tractor-trailers for hauling mechanical and electrical items, metals, and other waste materials on paved public roads (at posted speed limits), with a nominal load capacity of 12.5 tons or 10 cubic yards each. A bulking factor of 30% for concrete rubble has been assumed for determining the number of truck trips required for hauling loose materials. All values have been rounded. Miles shown are average for one round trip, from demolition site to disposal site and return. Total miles (not shown) would be computed from the estimated number of total trips shown multiplied by the average trip distance. Peak daily trips for each site are based on the number of vehicles (units) shown, operating within one 8-hour shift.

Table 2-4. Non-Hazardous Waste Disposal for Removal of Copco No. 1 Dam

Waste material	Bulk quantity*	Disposal site	Peak daily trips	Total trips
Concrete	80,000 yd^3	Right abutment structure sites	2 units/50 trips (unpaved road)	4,000 trips (2 mi RT)
Metal and Rebar	2,100 tons	Transfer station near Yreka	1 unit/5 trips (Copco Road)	170 trips (62 mi RT)
Building Waste	300 yd^3	Transfer station near Yreka	1 unit/5 trips (Copco Road)	30 trips (62 mi RT)

* Volumes increased 30% for concrete.

2.2.3 Copco No. 2 Dam and Powerhouse

2.2.3.1 Removal Limits

Copco No. 2 Dam is located within a narrow canyon on the Klamath River at RM 198.3 (Figure 2-5). Minimum requirements for a free-flowing condition and for volitional fish passage on the Klamath River through the Copco No. 2 damsite would require the removal of the concrete gated spillway structure and concrete end sill between the existing sidewalls. The spillway gates, bridge deck, piers, and crest structure would be removed to permit reservoir drawdown for restoration of the river channel. The right sidewall and embankment section would remain within the 100-year floodplain, if left intact. Equipment on the right abutment embankment section would be removed to facilitate construction access to the gated spillway, and to restore the original appearance of the armored embankment. The left abutment power penstock intake structure and the downstream powerhouse could also be retained, provided any openings are sealed and security fencing is installed to prevent unauthorized entry. Retention of any structures would involve long-term maintenance costs, including the preservation of any items with coatings containing heavy metals. The wood-stave penstock located between the first and second tunnels consists of creosote-treated wood and would be hauled to an approved disposal facility in Anderson, California, about 120 mi away (consistent with current PacifiCorp policy). The steel penstocks between the second tunnel and the powerhouse could be retained to preserve the appearance of the historical power generation features, although long-term maintenance issues related to the steel, which is assumed to include coatings containing heavy metals, would have to be addressed, and the penstocks would continue to provide a potential barrier to wildlife migration. All open tunnel and shaft portals would be plugged with reinforced concrete to avoid unauthorized entry. The excavated tailrace channel between the powerhouse and the river would be backfilled. The Copco No. 2 substation located at the powerhouse, and a 230 kV switchyard located on a bluff north of the river, must remain in service following dam removal. Any unused transmission lines would be removed, including poles and transformers. The existing transmission lines cross over steep terrain in some areas and may be difficult to access.

Removal of the Copco No. 2 powerhouse would involve the following major mechanical and electrical equipment: two vertical-shaft, Francis-type hydraulic turbine units, two turbine governor hydraulic control systems with oil storage reservoir and pressure tank, two turbine runner spiral casings and head covers/operating rings, four turbine gate hydraulic servomotors, two vertical turbine shafts, two turbine draft tubes, draft tube bulkhead gate(s), vertical sump pump(s), bearing oil storage tank(s), two 40-ton overhead traveling crane and structural members, and other miscellaneous mechanical equipment, piping, and valves; distribution equipment, unit breaker, two generators, conduit and cable, plant control equipment, and other miscellaneous electrical equipment. The existing plant transformers located within the switchyard are expected to remain in service.

Features to be removed or retained for the dam removal alternatives are summarized in Table 2-5.

Table 2-5. Copco No. 2 Dam and Powerhouse Removal Requirements

Feature	Full removal
Spillway Gates, Structure	Remove
Power Penstock Intake Structure	Remove
Tunnel Portals	Concrete Plug
Embankment Section	Remove
Wood-stave Penstock	Remove
Concrete Pipe Cradles	Remove
Steel Penstock, Supports, Anchors	Remove
Powerhouse	Remove
Powerhouse Hazardous Materials (transformers, batteries, insulation)	Remove
69-kV Transmission Line, 1.23 mi	Remove
Switchyard	Retain
Tailrace Channel	Backfill

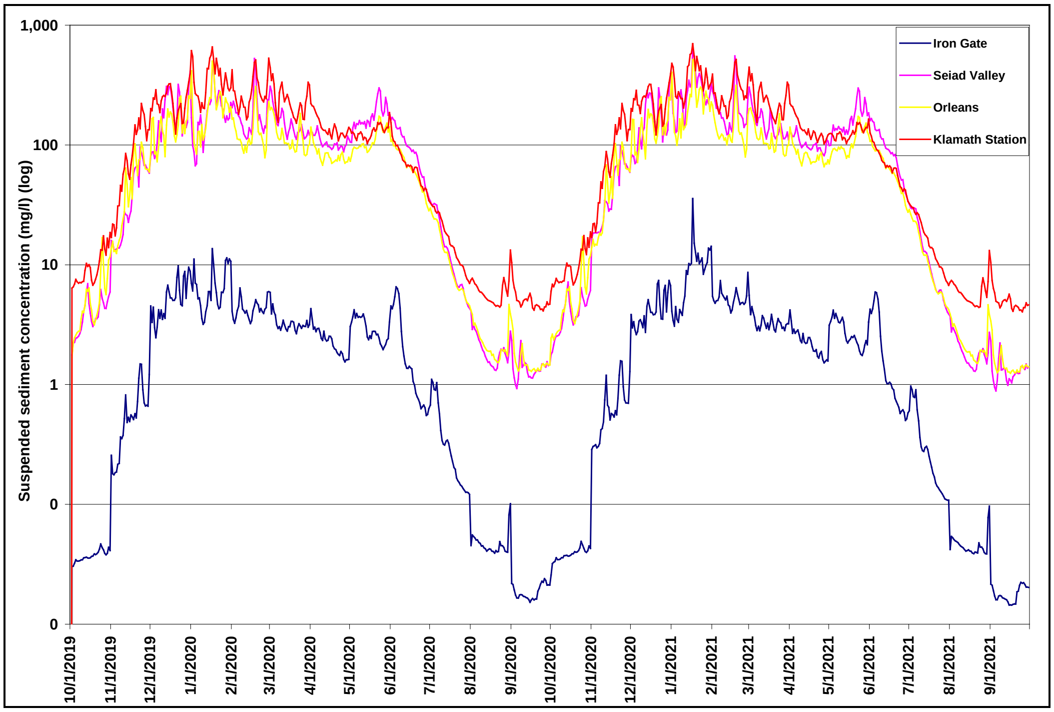


Figure 4-4. Extreme Conditions (10% Exceedance Probability) SSCs for Four Locations Downstream of Iron Gate Dam under Existing Conditions, as Predicted Using the SRH-1D Model

4.1.5.4 Dissolved Oxygen

Dissolved oxygen concentrations in the Klamath Basin depend on several factors, including water temperature (colder water absorbs more oxygen), water depth and volume, stream velocity (as related to mixing and re-aeration), atmospheric pressure, salinity, and the activity of organisms that depend upon dissolved oxygen for respiration. This last factor (respiratory consumption) is strongly influenced by the availability of nitrogen and phosphorus for supporting algal and aquatic plant growth.

In tributaries to UKL, limited data indicate that dissolved oxygen varies from <7 to 13 mg/L (Kann 1993, Oregon DEQ 2002). Concentrations in the lake itself exhibit high seasonal and spatial variability, ranging from less than 4 mg/L to greater than 10 mg/L. High nutrient loading is the primary cause of eutrophication and subsequent low dissolved oxygen levels in UKL. Water quality datasets collected by the Klamath Tribes include periods of weeks during the summer months when dissolved oxygen levels in the lake are continuously below the Oregon DEQ criterion of 5.5 mg/L for support of warm water aquatic life (Kann 2010). Low (0–4 mg/L) dissolved oxygen concentrations occur most frequently in August, the period of declining algal blooms in the lake and warm water temperatures (Oregon DEQ 2002, Walker 2001) (see Appendix C of the Klamath Facilities Removal EIS/EIR for additional details).

Downstream in the Keno Impoundment (including Lake Ewauna), dissolved oxygen reaches very low levels (<1−2 mg/L) during July–October as algae transported from UKL settle out of the water and decay. Four water treatment facilities discharge treated wastewater to the Keno Impoundment; however, these facilities contribute a very small amount (<1.5% of the organic material loading) to the overall oxygen demand in the Keno Reach. Decomposition of algae transported from UKL appears to be the primary driver of low oxygen in the Keno Impoundment (including Lake Ewauna) (Sullivan et al. 2009, 2011; Kirk et al. 2010).

2.2.3.3 Dam Removal (May 1, 2020)

a. Close caterpillar gate at power penstock intake structure to stop releases to Copco No. 2 Powerhouse. Make controlled releases through gated spillway (crest elevation 2,473) during low flow period, for initial reservoir drawdown from RWS elevation 2,483 to RWS elevation 2,478 in one day, using the two spillway gates on the right-hand side. Remove equipment and concrete pad from dike crest to provide room for demolition equipment and for construction access.
b. Construct a temporary cofferdam within the river channel to isolate the two left-hand spillway bays for removal to elevation 2,454 in the dry, including spillway gates, hoists, bridge deck, and concrete crest structure. Remove temporary cofferdam and allow reservoir to stabilize at approximately RWS elevation 2,460 through dam breach. Construct a second temporary cofferdam within the river channel to isolate the three remaining spillway bays on the right-hand side for removal to elevation 2,454 in the dry, including the remaining spillway gates, hoists, bridge deck, and concrete crest structure. Remove temporary cofferdam.
c. Use small cofferdam at power penstock intake structure for removal of trashracks, caterpillar gate, and concrete structure, and to construct tunnel plug in the dry. Leave cofferdam in place within approach channel to restore left river bank.
d. Complete any remaining demolition work as required. Restore dam site and on-site disposal area (shared with Copco No. 1 demolition) as required by October 2020, including the placement of topsoil and seeding. Demobilize from site.

Remove penstock and powerhouse

a. Remove wood-stave penstock and concrete features as required following closure of the upstream caterpillar gate and shutdown of the powerhouse. Construct reinforced concrete tunnel plugs at each open portal.
b. Construct cofferdam in tailrace channel for removal of powerhouse in the dry as required, during low flow period. Use sump pumps to dewater area. Leave cofferdam in place within tailrace channel and backfill to restore left river bank.

Demolition methods and equipment

The following demolition methods and sequence, construction equipment requirements, workforce requirements, and construction activity durations have been assumed for planning, scheduling, and cost estimating purposes, based on engineering judgment. Alternative methods, sequence, equipment, and durations which would also meet project requirements are possible.

The concrete dam is situated in a steep, narrow canyon. The existing access road would require significant upgrading to handle the hauling of the excavated concrete and provide access for a large crawler-mounted crane. The contractor would have to mobilize construction equipment to the site by March 2020, and improve the existing access road between the dam and on-site disposal area shared with Copco No. 1 Dam demolition. The delivery of off-road construction equipment, including cranes, large excavators, loaders, and large capacity dump trucks would be by special tractor-trailer vehicles operating under “wide load” restrictions and at appropriate speeds. Equipment staging areas would include the right abutment of the dam and the vicinity of the downstream powerhouse. The access bridge across the Klamath River downstream of the powerhouse may require improvements to handle the construction equipment loads. A new bridge was assumed for development of the most probable high cost estimate.

The spillway gates and traveling hoists would be removed by a large crane for loading onto highway trucks and heavy-haul trailers, with the reservoir drawn down as much as possible. The reinforced concrete spillway bridge deck and piers could be removed in pieces by hydraulic excavators, or in sections by conventional or diamond-wire sawcutting. Removal of the remainder of the spillway concrete structure would likely be performed using conventional drilling and blasting methods as each portion is unwatered. Drilling for blasting would include small- to mid-sized hydraulic track drills and perhaps air-track drills supported by 850 to 1,200 ft^3/min air compressors. Considerable jack-leg and hand drilling could be used to supplement the machine drilling for special shots. The loading and hauling equipment would be similar to that employed at Copco No. 1, but with fewer active crews. An average haul distance of 1.25 mi was assumed for construction scheduling purposes, with an average speed for the haul units of 12 mph. Reinforced concrete in deck, wall, and floor slabs for remaining features to be removed (including intake structure, gravity structure, sidewalls, apron, and powerhouse) would be excavated by mechanical methods (e.g., hydraulic shears or hoe-ramming).

Assumed equipment for the removal of Copco No. 2 Dam and Powerhouse includes:

- Crawler-mounted lattice boom crane, 200 ton, 160- to 200-ft boom
- Rough terrain hydraulic crane, 35 to 75 ton
- Mid-size hydraulic excavator, 28,000 to 60,000 lb, 1 to 2 yd^3 bucket
- Cat 336 hydraulic track excavator, 80,000 lb, 3.5 yd^3 bucket
- Hydraulic track excavators, 65,000 to 120,000 lb, with Cat H120 hoe-ram, thumb and shear attachments
- Cat 966 articulated wheel-loader, 52,000 lb, 5 yd^3 bucket
- Cat 730 articulated rear dump truck, 50,000 lb, 30 ton (20 yd^3)
- D-6 or D-7 standard crawler dozers
- Front-end wheel loader, integrated tool carrier, 25,000 lb
- Cat TL943 rough terrain telescoping forklift
- Rough terrain telescoping manlift
- On-highway, light-duty diesel pickup trucks, ½-ton and 1-ton crew
- On-highway flatbed truck with boom crane, 16,000 lb
- On-highway truck tractors, 45,000 lb
- Off-highway water tanker, 5,000 gallon
- On-highway water truck, 4,000 gallon
- Self-propelled rubber tire and drum vibratory compactor, 5 to 15 ton
- Engine generators, 6.5 KW to 40 KW, diesel or gasoline
- Air compressors, 100 to 150 psi, 185 to 850 cfm, diesel
- Airtrack drill or hydraulic track drill
- Hand-held drilling, cutting, and demolition equipment
- Portable welders and acetylene torches
- 4-inch submersible trash pumps, electric

Imported materials that may be required for construction would include gravel surfacing for temporary haul roads, soil cover for concrete waste disposal, seed and mulch materials, and minor quantities of ready-mix concrete from local commercial sources for tunnel plugs.

An estimated average workforce of 25–30 people would be required for the construction activities, for an estimated duration of about six months from site mobilization to construction completion for either alternative. The peak workforce required during excavation of the dam and powerhouse could reach 35–40 people.

Waste disposal

Estimated waste quantities for the Copco No. 2 Dam and Powerhouse include nearly 1,500 yd^3 of earthfill, over 6,000 yd^3 of concrete, an estimated 300 tons of reinforcing steel, and nearly 500 tons of mechanical and electrical items at the dam (to the first tunnel portal); and over 6,000 yd^3 of concrete, an estimated 300 tons of reinforcing steel, over 1,500 tons of mechanical and electrical items, and 550 tons of treated wood (in wood-stave penstock) from the first tunnel portal to the powerhouse. There is also a large shop building with a total area of 3,600 ft^2 and estimated waste volume of 600 yd^3, and 0.14 mi of 69-kV transmission lines.

All concrete rubble and embankment material from the dam is assumed to be buried on the right abutment within an on-site disposal area prepared for the disposal of concrete rubble from Copco No. 1 Dam, covering an area of approximately 7 acres. Concrete rubble from the powerhouse may be buried within the existing tailrace channel. Reinforcing steel would be separated from the concrete and hauled to a local recycling facility. The on-site disposal areas would be covered with soil, graded, and sloped for drainage upon completion. Compaction other than by equipment travel would not be necessary.

All mechanical and electrical equipment would be hauled to a suitable dump site or salvage collection point outside the FERC project boundaries. A Class III sanitary landfill and medium volume transfer station is located in Yreka, California, in Siskiyou County, approximately 28 mi from the damsite, and is accessible by county road and federal highway (Interstate 5). The landfill accepts construction and demolition waste and mixed municipal waste, and has an estimated remaining capacity of 3,924,000 yd^3. The transfer station accepts metals and mixed municipal recyclable materials.

Potential hazardous materials at Copco No. 2 Dam and Powerhouse include creosote-treated wood-stave (redwood) penstock and treated wood, asbestos, batteries, bearing and hydraulic control system oils, and coatings containing heavy metals in the powerhouse and on the exterior surfaces of the steel penstock and air vent pipes, which would need specialized abatement and disposal requirements. The treated wood materials would be hauled approximately 120 mi to Anderson, California for disposal, as has been done by PacifiCorp for similar removed materials in the past. Contaminated soils may exist at the locations of painted exterior equipment. Asbestos may be found in electrical wiring insulation and possibly in other building materials. Mercury may exist in older light switches. Although all transformers have been tested negative for PCB, some residual PCB's may exist in closed systems such as transformer bushings. Equipment containing over 18,000 gallons of various types of oils and fuels has been identified at the site. The administration and control center includes a building for the storage of EPA-regulated materials, and a fueling facility containing above-ground gasoline (1,000 gallon) and diesel (500 gallon) tanks which meet state and federal requirements. Underground septic systems are in use for seven residences near the Powerhouse.

All hazardous materials shall be shipped to disposal sites that are licensed to receive such materials. Established BMPs shall be followed to avoid or minimize accidental spills of hazardous materials into the Klamath River during demolition and shipping activities. The contractor shall have spill kits available in easily accessible locations at each of the dam and facilities removal sites. All hazardous material removal and transport activities shall also be subject to state and federal permit terms and conditions that regulate such activities. Federal law requires that owners/operators of facilities with large quantities of oils and fuels have SPCC Plans to address spills. The Contractor(s) will be required to have an approved SPCC Plan prior to performing the dam removal work. Any accidental discharge or spill of hazardous materials will be reported immediately to the DRE.

Estimated quantities, numbers of truck trips, proposed haul routes to disposal sites, and approximate haul distances for non-hazardous waste disposal are summarized in Table 2-6. This table assumes off-highway articulated rear dump trucks would be used for hauling concrete and earth materials on unpaved roads between the dam or powerhouse and proposed waste sites on PacifiCorp property, with a nominal load capacity of 20 cubic yards each, and truck tractor-trailers for hauling mechanical and electrical items, metals, and other waste materials on paved public roads (at posted speed limits), with a nominal load capacity of 12.5 tons or 10 cubic yards each. A bulking factor of 30% for concrete rubble and 20% for earth materials has been assumed for determining the number of truck trips required for hauling loose materials. All values have been rounded. Miles shown are average for one round trip, from demolition site to disposal site and return. Total miles (not shown) would be computed from the estimated number of total trips shown multiplied by the average trip distance. Peak daily trips for each site are based on the number of vehicles (units) shown, operating within one 8-hour shift.

Table 2-6. Non-Hazardous Waste Disposal for Full Removal of Copco No. 2 Dam

Waste material	Bulk quantity*	Disposal site	Peak daily trips	Total trips
Earth	1,800 yd^3	Right abutment structures site	2 units/50 trips (unpaved road)	90 trips (2 mi RT)
Concrete at dam	8,000 yd^3	Right abutment structures site	2 units/50 trips (unpaved road)	400 trips (2 mi RT)
Concrete at powerhouse	8,000 yd^3	Tailrace area	Dispose at site (no hauling)	0
Metal and Rebar at dam	560 tons	Transfer station near Yreka, CA	1 unit/5 trips (Copco Road)	45 trips (62 mi RT)
Metal and Rebar at powerhouse	1,800 tons	Transfer station near Yreka, CA	2 units/10 trips (Copco Road)	145 trips (56 mi RT)
Building Waste	600 yd^3	Transfer station near Yreka, CA	2 units/10 trips (Copco Road)	60 trips (56 mi RT)
Treated Wood	550 tons	Landfill near Anderson, CA	1 unit/2 trips (Interstate 5)	45 trips (240 miRT)

* Volumes increased 30% for concrete rubble, 20% for loose earth materials.

2.2.4 Iron Gate Dam and Powerhouse

2.2.4.1 Removal Limits

IGD is located in a relatively narrow canyon on the Klamath River at RM 190.1 (Figure 2-6). Minimum requirements for a free-flowing condition and for volitional fish passage on the Klamath River through the Iron Gate damsite would require the complete removal of the zoned earthfill embankment and concrete cutoff walls between the rock abutments and to the bedrock foundation, to ensure long-term stability of the site and to prevent the development of a potential fish barrier in the future. The fish trapping and holding facilities located on random fill in the river channel below the dam would also have to be removed to restore the river channel. The concrete intake towers and access footbridges would be removed for public safety and to prevent potential future seismic stability concerns. The spillway side-channel inlet structure, chute, and terminal structure would be buried (requiring up to 300,000 yd^3 of backfill) to reduce project costs and to restore the pre-dam appearance of the right abutment. The diversion intake structure would be removed, and the tunnel and vertical shaft portals would be plugged with reinforced concrete to avoid unauthorized entry for either alternative. The steel penstock and water supply pipes between the intake structure and the powerhouse would be removed to accommodate removal of the dam embankment, and to avoid long-term maintenance issues related to the steel, which is assumed to include coatings containing heavy metals. The excavated tailrace channel between the powerhouse and the river would be backfilled as necessary, and the switchyard would be removed. Any unused transmission lines would be removed, including poles and transformers. The existing transmission lines cross over steep terrain in some areas and may be difficult to access.

Figure 2-6. Iron Gate Reservoir, Dam, Fish Collection Facilities, and Powerhouse (Images from Klamath Riverkeeper)

The Iron Gate fish hatchery, located near Bogus Creek, is assumed to be retained for at least 8 years, upon which time the state of California will make a determination whether or not to continue funding the facility. An alternative water source would have to be found for the fish hatchery to remain operational. The existing 30-inch-diameter cold water supply distribution system from the penstock intake structure to the Iron Gate fish hatchery (including aerator) would be removed with the embankment dam sometime after June 2020.

Removal of the Iron Gate powerhouse would involve the following major mechanical and electrical equipment: one vertical-shaft, Francis-type hydraulic turbine unit, one turbine governor hydraulic control system with oil storage reservoir and pressure tank, one turbine runner spiral casing and head cover/operating ring, two turbine gate hydraulic servomotors, one vertical turbine shaft, one 96-inch-diameter bypass pipe from penstock around unit to tailrace, one turbine draft tube, three draft tube bulkhead gates, four vertical turbine pumps on powerhouse tailrace deck for fish ladder water supply, a vertical sump pump, bearing oil storage tanks, and other miscellaneous mechanical equipment, piping, and valves; three plant transformers, distribution equipment, unit breaker, one generator, conduit and cable, plant control equipment, and other miscellaneous electrical equipment. Removal of the Iron Gate switchyard for either alternative would involve the removal of all transformers, breakers, switches, and take-off structures. The 150-ton generator gantry crane is currently located at J.C. Boyle Dam and is assumed to be removed from that site.

The short tailrace channel between the powerhouse and the river channel could be backfilled to the pre-construction contours if necessary, effectively burying the remaining structure.

Features to be removed or retained for the dam removal are summarized in Table 2-7.

Table 2-7. IGD and Powerhouse Removal Requirements

Feature	Full removal
Embankment Dam, Cutoff Walls	Remove
Penstock Intake Structure	Remove
Penstock	Remove
Water Supply Pipes	Remove
Spillway Structure	Retain, Bury
Powerhouse	Remove
Powerhouse Hazardous Materials (transformers, batteries, insulation)	Remove
Powerhouse Tailrace Area	Backfill
Fish Facilities on Dam	Remove
Fish Hatchery	Retain
Switchyard	Remove
69-kV Transmission Line, 6.55 mi	Remove
Diversion Tunnel Intake Structure	Remove
Diversion Tunnel Portals	Concrete Plug
Diversion Tunnel Control Gate	Remove

2.2.4.2 Reservoir Drawdown

The following reservoir drawdown and streamflow diversion plan is proposed to facilitate the removal of IGD, while minimizing flood risks and downstream impacts due to the release of impounded sediments. Additional releases due to concurrent drawdown at J.C. Boyle Dam and Copco No. 1 Dam may affect the drawdown of Iron Gate Reservoir. The proposed plan assumes that power generation at IGD ends on January 1, 2020, as specified by the KHSA. Reservoir drawdown would not commence until that time.

The natural slopes on the reservoir rim usually control the allowable drawdown rate because natural slopes in soil are often not as stable as the engineered slopes of an embankment. Typically, rapid drawdown failures in soil are shallow slides that do not have significant impact. A preliminary review of the reservoir rim at IGD did not reveal obvious stability problems, nor were there any significant structures that could be impacted by rapid drawdown slope failures (PanGEO 2008). The drawdown of Iron Gate Reservoir would therefore be controlled by the rate that would be safe for the embankment dam. A nominal drawdown rate of 1 ft/day would not impact the stability of IGD because the dam has wide, pervious outer shells that not only have high strength, but should also drain relatively quickly as the reservoir is drawn down. Increasing the drawdown rate beyond 1 ft/day would provide increased flexibility in the removal schedule as less time would be required for reservoir drawdown. Although a faster drawdown rate of 3 ft/day or more may be acceptable for the existing conditions, additional slope stability analyses and a much more detailed evaluation of the reservoir rim slopes would be required to confirm this condition. Faster drawdown rates could result in deeper slides which may present a greater safety concern due either to the slide or the potential for reservoir waves generated by the slide. For the drawdown modeling runs, an average drawdown rate of 3 ft/day was assumed for Iron Gate Reservoir, which would be confirmed by additional analyses for final design.

Sufficient freeboard would have to be maintained at all times between the elevation of the excavated embankment surface and the reservoir to prevent flood overtopping and potential embankment failure. The freeboard would be dictated by the amount of flood protection that is desired (in terms of flood return period) during the removal operation.

Normally when the dam is higher and failure due to flood overtopping would cause a catastrophic release of reservoir water, the flood storage (freeboard) has to be larger. As dam removal nears completion and the reservoir impoundment is much smaller, the consequences of overtopping are not as great and less freeboard and flood protection would be acceptable. The proposed plan described below does not permit any excavation of the embankment section at IGD until June 1, 2020, and requires completion by September 30, 2020, to minimize hydrologic risk.

Modify diversion tunnel to increase total release capacity (June-July, 2019)

a. With upstream (upper sluice and lower diversion) concrete gates closed, remove downstream stoplog structure and miscellaneous metalwork from downstream tunnel in the dry. Maintain air vent pipe in tunnel crown if needed for final operation. Securely bolt existing blind flange to the reinforced concrete ring downstream of the concrete gates to retain full reservoir head. (Preliminary analyses confirm the existing features would be capable of accommodating this loading condition).

b. Raise upper sluice gate slowly to fill portion of downstream tunnel between concrete gates and blind flange. Provide air vent and drain valve through downstream concrete ring as necessary. Close air vent when filling has been completed.

c. Mobilize barge-mounted crane onto reservoir in June 2019. Raise upper sluice gate to top of control tower using the existing hoist and remove using barge-mounted crane. Send hard-hat divers to bottom of wet-well shaft to install lifting device for lower diversion gate, and to cut welded connection along downstream seal of lower diversion gate. Raise lower diversion gate to top of control tower using existing hoist and remove using barge-mounted crane. Fabricate, deliver, and install new 16.5- by 18-ft roller gate into existing slots in gate shaft (with a 150-ft design head) using hard-hat divers and barge-mounted crane. Install new gate operator with remote controls. Close new roller gate. Move barge-mounted crane to Copco Reservoir by mid-July 2019.

d. With new roller gate closed, drain downstream tunnel using air vent and drain valve provided at the blind flange. Remove blind flange and reinforced concrete ring. Complete any repairs to downstream tunnel lining as needed.

Begin reservoir drawdown and sediment release using modified tunnel (January 1, 2020)

a. Cease power generation and begin reservoir drawdown from RWS elevation 2,328 on January 1, 2020. Make controlled releases through modified diversion tunnel. Assume predicted inflows, plus drawdown releases from upstream reservoirs of up to about 500 cfs.

b. Continue reservoir drawdown at an allowable drawdown rate (assumed for scheduling purposes at 3 ft per day) using modified diversion tunnel. Should reach RWS elevation 2,202 or lower for a median (50% exceedance) or dry (90% exceedance) year, or about RWS elevation 2,220 for a wet (10% exceedance) year, based on estimated release capacities; however, some refill should be expected for higher flows in March and April, which may be acceptable. (Note that elevation 2,202 is 3 ft below original cofferdam crest.).

2.2.4.3 Dam Removal (June 1, 2020)

a. Drawdown reservoir, but maintain a minimum flood release capacity of approximately 7,500 cfs in June (RWS elevation 2,294), to accommodate at least a flood event having a 1% exceedance probability at that time of year, based on historical records plus total drawdown release. Remove fish facilities near downstream toe of embankment (including fish ladder and holding tanks) and dam crest sheet piles in the dry. Retain embankment dam crest at level needed for flood protection, and the existing access bridge to the gate control house for regulating tunnel releases.

b. Begin embankment excavation for dam removal, but maintain a minimum flood release capacity of approximately 4,000 ft^3/s in July (RWS elevation 2,214) and 2,000 ft^3/s in August and September (RWS elevation 2,190), to accommodate at least a flood event having a 1% exceedance probability at that time of year, based on historical records. Remove embankment materials (estimated 880,000

yd^3 without upstream cofferdam volume of 20,000 yd^3), 5-ft riprap on downstream face (30,000 yd^3), and 10-ft riprap on upstream face (80,000 yd^3) in the dry. Requires two shifts per day, 6 days per week, for 16,000 yd^3 per day (average 1,000 yd^3 per hour). Assume left abutment disposal site (shown on drawings) for earth and concrete rubble, with approximately a 1-mi haul. Begin wasting earth and concrete materials in spillway chute and basin (up to 300,000 yd^3) after June, with dam crest below existing spillway crest (elevation 2,328). Provide new access to gate control house between base of tower at elevation 2,254 and deck at elevation 2,338 (84 ft high – assume vertical stairway structure, or longer footbridge from spillway crest). Also consider remote operation of the roller gate for flow control.

c. Draw down reservoir to maximum extent (during minimum streamflow and with no upstream drawdown releases) by September 1, 2020 and place rockfill on downstream face of cofferdam (crest elevation 2,202 or lower) for controlled breach of cofferdam embankment above the existing bedrock surface at elevation 2,154 by notching below the reservoir level. Remove remaining materials from the river channel in the wet, during the low flow period. Breach cofferdam at IGD prior to breach of cofferdam at J.C. Boyle Dam to minimize potential downstream impacts. Maximum breach outflow from cofferdam at IGD is estimated to be approximately 5,000 cfs.
d. Remove diversion tunnel intake structure (invert elevation 2,175), topple gate control tower for removal, and plug tunnel and shaft portals with reinforced concrete. Topple and remove penstock intake structure, and plug openings. Remove water supply features for fish facilities.
e. Construct cofferdam in tailrace channel for removal of powerhouse in the dry. Use sump pumps to unwater area. Remove cofferdam when no longer needed. Demobilize from site when construction activities are complete.

Demolition methods and equipment

The following demolition methods and sequence, construction equipment requirements, workforce requirements, and construction activity durations have been assumed for planning, scheduling, and cost estimating purposes, based on engineering judgment. Alternative methods, sequence, equipment, and durations, which would also meet project requirements, are possible.

The contractor would have to mobilize construction equipment to the site by June 2019 for the diversion tunnel modifications and to improve the existing access roads between the dam and on-site waste disposal areas for two-way traffic where required. The delivery of off-road construction equipment, including cranes, large excavators, loaders, and large capacity dump trucks would be by special tractor-trailer vehicles operating under “wide load” restrictions and at appropriate speeds. Equipment staging areas would include both abutments of the dam and in the vicinity of the powerhouse. New haul routes from the dam would continually have to be constructed and maintained as the excavation level and shape changes. An average haul distance of 1.5 mi was assumed for construction scheduling purposes, with an average speed for the haul units of 20 mph empty and 10 mph loaded. During a site visit in October 2007, the morning fog was very thick until 10 am. If this were to occur during dam removal, it could impact the rate at which trucks could haul the excavated embankment materials due to reduced visibility on the haul road. The use of a conveyor belt may be considered as an alternative or supplement to truck hauling. The access bridge across the Klamath River downstream of the dam may also require improvements to handle the anticipated construction equipment loads. A conveyor belt was considered for development of the most probable low cost estimate, and a new bridge was assumed for development of the most probable high cost estimate, as described in Section 9 (Construction Cost Estimates) of the Detailed Plan (Reclamation 2012b).

The successful removal of IGD would be highly dependent upon the modification and operation of the diversion tunnel for low-level releases to permit controlled reservoir drawdown, and a very high excavation production rate for removal of the embankment during the summer, low-flow months (June through September). The Iron Gate production assessment considers the approximate lift area by elevation and how many concurrent excavation operations could be occurring at that elevation. At the top, the lift surface is narrow and long and the needed overall average production rate would not be attainable. As the excavation descends, the footprint would become wider and additional equipment could be added to the equipment spread. The short and wide bottom lifts would also limit production, similar to the top. Consequently, very high production rates would be needed for the larger middle lifts. The removal of the riprap would most likely occur as the embankment is excavated down. Some rockfill would have to be stockpiled for later use as slope protection for the upstream cofferdam.

The contractor would probably use conventional earthmoving equipment consisting of excavators and off-road articulated or fixed-wheel haul units to reach the required average production rate of 1,000 yd^3 per hour. Key factors would be sizing the excavators to minimize the loading passes per haul unit, and selecting the maximum size haul units that can effectively negotiate the dam surface and haul route. To achieve the desired daily production rates, shift work would be required. The potential for significant acceleration of the construction schedule may be very limited, if required, and may only be obtained by adding additional excavation time (increasing to 6 or 7 days per week, and/or longer shifts) and probably not by adding more equipment to the limited lift surfaces. The current assessment assumes five days per week and 1.75 shifts per day for eight to nine shifts per week, and assumes an average of twenty 35-ton haul units loaded by up to four 180,000 to 240,000 lb, 6 to 8 yd^3 excavators, to remove the dam embankment within about 16 weeks. This assessment could be revised to increase the number of shifts per week, the lengths of the shifts, and the size of the haul units, but would produce a best-case scenario that would probably not be consistently achievable.

Reinforced concrete in deck, wall, and floor slabs for any structures to be removed (including intake structures, control structures, fish handling facilities, and powerhouse) would likely be excavated by mechanical methods (e.g., hydraulic shears or hoe-ramming). Removal of any mass concrete may be performed using conventional drilling and blasting methods.

Assumed equipment for the removal of IGD and Powerhouse and for restoration of the reservoir area includes:

- Crawler-mounted lattice boom crane, 200 ton, 160- to 200-ft boom
- Rough terrain hydraulic crane, 35 to 75 ton
- Hitachi hydraulic excavator, 180,000 to 240,000 lb, 6 to 8 yd^3 bucket
- Cat 336 hydraulic track excavator, 80,000 lb, 3.5 yd^3 bucket
- Hydraulic track excavators, 65,000 to 100,000 lb, with Cat H120 hoe-ram, thumb and shear attachments
- Cat 966 articulated wheel-loader, 52,000 lb, 5 yd^3 bucket, or
- Cat 980 or Cat 988 articulated wheel-loader, 65,000 lb, 6 or 10 yd^3 bucket
- Cat 735 articulated rear dump truck, 70,000 lb, 35 ton (22 yd^3), or
- Cat 770 fixed haul unit, 160,000 lb, 40 ton
- D-7 or D-9 standard crawler dozers, or
- D-8 support and knockdown dozer
- Front-end wheel loader, integrated tool carrier, 25,000 lb
- Cat TL943 rough terrain telescoping forklift
- Rough terrain telescoping manlift
- Cat 14 or Cat 16 motorgrader

- Truck-mounted seed sprayer, 2,500 gallon
- On-highway, light-duty diesel pickup trucks, ½-ton, ¾-ton, and 1-ton crew
- On-highway flatbed truck with boom crane, 16,000 lb
- On-highway truck tractors, 45,000 lb
- Off-highway water tanker, 5,000 gallon
- On-highway water truck, 5,000 to 9,000 gallon
- Wheel-mounted asphalt paver (for most probable high estimate only)
- Self-propelled rubber tire and drum vibratory compactor, 5 to 15 ton
- Engine generators, 6.5 KW to 40 KW, diesel or gasoline
- Air compressors, 100 to 150 psi, 185 to 850 cfm, diesel
- Airtrack drill or hydraulic track drill
- Hand-held drilling, cutting, and demolition equipment
- Portable welders and acetylene torches
- 4-inch submersible trash pumps, electric
- Light plants, 2,000 to 6,000 watt, 10 to 25 hp, diesel

Imported materials that may be required for construction would include gravel surfacing for temporary haul roads (approximately 5,300 tons), soil cover for concrete waste disposal (if not from required excavation), seed and mulch materials, and minor quantities of ready-mix concrete from local commercial sources for tunnel plugs.

An estimated average workforce of 35 to 40 people would be required for the construction activities, for an estimated duration of 17 months from site mobilization to construction completion for either alternative. The peak workforce required during excavation of the dam embankment could reach 75 to 80 people.

Waste disposal

Estimated waste quantities for the IGD and Powerhouse include nearly 1,100,000 yd^3 of earthfill, nearly 12,000 yd^3 of concrete, an estimated 600 tons of reinforcing steel, and nearly 1,000 tons of mechanical and electrical items at the dam and powerhouse. In addition, there are four buildings at the site with a combined area of over 2,300 ft^2 and estimated waste volume of 400 yd^3.

A suitable disposal site for excavated embankment materials has been identified approximately 1 mi upstream from the dam on the left abutment, at an original borrow site, covering an area of approximately 29 acres. Some initial clearing and improvements to the disposal area would be required, including the stockpiling of excavated topsoil for later use. In addition, the existing concrete-lined side-channel spillway, chute, and flip-bucket terminal structure would be filled with up to 300,000 yd^3 of excavated embankment material for disposal and restoration of the site. An adjoining area below the spillway along the right bank of the river (currently occupied by two PacifiCorp residences and some outbuildings) could be used for a riprap stockpile area. The final disposal site location for all materials would have a significant impact on the costs to upgrade or construct the haul roads. Also, as the excavation descends, ramps out of the canyon would have to be constructed and maintained.

All concrete rubble is assumed to be buried within an on-site disposal area. Reinforcing steel would be separated from the concrete and hauled to a local recycling facility. The on-site disposal areas would be covered with topsoil, graded, and sloped for drainage upon completion. Compaction other than by equipment travel would not be necessary.

All mechanical and electrical equipment would be hauled to a suitable dump site or salvage collection point outside the FERC project boundaries. A Class III sanitary landfill and medium volume transfer station is located in Yreka, California, in Siskiyou County, approximately 25 mi from the damsite, and is accessible by county road and federal highway (Interstate 5). The landfill accepts construction and demolition waste and mixed municipal waste, and has an estimated remaining capacity of 3,924,000 yd^3. The transfer station accepts metals and mixed municipal recyclable materials.

Potential hazardous materials at IGD and Powerhouse include asbestos, batteries, bearing and hydraulic control system oils, treated wood, and coatings containing heavy metals in the powerhouse and on the exterior surfaces of the steel penstock and air vent pipes, and other painted equipment, which would need specialized abatement and disposal requirements. Contaminated soils may exist at the locations of painted exterior equipment. Asbestos may be found in electrical wiring insulation and possibly in other building materials. Although all transformers have been tested negative for PCB, some residual PCBs may exist in closed systems such as transformer bushings. Equipment containing nearly 5,000 gallons of various types of oils has been identified at the site. Underground septic systems are in use for the restroom and two residences near the dam and should be removed.

All hazardous materials shall be shipped to disposal sites that are licensed to receive such materials. Established BMPs shall be followed to avoid or minimize accidental spills of hazardous materials into the Klamath River during demolition and shipping activities. The contractor shall have spill kits available in easily accessible locations at each of the dam and facilities removal sites. All hazardous material removal and transport activities shall also be subject to state and federal permit terms and conditions that regulate such activities. Federal law requires that owners/operators of facilities with large quantities of oils and fuels have SPCC Plans to address spills. The contractor(s) will be required to have an approved SPCC Plan prior to performing the dam removal work. Any accidental discharge or spill of hazardous materials will be reported immediately to the DRE.

Estimated quantities, numbers of truck trips, proposed haul routes to disposal sites, and approximate haul distances for non-hazardous waste disposal are summarized in Table 2-8. This table assumes off-highway articulated rear dump trucks would be used for hauling concrete and earth materials on unpaved roads between the dam and proposed waste sites on PacifiCorp property, with a nominal load capacity of 22 cubic yards each, and truck tractor-trailers for hauling mechanical and electrical items, metals, and other waste materials on paved public roads (at posted speed limits), with a nominal load capacity of 12.5 tons, or 10 cubic yards each. A bulking factor of 30% for concrete rubble and 20% for earth materials has been assumed for determining the number of truck trips required for hauling loose materials. All values have been rounded. Miles shown are average for one round trip, from demolition site to disposal site and return. Total miles (not shown) would be computed from the estimated number of total trips shown multiplied by the average trip distance. Peak daily trips for each site are based on the number of vehicles (units) shown, operating within two 8-hour shifts for earth materials, and one 8-hour shift for concrete rubble and metal.

Table 2-8. Non-Hazardous Waste Disposal for Removal of IGD

Waste material	Bulk quantity*	Disposal site	Peak daily trips	Total trips
Earth	1,300,000 yd^3	Left and right abutment areas	12 units/800 trips (unpaved road)	60,000 trips (2 mi RT)
Concrete	15,000 yd^3	Left abutment borrow area	2 units/50 trips (unpaved road)	750 trips (2 mi RT)
Metal and Rebar	1,600 tons	Transfer station near Yreka, CA	1 unit/5 trips (Copco Road)	130 trips (54 mi RT)
Building Waste	400 yd^3	Transfer station near Yreka, CA	1 unit/5 trips (Copco Road)	40 trips (54 mi RT)

* Volumes increased 30% for concrete rubble, 20% for loose earth materials.

2.2.5 Reservoir Restoration

Under the Proposed Action, there would be substantial erosion of the reservoir sediment while the reservoirs were being drawn down. The eroded sediment would then be transported downstream. Following drawdown of the reservoirs, the DRE would complete restoration actions including revegetation as described in this section.

Following drawdown of the reservoirs, herbaceous species would be planted or would naturally recruit in the spring following drawdown. Woody species would gradually establish on the river terraces as they propagated from the outer edges of the reservoir. Revegetation efforts would be initiated to support establishment of native wetland and riparian species on newly exposed reservoir sediment. Access for ground application equipment is expected to be limited immediately following drawdown due to terrain, slope, and sediment instability. Upper areas would be reseeded from a barge until the reservoir levels become too low to operate and access the barge. As the reservoirs are drawn down, trucks will be used to apply hydroseed to all accessible areas. Aerial application would be necessary for precision applications of material near the sensitive areas and the newly established river channel, as well as in the remaining areas inaccessible by barge or truck.

Additional fall seeding might be necessary to supplement areas where spring hydroseeding was unsuccessful. In cases where mulch moved/degraded or otherwise exposed bare soil, aerial hydroseeding would be used again for the fall re-seeding. In other cases, where establishment failed, yet the mulch remained intact, new seed material applications might need to be incorporated in order to re-establish seed/soil contact sufficient for germination.

Several aggressive invasive weed species currently infest areas in relative proximity to the reservoir shorelines. Although hydromulching should theoretically suppress a good degree of weed infestations that would otherwise hinder revegetation efforts, further weed management will likely be necessary. Monitoring and management activities should commence as soon as deposits are stable enough to support application equipment and ground crew activities, as well as prevent chemically treated soils from entering the river.

Glyphosate will be used to control invasive weed species if other management efforts are ineffective or do not meet the restoration objectives. Glyphosate will be applied either in its commercial formulations (Rodeo® or Aqua-Master®) or mixed with the least toxic surfactant available to achieve effective coverage of the target species. Application of the herbicide shall be applied using techniques to avoid drift during application. The application rate will be under typical conditions (2 to 5.5 lbs of active glyphosate incredient/acre). Once grasses are established, spot treatments of post-emergent glyphosate herbicide will be applied to invasive species within the revegetation areas and may be re-applied the following year if further treatments are necessary. As noted in Section 2.2.6.7 and described in more detail in Apppendix A, minimization measures will be implemented as part of the herbicide treatment program.

2.2.6 Conservation/Protective Measures

Conservation and protection measures have been designed to limit project-related impacts on aquatic and terrestrial species. The drawdown of the reservoirs and removal of the four dams and associated facilities will result in a significant amount of sediment being entrained into the river flow. This action will likely have a significant impact on coho salmon downstream of the Hydroelectric Reach and on suckers within the reservoirs. Construction associated with the removal of project structures results in noise, which has the potential to disturb the northern spotted owl. Therefore, conservation and protective measures have been developed to minimize the potential impacts and are incoroporated into the Proposed Action. The conservation and protective measures are described below.

2.2.6.1 Protection of Mainstem Spawning

Measures have been developed to protect spawning Chinook and coho salmon during the year of dam removal and sediment release. Short-term effects of the Proposed Action (suspended sediment concentrations [SSCs] and bedload movement) will result in up to 100% mortality of fall Chinook and coho salmon embryos and pre-emergent alevin within redds that were constructed in the mainstem in the fall of 2019 (see Section 5.1 for a detailed effects analysis). Therefore, the DRE will implement an adult salmonid capture and relocation program prior to reservoir drawdown. Only seine nets will be used to capture adults on high-use mainstem spawning grounds, which are mostly in the reach between IGD and the Shasta River. Electro-shocking will not be included as an option to capture adults. All captured adults will be transported and released upstream of Keno Dam, or in other suitable locations. The relocated fish would be able to migrate upstream and spawn in the mainstem or tributary streams. A detailed plan describing capture techniques, release locations, and monitoring methods will be developed by the DRE prior to 2019 in coordination with NMFS.

2.2.6.2 Protection of Outmigrating Juveniles

Measures have been developed to protect juvenile coho salmon during the year of dam removal and sediment release. Short-term SSC effects of the Proposed Action will result in mostly sublethal and in some cases lethal, impacts on a portion of the juvenile coho that are outmigrating from tributary streams to the Klamath River upstream of Orleans during late winter and early spring of 2020. See Section 5.1 for a detailed effects analysis.

Short-term impacts on outmigrating juveniles can be reduced by capturing juveniles outmigrating from tributaries prior to their entry into the mainstem. This measure includes the installation of downstream migrant traps on up to 13 key tributary streams downstream of IGD: Bogus Creek, Dry Creek, Walker Creek, Shasta River, Seiad Creek, Oneil Creek, Scott River, Grider Creek, Tom Martin Creek, Horse Creek, Beaver Creek, Cottonwood Creek, and Humbug Creek. As described in Section 2.2.6.8 below (Contingency Measures), based on monitoring results trapping can also occur within additional tributaries between Seiad Valley and Orleans (e.g., Indian, Elk, Clear, and Dillon creeks, and the Salmon River). Results of spawning surveys in fall 2019 could be used to focus trapping efforts within these or other tributaries. Trapping on all of these streams is proposed to help preserve the genetic integrity and varied life history tactics that are represented by this group of streams that have a high diversity with respect to size, channel types, water temperature regimes, geographic distribution, and other attributes.

The trapping will involve the standard CDFG/USFWS rotary screw trap/fyke net/pipe trap methods currently in use. However, placement of a second trap downstream of the first would increase the number of captures. Captured fish will then be placed in aerated tank trucks and transported to a release site downstream of the Trinity River or other locations that have suitable water quality.

Capturing juveniles and transporting them downstream could effectively reduce the exposure of a large number of individuals to SSC impacts in the mainstem Klamath River during 2020. However, the procedures of trapping, handling, trucking, and releasing outmigrating salmonids can result in harm or mortality to some individuals, and releasing fish at downstream locations can reduce natal cues and increase stray rates. Therefore the intensity of the implementation of this conservation measure will be adjusted based on the conditions that occur during the spring of 2020; more trapping and protection if conditions are as or more severe than predicted, or less intensive trapping if conditions are less severe. As described in Section 2.2.6.8 (Contingency Measures), the magnitude of trapping during the implementation of this measure will be adjusted to ensure that actual impacts are within the ranges described in Section 5.1.4.1 for coho salmon.

Release locations will be varied to prevent predators from congregating at release locations. Alternatively, in a portion of tributaries, juveniles could be held in temporary facilities within tributaries and released when SSC in the mainstem are non-stressful. This would prevent any decrease in the natal cue, as well as any potential associated effects of fish transport. A detailed plan describing trapping techniques, release locations, and monitoring methods will be developed by the DRE prior to 2019 in coordination with NMFS.

2.2.6.3 Fall Flow Pulses

Measures have been developed to reduce impacts on fish during the year of dam removal and sediment release. Short-term SSC effects of the Proposed Action will result in sublethal effects on the northern DPS green sturgeon adults remaining in the mainstem Klamath River during fall 2019, mortality for mainstem spawning fall-run Chinook salmon, mortality for migrating adult winter steelhead, and sublethal effects for adult coho salmon remaining in mainstem prior to entering tributaries. See Section 5.1 for a detailed effects analysis for coho salmon.

Short-term impacts on adults can be reduced by augmenting flows during fall 2019 prior to dam removal. It has been observed that fall pulse flows result in the downstream migration of post-spawned northern DPS green sturgeon out of the Klamath River (Benson et al. 2007), and increased flows during fall prior to dam removal may increase the rate and proportion of fall-run Chinook salmon, steelhead, and coho salmon spawning in tributaries, and thus reducing the proportion of the population spawning in the mainstem or being exposed to SSC in the mainstem during migration (Stillwater Sciences 2009a).

Water releases in the fall prior to dam removal should mimic the natural hydrograph that will have existed in the Klamath River during a “wet year” prior to the Klamath Project, consistent with recommendations from the National Research Council (NRC 2004). However, if the water year during dam removal is dry, managers will need to balance the benefits of increased flows during fall with the risk of impacts on the basin if less water is available in the following spring (during smolt outmigration). To maximize the benefits of fall flow increases, pulse flows will be considered to occur in conjunction with natural precipitation events as described in NMFS’ 2011 Fall/Winter Flow Variability Program guidelines (NMFS 2011a). Doing so will also ensure that adults that are attracted up the mainstem by increasing fall flows are not blocked from accessing their natal streams due to natural low flow conditions.

A detailed plan describing target flows and monitoring methods will be developed by the DRE prior to 2019, and will be implemented to the extent conditions allow.

2.2.6.4 Hatchery Management

Measures have been developed to reduce impacts on hatchery-reared smolts during the year of and in the spring of 2021 following dam removal and sediment release. Short-term SSC effects of the Proposed Action will result in mostly sublethal, and in some cases lethal, impacts on a portion of the juvenile Chinook, coho, and steelhead smolts outmigrating from tributary streams to the Klamath River upstream of Orleans during late winter and early spring of 2020.

Short-term impacts on outmigrating hatchery Chinook and coho salmon smolts could be reduced by changes in hatchery management. Hatchery managers could adjust the timing of hatchery releases during spring 2020. Although it would be out of synch with natural life history timing, if smolts are released later in the spring (e.g., mid-May), survival is anticipated to be higher. In addition, holding smolts longer during the spring of 2021 would reduce impacts on smolts by avoiding the peak in spring release of sediment in the year following dam removal.

An alternative to adjusting the hatchery release timing would be to allow the sub-yearling and yearling smolts to imprint at the hatchery and then truck them to release locations downstream where SSC effects may be muted by tributary accretion flow. Trucking could be accomplished during the normal releasing timing period.

The implementation of this mitigation measure is dependent on the hatchery remaining open and having a suitable water supply. A detailed plan describing adjustments to hatchery management will be developed by the DRE prior to 2019 in coordination with NMFS.

2.2.6.5 Sucker Rescue and Relocation

Measures have been developed to reduce impacts on Lost River and shortnose suckers that are present in the Hydroelectric Reach. Short-term effects of the Proposed Action will result in mostly lethal impacts on Lost River and shortnose suckers within reservoirs in the Hydroelectric Reach. Under this measure adult Lost River and shortnose suckers in reservoirs downstream of Keno Dam can be captured and relocated to UKL (Buchanan et al. 2011).

The Proposed Action includes development and implementation of a radio-tagging and telemetry study that focuses on Lost River and shortnose suckers. The purpose of the study will be to identify preferred habitat and congregations of suckers in the reservoirs. This information will be used to better target heavy fish use areas and maximize salvage of suckers prior to reservoir drawdown.

Lost River and shortnose suckers can also be captured using electrofishing and trammel nets. It is recommended that these and other approved capture techniques be utilized for this relocation effort. Captured Lost River and shortnose suckers can then be placed in aerated tank trucks and transported to suitable release sites in UKL.

If deemed feasible in 2019 prior to dam removal, Klamath smallscale suckers will be collected directly downstream of J.C. Boyle Dam and terminating approximately 2 mi downstream in the approximate area of the current powerhouse. Fish will be collected using electro- fishing techniques. Smallscale suckers can then be placed in aerated tank trucks and transported to suitable release sites in Spencer Creek, immediately downstream of the Spencer Creek hook up road (upper limits for sucker in Spencer creek). Smallscale suckers will not be relocated upstream of Keno Dam. In coordination and consulation with the USFWS, a detailed plan describing sucker rescue and relocation will be developed by the DRE prior to 2019.

2.2.6.6 Noise and Disturbance Minimization to Protect Fish and Northern Spotted Owl

Fish

Underwater blasting and pile driving are not planned to occur downstream of IGD as part of the Proposed Action. Upon preparation of the definite plan, pile driving and underwater blasting activities upstream of IGD at J.C. Boyle, Copco 1, and Copco 2 dams will involve demolition of the dams and their associated structures, power generation facilities, installation of cofferdams, and other activities. These actions will include the use of heavy equipment, pile driving, and underwater or near-water blasting as necessary and as such, have the potential to disturb or even kill listed aquatic species. However, IGD would still serve as a barrier and coho salmon would not be affected by these activities.

It is understood that the coho salmon spawning migration will be nearly complete by the time the reservoir drawdown and sediment release at IGD occurs. In addition, any juvenile coho in the vicinity of IGD during drawdown will either suffer mortality or move away from the dam's vicinity due the presence of the sediment plume. However, it is possible that juvenile coho could move back into the project area and adult coho would arrive during the 2020 spawning migration season while demolition is underway. Therefore, there is the potential that coho salmon could be affected by construction-related noise impacts downstream of IGD.

Northern spotted owl

The following minimization measures for the northern spotted owl (NSO) will be implemented as part of the Proposed Action:

- Measures NSO 1: Prior to initiating any construction activities, potential impacts of ground-disturbing construction activities will be evaluated for NSO and its habitat, and construction plans will be modified as appropriate, with an overall goal of preventing or minimizing impacts. Locations of the individual components of the Proposed Action, noise disturbances, and habitat geographic information system (GIS) layers will be reevaluated using the best available data at the time of construction to determine whether or not additional measures are needed.
- Measure NSO 2: Protocol-level surveys will be conducted within suitable nesting and roosting habitat (assessed by using best available GIS information, aerial photos, and consultation with the USFWS) that occur within the NSO disturbance distance of the construction activity (Table 5-6). If no nesting is observed, no seasonal restriction will be required. If nesting is observed, a California seasonal restriction (February 1–September 15) or Oregon seasonal restriction (March 1–September 30) will be followed or activity will be delayed as late as possible into the late breeding season for California (July 10–September 15) or Oregon (August 11–September 30) to minimize the disturbance to young prior to fledging.
- Measure NSO 3: To prevent direct injury of young resulting from aircraft, no helicopter flights will occur within or at an elevation lower than 0.8 km (0.5 mi) of suitable nesting and roosting habitat during the entire breeding season unless protocol level surveys identify no activity centers.
- Measure NSO 4: No component of suitable nesting, roosting, foraging, or dispersal habitat will be modified or removed during the removal of transmission lines or installation or removal of fencing.

2.2.6.7 Standard Operating Procedures and Best Management Practices

In addition to measures listed previously in this section, Appendix A of this BA for herbicide treatment minimization measures and Appendix B of this BA for standard operating procedures and BMPs (taken from Appendix B of the Klamath Facilities Removal EIS/EIR [DOI and CDFG 2012]) will be implemented as a part of the Proposed Action, and are summarized below:

- Minimization measures for herbicide treatment program (refer to Appendix A);

- A Storm Water Pollution Prevention Plan will be prepared and implemented during and after deconstruction and/or construction activities and would include an erosion control and restoration plan for each construction site, a water quality monitoring plan, a hazardous materials management plan, and post-construction best management practices BMPs;
- Instream construction - Measures to Minimize Disturbance from Construction, on page IX-50 of the California Department of Fish and Game Manual (2010);
- Guidelines for temporary stockpiling;
- Adjacent land management practices;
- Removal of large woody debris, ditching, diking, bank armoring and gravel removal has the potential to eliminate connectivity between rivers and side channels and off-channel waters, increased speed and volume of stream flows, simplified channel structure, and degraded estuarine and nearshore habitat;
- Measures to reduce effects on riparian areas;
- Any stream bank area left barren of vegetation as a result of the implementation or maintenance of the practices shall be restored to a natural state by seeding, replanting, or other agreed upon means with native trees, shrubs, and/or grasses prior to November 15 of the project year;
- Avoidance and minimization measures of impacts on wetlands;
- Avoidance and minimization measures for bald and golden eagle, osprey, nesting great blue heron, willow flycatcher, and other protected species of birds within the Action Area;
- Protocol-level surveys for special status plant species and avoidance measures;
- Public health and safety measures;
- Air quality control measures;
- Cultural and historic resources conservation measures;
- Toxic and hazardous materials management procedures; and
- Minimization of impacts to traffic and transportation.

Please refer to Appendices A and B of this BA for more details regarding the measures listed above.

2.2.6.8 Contingency Measures

The conservation/protective measures identified above are expected to result in reduced impacts to listed species during facilities removal. The predicted impacts to coho salmon smolts from released sediment are based on the hydrologic conditions that occur during winter and spring of 2020. As discussed in detail Section 5.1.4.1, there is a 10% probability that the hydrologic conditions leading to the worst case scenario will occur during the implementation of the Proposed Action. Anticipated reduction in impacts are based on assuming that the SCCs in 2020 are equal to, or lower in intensity than this worst-case scenario. Should there be a significant change not analyzed, re-consultation on this aspect may be required.

Contingency measures have been developed to address the possibility of increased impacts to coho salmon if environmental conditions exceed the worst case scenario. The goal of contingency measures will be to ensure that the overall impact to coho salmon does not exceed the levels predicted in Section 5.1.4.1 for the worst case scenario. Contingency actions will be implemented based on monitoring two factors: 1) hydrologic conditions, and 2) SSCs and durations. The hydrologic conditions will be monitored during the late-fall, winter, and spring 2020 to determine if conditions are approaching a worst case scenario.

The Proposed Action includes the establishment of monitoring stations downstream of Keno Dam, IGD, Seiad Valley, Orleans, and at the Klamath Station. Turbidity data will be continuously monitored at these stations for a period of one to two years prior to reservoir drawdown. Suspended sediment samples will also be collected at the turbidity monitoring stations to develop a relationship between turbidity and SSC at these individual sites on the mainstem Klamath River. The continuous turbidity monitoring coupled with telemetry will allow the DRE to develop a real-time estimate of SSC, with feedback for comparison with the modeled SSC results. Monitoring will continue for up to five years following dam removal.

If hydrologic conditions or levels of SSC and durations exceed those detailed under a worst-case scenario described in Section 5.1.4.1 (Table 2-9), the DRE, Reclamation, and state and federal regulatory agencies will convene and decide on the breadth and scope of additional protective measures that will reduce the predicted impacts to the level determined in this BA and USFWS/NMFS BO. For example, downstream migrant trapping will be implemented on key tributary streams in addition to the 13 considered for the conservation measure described in Section 2.2.6. This can include trapping on additional tributaries between Seiad Valley and Orleans (e.g., Indian, Elk, Clear, and Dillon creeks, and the Salmon River) and/or increasing the number of traps on key tributaries with relatively large populations of juvenile coho salmon. Conversely, if reservoir refilling does not occur, and monitored SSCs are less than predicted for a worst-case scenario, conservation measure efforts will be reduced to avoid handling and transportation effects.

Table 2-9. Predicted SSCs and Exposure Durations for Coho Salmon Age 1 Juvenile Outmigration for Proposed Action Worst-Case Scenario (10% exceedance probability), for Klamath River at Seiad Valley (RM 129)

Life-history timing	Suspended sediment concentration (mg/L)	Exposure duration (days)
Age 1 juvenile outmigration (Feb 15–March 31, 2020)	4,915 to 13,360	3
	1,808 to 4,915	6
	665 to 1,808	11
	245 to 665	18
	90 to 245	20
	33 to 90	20
Age 1 juvenile outmigration (April 1– June 30, 2020)	665 to 1,808	1
	245 to 665	12
	90 to 245	20
	33 to 90	20

2.3 Interrelated and Interdependent Actions

There are no interrelated and interdependent actions related to USFWS species. The following interrelated and interdependent actions apply only to NMFS species.

2.3.1 Iron Gate Hatchery Removal

Interrelated to the Proposed Action is the potential and assumed closure of the Iron Gate Hatchery (IGH) eight years after removal of the Four Facilities because PacifiCorp will terminate funding for IGH at that time. The hatchery is currently operated by the CDFG, which has not indicated whether or not they would continue operating the hatchery without PacifiCorps funding. Closure of the hatchery could potentially result in the loss of production of about 5.1 million Chinook salmon smolts, 900,000 Chinook salmon yearlings, 75,000 coho salmon yearlings, and 200,000 juvenile steelhead.

2.3.2 Interim Measures

The KHSA had an effective date of February 18, 2010. PacifiCorp agreed to implement Interim Measures (IM) for the 10-year period between the effective date and the start of the removal of the Four Facilities. Many of the IM involve development of fish disease and genetic studies, management plans, flow and diversion studies, and a continuation of current agreed-upon reservoir and power management operations. As such, many IM would either not have a direct or indirect impact on ESA-listed species or have already undergone required permitting and/or consultation processes. However, three IM have not been consulted on and do have the potential to affect ESA-listed fish species. These include:

- IM-7: J.C. Boyle gravel placement and/or habitat enhancement,
- IM-8: J.C. Boyle bypass barrier removal, and
- IM-16: Water Diversions.

These IM are being undertaken by PacifiCorp and are discussed below.

2.3.2.1 Interim Measure 7

Beginning on the Effective Date and continuing through decommissioning of the J.C. Boyle Facility, PacifiCorp shall provide funding of $150,000 per year, subject to adjustment for inflation as set forth in Section 6.1.5 of the KHSA for the planning, permitting, and implementation of gravel placement or habitat enhancement projects, including related monitoring, in the Klamath River above Copco Reservoir.

Existing substrate in the majority of the J.C. Boyle reach consists primarily of boulder and cobbles (PacifiCorp 2011). The preferred ranges in particle size of spawning g ravels are as follows: for Klamath River redband trout (0.2-2 inches), Chinook salmon (2-3 inches), coho salmon (1-3 inches), and steelhead (1-3 inches) (PacifiCorp 2011). A diverse particle size distribution would be conducive to more natural geomorphic processes in the Klamath River (PacifiCorp 2011). All gravel utilized for this project will be sorted to remove silt and sand particles.

Selective gravel placement within the J.C. Boyle reach of the Klamath River is proposed at 12 locations to enhance fish spawning habitat, macroinvertebrate habitat, and channel geomorphic processes throughout the reach. Seven gravel placement sites are proposed within the 3.8-milelong bypass reach between the J.C. Boyle Dam and the powerhouse. Five additional gravel placement sites are proposed within the 16.9-mile-long peaking reach between the powerhouse and Copco Reservoir; these sites are all located in Oregon. Proposed sites were selected based on their accessibility for gravel placement and aquatic habitat type (e.g., riffle, run, or pool tailout locations). Preference was also given to upstream locations that would facilitate gravel seeding to downstream habitat types during peak flows. Based on the preferred particle sizes for resident and anadromous fish spawning habitat, and the existing channel substrate, a mix of 0.5 to 3-inch clean, round, gravel is proposed for placement. Gravel would be placed approximately 1-foot deep across the proposed placement areas. This is intended to minimize hydraulic changes at the placement sites while still providing suitable gravel depths for spawning.

The proposed methods of gravel placement include the use of a truck equipped with a gravel “shooter”, and helicopter placement. The gravel shooter consists of a 16-foot-long conveyor belt mounted on the back of a dump truck. The gravel shooter can distribute gravel up to 3 inches in diameter approximately 100 feet horizontally beyond the end of the boom, and up to 120 feet when applied from locations that are vertically elevated above the river. Applying gravel from a truck outfitted with a gravel shooter is proposed in locations within 100± feet of a road. Gravel trucks would only utilize existing roadways and pull-outs for access. In locations where this strategy is not feasible, helicopter placement of gravel would be employed. Helicopter placement involves transporting gravel from a stockpile location to the proposed in-stream placement locations using a specialized bucket carried below the helicopter. Channel characteristics and details of proposed gravel placement at each proposed site are shown below.

2.3.2.2 Interim Measure 8

A high gradient riffle in the J.C. Boyle bypass reach at RM 223.3 has been identified as a potential barrier for migrating adult fish. The riffle has large, side-cast boulders in the river channel that effectively cover all surface flow at low flow levels; removal of some of these boulders to improve passage for resident redband trout and future migrating adult anadromous salmonids is proposed.

Within 90 days of the Effective Date, PacifiCorp shall commence scoping and planning for the removal of the sidecast rock barrier located approximately three miles upstream of the J.C. Boyle Powerhouse in the J.C. Boyle bypass reach. If blasting will be used, PacifiCorp shall coordinate with ODFW to ensure the work occurs during the appropriate in-water work period.

Since there is no direct vehicle access to this site, a rock expansion technique, using a commercially available and non-hazardous material such as Bustar®, would be used to fracture the boulders to manageable sized pieces. This would eliminate the need for constructing a road and disturbing the hillside for equipment access. A standard battery powered rock drill would be used to bore holes into the boulders selected for removal. T he proposed rock expansion compound is comprised primarily (97%) of limestone and dolomite, and becomes an inert material when cured. To ensure that the compound does not come into contact with the river during placement into the drilled holes, a PVC funnel and temporary plastic liner would be used to cover the immediate area. As the inert product sets and expands it causes the rock to fracture. Once reduced to proper size, the liner would be removed and the fractured rock would be repositioned within the channel. No rock would be removed from the site, and with the possible exception of hand operated winches, no heavy equipment or machinery would be used. All proposed work would be done during agency-approved in-water work periods.

2.3.2.3 Interim Measure 16

PacifiCorp shall seek to eliminate three screened diversions on Lower Shovel, Upper Shovel, and Negro (a tributary to Shovel Creek) creeks. These creeks are located upstream of Copco 1 reservoir. PacifiCorp shall also seek to modify its water rights to move the points of diversion from Shovel and Negro creeks to the mainstem Klamath River. Should the modification of the water rights be successful, PacifiCorp shall remove the screened diversions from Shovel and Negro creeks prior to the time that anadromous fish are likely to be present upstream of Copco Reservoir following the breach of Iron Gate and Copco dams.To continue use of the modified water rights, PacifiCorp will install screened irrigation pumps, as necessary, in the Klamath River. The intent of this measure is to provide additional water to Shovel and Negro creeks while not significantly diminishing the water rights or the value of the ranch property owned by PacifiCorp.

3 APPROACH TO THE ANALYSIS

In this section the analytical approaches used to assess effects of the Proposed Action on ESA-listed species and critical habitat are described.

3.1 Effects on Individuals or Populations

To determine the effects of an action, the potentially exposed listed resources (endangered and threatened species and designated and proposed critical habitat) need to be identified, then the potential stressors associated with the action and the nature of that exposure (effects) needs to be determined. The next step requires an examination of the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure. The final step of the analysis is making a determination of risk that the project effects pose to listed resources.

A “no effect” determination is the appropriate conclusion when the action agency determines that the Proposed Action will not affect listed species or critical habitat (USFWS and NMFS 1998). A “may affect, not likely to adversely affect” determination is the appropriate conclusion when effects on listed species are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects on the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.

A “may affect, likely to adversely affect” determination is the appropriate conclusion if any adverse effect to listed species may occur as a direct or indirect result of the Proposed Action or its interrelated or interdependent actions, and the effect is not: discountable, insignificant, or beneficial (USFWS and NMFS 1998). In the event the overall effect of the proposed action is beneficial to the listed species, but also is likely to cause some adverse effects, then the proposed action "is likely to adversely affect" the listed species. If the adverse effect can be detected in any way or if it can be meaningfully articulated in a discussion of the results, then it is not insignificant, it is likely to adversely affect. A "may affect, likely to adversely affect" determination requires formal section 7 consultation.

The BA also assesses impacts of the Proposed Action on a “short-term” and “long-term” basis. Reclamation considers effects in the short-term (less than 2 years) and the long term (more than 2 years), but either short- or long-term impacts may affect listed species. For the purposes of this BA, impacts would be “likely to adversely affect” if they would result in the following:

Short-term:

- Disturb any life history stage of a species such that it causes a disruption of breeding, feeding or sheltering in the short-term.
- Take any individuals of any life history stage in the short-term.
- Decrease the quality of any Primary Constituant Elemant of critical habitat for any life history stage of a listed in the short-term.
- Decrease the quality of a large proportion of critical habitat under the ESA or EFH under the Magnuson-Stevens Act in the short-term.

Long-term:

- Take any ESA-listed fish or terrestrial species for more than two generations after removal of all dams.

- Decrease the quality and quantity of any Primary Constituent Element (PCE) of critical habitat for ESA-listed fish species, decrease foraging, nesting, and roosting habitat for northern spotted owl, or decrease the habitat community in the long-term.
- Decrease the quality and quantity of any PCE of critical habitat for ESA-listed fish species or terrestrial foraging, nesting, and roosting habitat for northern spoted owl over a large proportion of the habitat available to it in the long-term.
- Decrease the quality or amount EFH under the Magnuson-Stevens Act in the long-term.
- Continue or worsen conditions that are currently causing an ESA-listed species to decline in the long-term.
- Eliminate a year class of salmon or steelhead, thereby jeopardizing the long-term viability within the Klamath Basin. Because of the fixed, three-year timing of the coho salmon life cycle, which has little to no plasticity, this criterion was added for the protection of coho salmon in particular.

3.1.1 Suspended Sediment Effects

The analyses of suspended sediment effects resulting from the Proposed Action below on anadromous fish below were taken from Appendix E of the Klamath Facilities Removal EIS/EIR. Please refer to Appendix E of the Klamath Facilities Removal EIS/EIR for more detailed information regarding suspended sediment-related effects on native fish stocks in the Klamath River.

The Klamath Facilities Removal EIS/EIR Appendix E analyses were based on a modeling analysis of the potential effects of suspended sediment on anadromous fish populations in the Klamath Basin under existing conditions and the Proposed Action. Available data on suspended sediment under existing conditions in the Klamath River upstream and downstream of IGD (summarized in Klamath Facilities Removal EIS/EIR Section 3.2.3 [Water Quality]) were determined to be insufficient for conducting this type of analysis. To compensate for this limitation, the Reclamation used suspended sediment data collected by the USGS at the (1) Shasta River near Yreka, (2) Klamath River near Orleans, and (3) Klamath River at Klamath gauges to estimate daily SSCs (mg/L) as a function of flow (cfs) using the SRH-1D 2.4 sediment transport model (Sedimentation and River Hydraulics–One Dimension Version 2.4) (Huang and Greimann 2010, Reclamation 2011c), hereafter referred to as “the model.” Daily SSC were modeled for water years 1961 through 2008 to represent existing conditions, as well as for the year following removal of the dams (Water Year 2020–2021) under multiple drawdown scenarios (Reclamation 2011c).

Modeling results are very sensitive to hydrology. Effects during winter are predicted to be more severe during a dry year when low reservoir levels expose more sediment in January. Effects during spring (when smolt outmigration generally occurs) are more severe during a wet year, when it is predicted that the reservoirs could re-fill during winter delaying the release of SSC until they drop during spring (Reclamation 2011c). Daily durations of SSC concentrations were modeled assuming the Proposed Action occurred within each of the 48 years in the available hydrology record since 1961 and the KBRA modeled hydrology. The suspended sediment model includes the KBRA modeled hydrology even though there are uncertainties about effects of actions under the KBRA on listed species. The suspended sediment model was used because this is the only model on the effects of removing the Four Facilities that is available, and therefore the best available scientific information for analyzing the effects of the suspended sediment.

The results of modeling all potential years were summarized for each life-stage of each species assessed. Because the suspended sediment varies with hydrology, two scenarios were analyzed for existing conditions and the Proposed Action, with the goal of predicting the potential impacts on fish that has either a 50% (likely to occur) or 10% (unlikely, or worst case) probability of occurring, defined as follows:

For Existing Conditions:

Normal conditions: SSCs and durations with a 50% exceedance probability for the mainstem Klamath River downstream of IGD (i.e., the probability of these concentrations and durations being equaled or exceeded for each assessed species and life-stage in any one year is 50%). Exceedance probabilities were based on modeling SSC for all water years subsequent to 1961 with facilities in place. To assess "normal conditions" the median (50 percentile) SSC and duration from these results was estimated.

Extreme conditions: SSCs and durations with a 10% exceedance probability; i.e., the probability of these concentrations and durations being equaled or exceeded for each assessed species and life-stage in any 1 year is 10%).

For the Proposed Action:

Most likely scenario: SSCs and durations with a 50% exceedance probability for the mainstem Klamath River downstream of IGD (i.e., the probability of these concentrations and durations being equaled or exceeded for each assessed species and life-stage in any one year is 50%). Exceedance probabilities were based on the results of modeling suspended sediment in the Klamath River downstream of IGD using hydrologic data for all water years observed since 1961 with facility removal. To assess the "most likely scenario" the median (50 percentile exposure concentration) was estimated.

- **Worst-case scenario:** SSCs and durations with a 10% exceedance probability; i.e., the probability of these concentrations and durations being equaled or exceeded for each assessed species and life-stage in any 1 year is 10%).

Based on a review of the scientific literature, the most commonly observed effects of suspended sediment on fish include: (1) avoidance of turbid waters in homing adult anadromous salmonids, (2) avoidance or alarm reactions by juvenile salmonids, (3) displacement of juvenile salmonids, (4) reduced feeding and growth, (5) physiological stress and respiratory impairment, (6) damage to gills, (7) reduced tolerance to disease and toxicants, (8) reduced survival, and (9) direct mortality (Newcombe and Jensen 1996). Information on both concentration and duration of suspended sediment is necessary for understanding the potential severity of its effects on salmonids (Newcombe and MacDonald 1991).

Potential population-level effects of suspended sediment released from dam removal activities for a given species not only depend on their abundance, distribution, and life stages present, but also on the timing, duration, and concentration of suspended sediment released. In this analysis the results of Newcombe and Jensen (1996) were used to assess impacts of SSC on aquatic species. Newcombe and Jensen (1996) reviewed and synthesized 80 published reports of fish responses to suspended sediment in streams and estuaries and established a set of equations to calculate "severity of ill effect" indices (Table 3-1) for various species and life stages based on the duration of exposure and concentration of suspended sediment present. The severity of ill effects provides a ranking of the effects of SSC on salmonid species, as calculated by any of six equations that address various taxonomic groups of fishes, life stages of species within those groups, and particle sizes of suspended sediments.

Assessing the potential effects of suspended sediment on anadromous fish species required identifying the spatial and temporal distribution of each life stage in the Klamath Basin relative to expected areas of elevated suspended sediment. For each focal species and life stage, potential effects were determined by evaluating the magnitude and duration of SSC predicted by the model for the mainstem Klamath River at times and locations where the life stage of any focal species is likely to be present. For salmonids, Newcombe and Jensen's (1996) Severity of Ill Effects table (Table 3-1) was used to rate the severity of exposure to suspended sediment. The values for SSCs were divided into ranges (33–90 mg/L, 90–245 mg/L, 245–685 mg/L, and so on) based on those used in Newcombe and Jensen (1996). Wherever possible, effects were quantified based on the percentage of the cohort predicted to be in the mainstem during suspended sediment events, considering both spatial distribution (proportion of the life stage expected to be in the mainstem compared with tributaries; proximity to IGD) and life-history timing (proportion of the population expected to be present during period of effect).

Table 3-1. Scale of the Severity of Ill Effects Associated with Elevated Suspended Sediment (based on Newcombe and Jensen 1996)

Severity	Category of effect	Description of effect
0	Nil effect	No behavioral effects
1	Behavioral effects	Alarm reaction
2		Abandonment of cover
3		Avoidance response
4	Sublethal effects	Short-term reduction in feeding rates Short-term reduction in feeding success
5		Minor physiological stress: Increase in rate of coughing Increased respiration rate
6		Moderate physiological stress
7		Moderate habitat degradation Impaired homing
8		Indications of major physiological stress: Long-term reduction in feeding rate Long-term reduction in feeding success Poor condition
9	Lethal effects	Reduced growth rate: Delayed hatching Reduced fish density
10		0–20% mortality Increased predation of affected fish
11		>20–40% mortality
12		>40–60% mortality
13		>60–80% mortality
14		>80–100% mortality

The indices used by Newcombe and Jensen (1996) have become a standard for selecting management-related turbidity and suspended sediment criteria (e.g., Walters et al. 2001), and their report remains the best available source for determining effects of SSC on salmonids (Berry et al. 2003). However, there are inherent sources of uncertainty in this application of the model. Newcombe and Jensen (1996) base much of their analysis on laboratory studies that were conducted in controlled environments over short-durations, mostly examining acute lethal impacts of non-fluctuating concentrations of suspended sediment. This analysis is a relatively complex application of the Newcombe and Jensen (1996) model, in that temporal variation in SSC within periods is captured by summing continuous days of exposure in various concentration categories of suspended sediment. This means that three occurrences of exposure to extreme sediment each lasting for two days can be, for example, equivalent to a severity of ill effect predicted for six continuous days. How the actual outcome will vary from predictions is uncertain. In addition, Newcombe and Jensen (1996) do not explicitly address the translation of sublethal severity levels into population-level effects. In addition, the model assumes that all effects of suspended sediment are negative. This exaggerates the effects of suspended sediment, particularly for lower concentrations and durations of exposure. Although the predictions of mortality at high concentrations and durations of exposure are considered more certain than the predictions of sublethal effects, in this application sublethal effects resulting from exposure to lower concentrations are included because of the concern that following sublethal impacts of suspended sediment could be adverse when occurring in conjunction with the already stressed condition of some species and life-stages from water temperature (Bozek and Young 1994) and disease.

Because of their listing status, potential impacts of SSC on the Southern DPS green sturgeon were assessed. However, little scientific literature exists regarding the effects of SSC on sturgeon. The models developed by Newcombe and Jensen (1996) for assessing impacts on nonsalmonids were used in this analysis to assess effects on green sturgeon, in conjunction with discussions with experts regarding the potential effects.

3.1.2 Klamath Chinook Population Dynamics

The Evaluation of Dam Removal and Restoration of Anadromy (EDRRA) model was constructed to forecast a range of annual abundances of Chinook salmon that could occur before, during, and after dam removal on the Klamath River and to explicitly incorporate uncertainty in the abundance forecasts. To quantify the uncertainty in the forecasts, two sources of information were used: 1) a Bayesian retrospective model that estimated historical production in the basin below IGD by providing posterior probability distributions to characterize the uncertainty; and 2) probability estimates of Chinook salmon productivity based on a meta-analysis of Chinook production by Liermann et al. (Liermann et al. 2010), which were applied to forecasting the production in the tributaries to UKL (Upper Basin). In both cases, Ricker stock-recruitment functions (1974) were used to define the relationship between spawners and age 3 ocean fish, which is the first age at which they are vulnerable to the fishery. Because EDRRA was developed to support an economic analysis of the effects of dam removal, the Klamath Harvest Rate Model (KHRM, Mohr In Prep) was used to remove fish from the population by the ongoing fishery. Additional information on the EDRRA model can be found in Hendrix (2011). This model represents the best scientific and commercial data available for the Klamath River.

As shown in Table 3-2 below, the EDRRA model was used to determine the potential percent increase in abundance as a result of the Proposed Action for three time periods: 1) prior to dam removal (2012 – 2020); 2) during active reintroduction in the Upper Basin (2020 – 2032); and after active reintroduction ceases and Iron Gate Hatchery production ceases (2033 – 2061).

Table 3-2. Percent Increase in Abundance due to Performing the Proposed Action (Hendrix 2012)

Metric	2012 – 2020		2021 – 2032		2033 – 2061	
	Median	95% CrI	Median	95% CrI	Median	95% CrI
Escapement in the absence of fishing	6.6%	-80.1% 473.3%	81.5%	-60.1% 853.5%	70.8%	-61.2% 779.4%

95% CrI = Credibility Interval - region over which the outcome has a 0.95 probability of occurrence

It should be noted that estimates from Table 3-2 are likely to be higher than what would occur under the Proposed Action since the EDRRA model incorporated active reintroduction and assumed that the issues/concerns from the Scientific Review Panels (Goodman et al 2011 and Dunne et al 2011) are not barriers.

In addition to the loss of food resources analysis summarized in Section 3.1.6 below, the annual abundance forecast for Klamath Chinook escapement in the absence of fishing can be used to assess the long-term indirect effects to Stellar seal lion (Section 5.1.8.2) and Southern Residen DPS killer whale (Section 5.1.9.2) when taking into consideration the potential loss in IGH production.

3.1.3 Habitat Modification/Removal

Each spotted owl activity center has a "home range" (defined as 1.9-km [1.2-mi] radius in Oregon from the activity center and a 2.1-km [1.3-mi] radius in California from the activity center), a "core area" (defined as 0.8-km [0.5-mi] radius from the activity center), and a "nest patch" (defined as a 0.3-km [300-m] radius from the activity center) (USFWS et al. 2008). The likelihood of an effect to an owl activity center is determined based on the amount of suitable habitat surrounding each activity center under current conditions, and the amount of habitat modification/removal that is anticipated to occur.

Because it is uncertain if habitat modification or removal of suitable habitat will be necessary or occur during the removal of transmission lines and the installation of fencing in Parcel B lands, it is assumed for this BA that no components of suitable habitat will be modified or removed and the analysis described above was not conducted.

3.1.4 Herbicide Treatment

As part of the Proposed Action, revegetation and management of noxious and invasive weeds using a glysophate-based herbicide will occur on newly exposed land (e.g., reservoir shoreline). Bautista (2007) reported on a USDA Forest Service study to characterize risks to wildlife from application of four common herbicides. As part of this analysis, a literature search was conducted to identify information on the effects to NSO from the use of glysophate. Appendix A describes the minimization measures that will be implemented as part of the herbicide treatment program.

3.1.5 Noise Effects

The Proposed Action will require demolition of the dams and their associated structures, power generation facilities, transmission lines, installation of cofferdams, road upgrading, hauling, reservoir restoration, and other activities such as fencing Parcel B Land. These actions will include the use of heavy equipment, and blasting as necessary, and as such, have the potential to disturb listed aquatic and terrestrial species. The following is a description of the analytical approach that was used to assess noise-related effects on listed species.

3.1.5.1 Underwater Noise Effects

The noise effects analysis for coho salmon rely on a review of the scientific literature, life history timing, behavioral characteristics, and analysis of impacts on fish from the reservoir drawdown and sediment release.

3.1.5.2 Noise and Disturbance to Northern Spotted Owl

The effects of anticipated deconstruction actions on NSO activity centers and nesting and roosting habitat were analyzed for actions resulting in disturbance. Owls can be disturbed from noise, visual, or physical disturbances which can include effects of downdrafting from a large helicopter. Based on the USFWS (2006) Estimating the Effects of Auditory and Visual Disturbance to Northern Spotted Owls in Northwestern California and in coordination with Lynn Roberts of the USFWS, noise disturbance distances were identified based on established buffers that may affect a northern spotted owl during the breeding period (Table 3-3). Each deconstruction action was analyzed using currently best available information of known activity centers, suitable nesting and roosting habitat, construction activity locations, and construction timing. Compiled information and analysis includes the sources listed below.

1. The NSO activity center locations were provided to the Reclamation in GIS format by the Klamath Falls USFWS office (E. Willy, Fish and Wildlife Biologist, USFWS, pers. comm., July 26, 2011) and Arcata USFWS office (N. Athearn, Habitat Conservation Planner, USFWS, pers. comm., July 25, 2011.
2. A habitat assessment within an 8-km (5-mi) buffer of Iron Gate, Copco 1 and Copco 2 dams was conducted by Oakley Consulting in June 2011 (Oakley Consulting 2011). The habitat-based assessment used Google Earth aerial photographs, vegetation maps, and knowledge of the area. Electronic document described two areas of suitable habitat: north of Copco Dam sites in Oregon and about 8-km (5-mi) east of Copco Dam. A GIS file of the suitable habitat east of Copco Dam (which was the only habitat that had the potential to be disturbed) was provided by the Arcata USFWS office (N. Athearn, Habitat Conservation Planner, USFWS).
3. A habitat assessment around J.C. Boyle Dam was conducted by Klamath Falls USFWS office and provided to the Reclamation in GIS format (E. Willy, Fish and Wildlife Biologist, USFWS, pers. comm., July 26, 2011).
4. Construction locations (i.e., haul routes, disposal sites, and helicopter staging areas) were identified by the Reclamation.

Table 3-3. Disturbance Distances[1] for the Northern Spotted Owl during the Breeding Period

Source of noise	Disturbance distance
Blasting	1,760 yards (1 mile)
Hauling on open roads	440 yards (0.25 mile)
Heavy equipment	440 yards (0.25 mile)
Rock crushing	440 yards (0.25 mile)
Helicopter—Type I[2]	880 yards (0.5 mile)
Aircraft—Fixed Wing	440 yards (0.25 mile)

[1] Noise distances were developed in coordination with the Arcata USFWS office using an estimation of auditory and visual disturbance effects (USFWS 2006) as a basis.

[2] Type I helicopters seat at least 16 people and have a minimum capacity of 2,300 kg (5,000 lbs). Both a CH 47 (Chinook) and UH 60 (Blackhawk) are Type I helicopters.

Spatial analysis was conducted to determine if a deconstruction activity has a potential to result in disturbance to a known activity center or within suitable nesting and roosting habitat which has the potential to suport a future activity center. Within the disturbance distance of each deconstruction activity, the presence of any activity centers and suitable habitat were identified. The determinations listed below were made based on the location of the activity center, the presence of suitable nesting and roosting habitat, the timing of the construction activity, and implementation of minimization measures:

- May Affect Likley to Adversely Effect: If an activity center is within the disturbance distance and the deconstruction activity occurs within the critical-breeding season (California: February 1–July 9; Oregon: March 1–August 10) or suitable habitat is present and no implementation of minimization measures.
- May Affect Not Likely to Adversely Effect: If an activity center is within the disturbance distance and activity occurs during the late breeding season (California: July 10–September 15; Oregon: August 11–September 30) or suitable habitat is present and implementation of minimization measures.

- No Effect: If an activity center is within the disturbance distance and activity occurs outside of the entire breeding season (California: February 1–September 15; Oregon March 1–September 30), if an activity center is outside of the disturbance distance, or no suitable habitat is present and no implementation of minimization measures. (Protocol-level surveys resulting in no activity center would also result in a No Effect.)

Spatial analysis was conducted by Dave Hanson from Reclamation, activity locations were identified by the Reclamation and construction timing was identified from the Detailed Plan (Reclamation 2012b).

3.1.6 Loss of Food Resources

The reservoir drawdown will release a large quantity of suspended and bedload sediment. This released material will adversely affect Chinook salmon, which makes up a part of the diet of Steller sea lions and Southern Resident killer whales. The loss of salmonid production may have an effect on individual marine mammals through reduction in food resources. The food resource analysis is based upon determining the percentages of the Steller sea lion and killer whale diets that are composed of Chinook salmon, determining the percentage that Klamath-origin Chinook salmon make up in the offshore population and the marine mammals' diet, and the potential for these marine mammals to substitute other fish to make up the loss of Klamath Chinook salmon.

3.2 Effects on Critical Habitat

The following describes the BA's analytic methodology to assess the Proposed Action's effects on designated critical habitat for bull trout, Lost River and shortnose suckers, Southern DPS green sturgeon, SONCC coho salmon, Southern DPS eulachon, NSO, Steller sea lions, and Southern Resident DPS killer whales. The effects of the Proposed Action were not assessed for tidewater goby and marbled murrelet because critical habitat for this species is not designated within the Action Area.

3.2.1 Bull Trout

The effects of the Proposed Action on bull trout critical habitat are limited to food resources and migration habitat. The effects on food resources were determined by assuming Chinook salmon and steelhead would reoccupy historical habitat upstream of UKL. It was also assumed that bull trout, being highly piscivorous, would take advantage of the increased food resources wherever available (anadromous salmonid fry and juveniles). Interaction would be limited due to barriers on all bull trout streams except Long Creek and a short section of Boulder Creek.

The effects of the Proposed Action on migration habitat were determined by analyzing the effects of the modeled hydrology on UKL water surface elevations. It was assumed that higher lake elevations would allow for greater tributary access by migrating bull trout.

3.2.2 Lost River and Shortnose Suckers

The effects of the Proposed Action on sucker foraging base were determined by analyzing the potential effects of naturally reintroducing anadromous salmonids to UKL.

3.2.3 Green Sturgeon

Critical habitat for the southern DPS green sturgeon is not designated in the Klamath River or its estuary. However, designated critical habitat for the southern DPS green sturgeon is located approximately one mile offshore of the mouth of the Klamath River. The primary issue of concern relating to this species' critical habitat is the potential for the Proposed Action to release fine sediment that is contaminated with chemicals, which when it settles offshore would affect food resources for green sturgeon. The BA analysis involved reviewing of project documents relating to substrate composition and contamination sampling and comparing those samples to marine toxicity criteria.

3.2.4 Coho Salmon

Within the range of the Southern Oregon/Northern California Coast (SONCC) coho salmon ESU, the life cycle of the species can be separated into five primary constituent elements or 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 (May 5, 1999, 64 FR 24049).

This BA analyzes the effects of the Proposed Action on critical habitat within the Action Area (Figure 2-1). This analysis is a habitat-based assessment that estimates the effect of the Proposed Action on substrate and sediment levels, water quality conditions, and other general conditions of watersheds that support the biological and ecological requirements of the species. The effects of the Project are overlayed on environmental baseline (Section 4) and combined with cumulative effects (Section 6) to determine if the Proposed Action is or is not reasonably likely to destroy or adversely modify the value of constituent elements essential to the conservation of SONCC coho salmon in the action area. Different areas and features of critical habitat will have varying roles in the recovery of natural, self-sustaining salmon populations. For example, tributary streams provide a significantly greater amount of juvenile coho summer and winter areas and adult spawning habitat than do mainstem rivers. However, mainstem rivers are critical as migratory routes for coho smolts migrating to the ocean and for adults moving upstream to spawn. Therefore, the final step in the critical habitat effects analysis is whether, with implementation of the Proposed Action, critical habitat would remain functional to serve the intended conservation role for the SONCC coho salmon ESU or retain its current ability to establish those features and functions essential to the conservation of the species.

3.2.5 Southern DPS Eulachon

Critical habitat for Southern DPS eulachon is designated from the mouth of the Klamath River upstream to Omogar Creek, a distance of 10.7 miles and does not include the nearshore or marine environment. The effects of the Proposed Action’s release of sediment and modification of hydrology are overlayed on environmental baseline (Section 4) to determine if the Proposed Action is or is not reasonably likely to destroy or adversely modify the physical and biological features that are essential to the conservation of the species in the Action Area.

3.2.6 Marbled Murrelet

Critical habitat for the marbled murrelet was designated in 1996 (61 FR 26256) and is located 44 mi west of IGD. On October 5, 2011, critical habitat for the marbled murrelt was revised to reduce acreage (76 FR 61599). Nesting murrelets in California are mostly concentrated near the coastal waters of Del Norte and Humboldt counties and in lesser numbers near San Mateo and Santa Cruz counties. Suspended sediment within the water column from the Proposed Action will not affect this species’ critical habitat (located 7 mi from the Klamath River).

3.2.7 Northern Spotted Owl

About 5,394 acres of northern spotted owl critical habitat is designated within a 3-mi buffer of the Klamath River that extends from IGD upstream to J.C. Boyle Reservoir (Figure 4-6). The designated critical habitat makes up about 4% of the area within the buffer. Critical habitat is present (1) north of Iron Gate Reservoir and (2) south of the Klamath River east of Copco 1 Reservoir. In addition, USFWS critical habitat designation (USFWS 2008b) includes the following PCEs, physical and biological attributes that are essential to a species' conservation: (i) forest types that support the species across its geographic range; (ii) nesting, roosting, and foraging habitat; and (iii) dispersal habitat (USFWS 2008b). These PCEs are described in further detail in Section 4.2.2.7; however, because no components of critical habitat will be removed or modified, no further analysis was conducted from what is already included in Section 4.2.2.7.

On March 8, 2012 the USFWS proposed to revise NSO critical habitat in which approximately 13,962,449 acres in California, Oregon, and Washington meet the definition of critical habitat (77 FR 14062). As part of the proposed revision and of the total 13,962,449 acres, the USFWS has identified the following units and subunits for exclusion in the final designation (77 FR 14062):

- 2,631,736 acres of National Park lands, Federal Wilderness Areas, and other Congressionally reserved natural areas
- 164,776 acres of State Park lands
- 936,816 acres of State and private lands that have a Habitat Conservation Plan, Safe Harbor Agreement, conservation easement, or similar conservation protection
- 833,344 acres of other non-Federal lands

As a result of the proposed exclusions, the final designation could result in no less than 9,391,973 acres designated as NSO critical habitat. As noted above, no components of critical habitat, existing or proposed, will be removed or modified; therefore, no further analysis was conducted.

3.2.8 Steller Sea Lion

The closest designated habitat for Steller sea lions is at Pyramid Rock 65 mi north of Klamath River Estuary and Sugarloaf Island and Cape Mendocino, about 80 mi south of the Klamath River Estuary. Therefore, the Proposed Action will have no direct effect on critical habitat locations. However, Chinook salmon are a food resource for sea lions and as such are a primary constituent of critical habitat. The analysis of the food resource PCE is identical to the individual effects analysis described in Section 5.1.8.

3.2.9 Southern Resident DPS Killer Whale

The closest designated habitat for the Southern Resident DPS killer whale is in Puget Sound, Washington. Therefore, the Proposed Action will have no direct effect on critical habitat locations. However, Chinook salmon are a food resource for killer whales and as such are a primary constituent of critical habitat. The analysis of the food resource PCE is identical to the individual effects analysis described in Section 5.1.9.

4 ENVIRONMENTAL BASELINE

The following description of baseline environmental conditions in the Klamath River and Basin is drawn primarily from the Klamath Facilities Removal EIS/EIR (DOI and CDFG 2012).

The Klamath Basin geography, topography, hydrology, and biology are unique from other watersheds in the Pacific Northwest. Water in the Klamath River, unlike other watersheds in the Pacific Northwest, originates in relatively flat, open valleys before crossing the Trinity and Coast Ranges in a steep river canyon and intercepting cold water inputs from the Shasta, Scott, Salmon, and Trinity rivers. The flat topography, along with lower average precipitation in the Upper Klamath Basin than the Lower Basin, influences water flow and temperature in the river.

4.1 Physical Environment

4.1.1 Watershed Setting

The Klamath River originates just downstream of UKL in southern Oregon and flows 253 mi southwest through the Cascade Mountains of Southern Oregon and Northern California to the Pacific Ocean.

The Upper Klamath Basin has five main lakes: Crater Lake, Upper Klamath Lake, Lower Klamath Lake, Clear Lake, and Tule Lake. The Lower Basin, with its border beginning at IGD, is almost 200 mi long and contains the four major Klamath River tributaries: the Shasta, Scott, Salmon, and Trinity rivers. The basin is generally rural, with a total human population of approximately 120,000. Its largest communities are Klamath Falls, Oregon and Yreka, California. The Upper Klamath Basin has broad, extending valleys shaped by volcanoes and active faulting. The fault-bounded valleys contain all of the large, natural lakes and large wetlands of the Klamath Basin. Here, the Klamath River forms a deep canyon surrounded by mountains of the Trinity and Coast ranges. Lower Klamath Basin valleys include those of the Shasta and Scott rivers (NRC 2004).

As described above, the Klamath is unlike most river systems, in that the river is warmer and flatter in its headwaters, while downstream portions, beginning near the dams, tend to be colder and steeper. The Klamath River flows through mountainous terrain from the Oregon-California border to the reaches downstream of IGD. Downstream of IGD, and for most of the river’s length to the Pacific Ocean, the river maintains a relatively steep, high-energy channel.

4.1.2 Climate and Hydrology

The Klamath Basin receives widely varying precipitation. The climate in the Upper Basin is dry, with an annual precipitation of approximately 13 inches at the river’s origin near Klamath Falls, Oregon. In contrast, the Lower Basin is wet, with an annual precipitation of approximately 80 inches near the river’s mouth at Requa, California. At its higher elevations (above 5,000 ft), the Upper Klamath Basin receives rain and snow during the late fall, winter, and spring. Peak stream flows generally occur during snowmelt runoff in late spring/early summer. After the runoff period, flows drop in the late summer/early fall. Fall storms may increase flows compared with the lower summer flows in the lower basin.

The United States Geological Survey (USGS) operates several stream gages on the Klamath River. The median daily average flows at Keno, Iron Gate, Seiad Valley, Orleans, and Klamath for the period of record October 1, 1960 to September 30, 2009 is given in Figure 4-1(Greimann et al. 2011). The months of July through October generally have much lower flows than the months of the spring runoff. Also, the tributaries downstream of Iron Gate contribute significant amounts of flow during all times of the year. The specific ratio of the tributary contribution does change with time of the year, however. During the month of August, the median flow at Iron Gate dam is about 1,000 cfs and the median flow at Orleans is about 1,800 cfs (an increase of 80%). During the month of March, the median flow at Iron Gate is about

2,500 cfs whereas the median flow at Orleans is greater than 11,000 cfs (an increase of 440%) (Greimann et al. 2011).

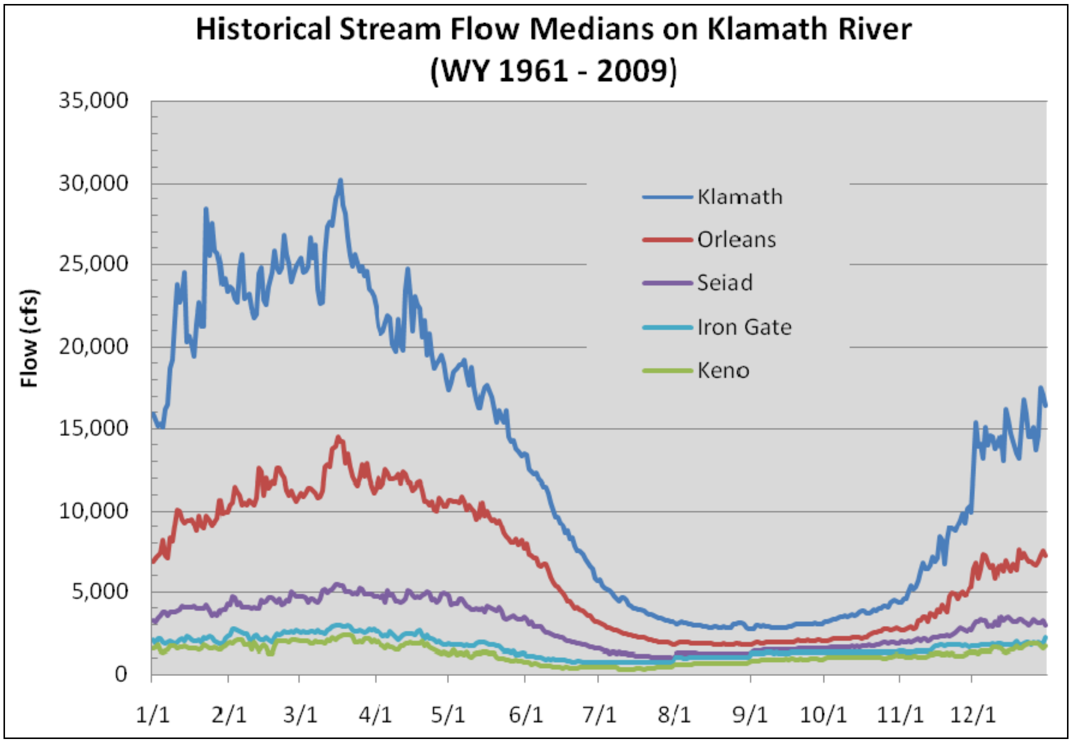


Figure 4-1. **Median Flows at USGS Stream Gages on Klamath River (Greimann et al. 2011)**

The median flows are greatest in March, during spring runoff, but the largest of the peak flows occur in December and January. A flood frequency analysis at each of the gages and dams is described in (Greimann et al. 2011). The peak flows at Iron Gate are significantly greater than peak flows at JC Boyle (Figure 4-2). This is because of the tributaries that enter the Klamath River between the two dams. In particular, Jenny Creek contributes a large amount to the peak flow during the winter and spring months. The watershed area of Jenny Creek is 210 mi^2 and it is the largest single tributary between Keno Dam and IGD. Peak flows increase significantly downstream of IGD due to flow accretion from numerous tributaries including Shasta, Scott, Salmon, and Trinity rivers.

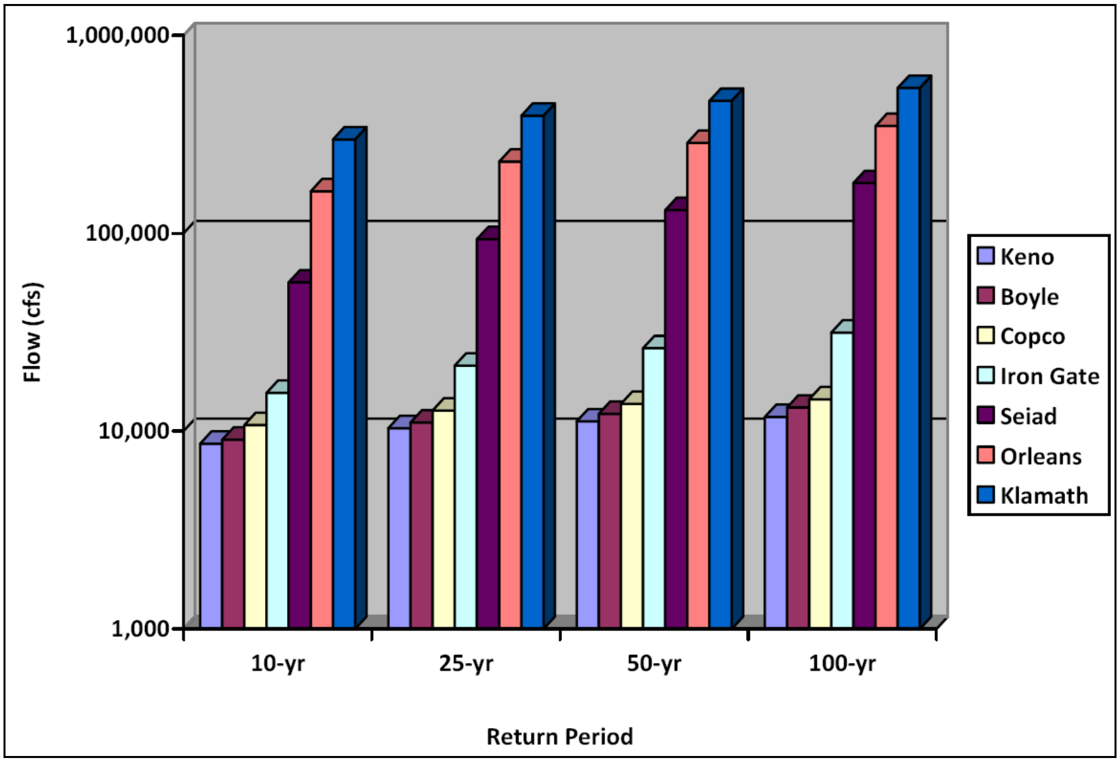


Figure 4-2. **Flood-Frequency of USGS Gages on Klamath River (Greimann et al. 2011)**

4.1.3 Vegetation Cover

The Klamath Basin is within the Klamath Bioregion (California) and the East and West Slope Cascades (Oregon) eco-regions. Vegetation communities in these eco-regions include drier pine and fir forests in the mountain ranges of Siskiyou County and wetter forests near the coast. Recognized for their biological diversity, the Klamath-Siskiyou mountain ranges contain more than 3,000 known plant species, including 30 temperate conifer tree species, more than any other ecosystem in the world (California Department of Fish and Game [CDFG] 2006). Land cover in the basin consists of a combination of upland tree habitat, aquatic habitat, and wetland habitat. Sagebrush and interior valley vegetation communities also exist within lower elevation areas. The Klamath River Canyon itself is a mosaic of mixed conifer forest communities and riparian habitats (FERC 2007). In addition to their ecological significance, many plants, especially wetland plants, in the Klamath Basin are culturally important to Indian Tribes in the Klamath River region for food, basketry, regalia, and medicine, and some have importance for ceremonial use as well (Larson and Brush 2010, FERC 2007).

4.1.4 Land Use

The major land uses categories in the Action Area are agriculture, open space, forestry, recreation, and rural communities. The main urban areas are Klamath Falls and the city of Yreka. Most of the land in the Action Area is made up of agriculture/grazing or open space and conservation. A small portion is developed as hydroelectric operations and recreation sites. Residential developments occur in and around the community of Keno and the Keno Recreation Area, and along portions of Copco 1 Reservoir. See the Klamath Facilities Removal EIS/EIR (DOI and CDFG 2011) for more detailed information about land use.

4.1.5 Water Quality Conditions

4.1.5.1 Total Maximum Daily Loads

Much of the Klamath basin is currently listed as water quality impaired under section 303(d) of the Clean Water Act (CWA). As such, total maximum daily loads (TMDLs) have been developed by Oregon, California, and the U.S. Environmental Protection Agency (EPA) for specific impaired water bodies with the intent to protect and restore beneficial uses of water. TMDLs (1) estimate the water body's capacity to assimilate pollutants without exceeding water quality standards; and (2) set limits on the amount of pollutants that can be added to a water body while still protecting identified beneficial uses. Table 4-1 lists the status of TMDLs in the Klamath River Basin. Additional information regarding the Oregon TMDLs can be found on Oregon Department of Environmental Quality's (DEQ) website (http://www.deq.state.or.us/WQ/TMDLs/klamath.htm) and for the California TMDLs on the North Coast Regional Water Quality Control Board (NCRWQCB) website: (http://www.swrcb.ca.gov/northcoast/water_issues/programs/tmdls/index.shtml).

Table 4-1. Status of TMDLs in the Klamath River Basin

Water body	Pollutant/Stressor	Agency	Original listing date	TMDL completion date[1]
Oregon				
Upper Klamath Lake Drainage	Temperature, dissolved oxygen, and pH	Oregon DEQ	1998	2002
Upper Klamath and Lost rivers	Temperature, dissolved oxygen, pH, ammonia toxicity, and chlorophyll-*a*	Oregon DEQ	1998	2011
California				
Lower Lost River[2]	pH and nutrients	EPA	1992	2008
Klamath River	Temperature, organic enrichment/low dissolved oxygen, nutrient, and microcystin	NCRWQCB	1996, 1998, 2006, and 2008	2010
Shasta River	Temperature and dissolved oxygen	NCRWQCB	1998 and 2008	2007
Scott River	Temperature and sediment	NCRWQCB	1992, 1996, and 1998	2006
Salmon River	Temperature	NCRWQCB	1996	2005
Trinity River	Sediment	EPA	1994 and 2006	2001
South Fork Trinity River	Sediment	EPA	1994 and 2002	1998

Notes:

[1] The TMDL completion date is the year the EPA approved or is expected to approve the TMDL.

[2] The Upper Lost River upstream of the Oregon border, Clear Lake Reservoir, and tributaries are listed for water temperature and nutrients. In 2004, North Coast Regional Board staff completed an analysis of beneficial uses and water quality conditions in the Upper Lost River watershed and concluded that the listing is not warranted.

Key:
TMDL: Total Maximum Daily Load
Oregon DEQ: Oregon Department of Environmental Quality
EPA: U.S. Environmental Protection Agency
NCRWQCB: North Coast Regional Water Quality Control Board

4.1.5.2 Water Temperatures

Water temperatures in the Klamath Basin vary seasonally and by location. In the Upper Klamath Basin, water temperatures are typically very warm in summer months as ambient air temperatures heat surface waters. Water temperatures (measured as 7-day-average maximum values) in UKL and much of the reach from Link River Dam to the Oregon-California border exceed 20°C (68°F) in June through August. Both UKL and the Keno Impoundment undergo periods of intermittent, weak summertime stratification, but water temperatures in these water bodies are generally similar throughout the water column and among the warmest in the Klamath Basin (peak values >25°C [>77°F]). Upper basin locations influenced by groundwater springs, such as the Wood River and the mainstem Klamath River downstream of J.C. Boyle Dam, have relatively constant water temperatures year-round and can be 5–15ºC (41–59ºF) cooler than other local water bodies during summer months, depending on the location.

Water temperatures in the Klamath Hydroelectric Reach are influenced by the facilities for the four hydroelectric projects. The relatively shallow depth and short hydraulic residence time in J.C. Boyle Reservoir do not support thermal stratification (FERC 2007; Raymond 2008, 2009, 2010) and this reservoir does not directly provide a source of cold water to downstream reaches during summer (NRC 2004). However, current power-peaking operations at the J.C. Boyle Powerhouse contribute to the availability of cold water in the river just downstream of the dam (≈RM 221), where cold groundwater springs enter the river. During daily peaking operations at J.C. Boyle Powerhouse, warm reservoir discharges are diverted from the bypass reach, allowing cold ground water to dominate flows in the river (PacifiCorp 2006). Water temperatures in the bypass reach can decrease by 5–15°C (9–27°F) when peaking operations are underway (Kirk et al. 2010).

Iron Gate and Copco 1 Reservoirs are the two deepest reservoirs in the Klamath Hydroelectric Reach. These reservoirs thermally stratify beginning in April/May and the surface and bottom waters do not mix again until October/November (Raymond 2008, 2009, 2010). 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 Klamath Hydroelectric Reach are generally cooler than would be expected under natural conditions, and summer and fall water temperatures are generally warmer (NCRWQCB 2010). In the Hydroelectric Reach, maximum weekly maximum temperatures (MWMTs), which generally occur in late July, regularly exceed the range of chronic effects temperature thresholds (13–20°C [55.4–68°F]) for full salmonid support in California (NCRWQCB 2010).

The temporal water temperature pattern of the Hydroelectric Reach is repeated in the Klamath River immediately downstream of IGD, where water released from the reservoirs is 1–2.5°C (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 2004b, Dunsmoor and Huntington 2006, NCRWQCB 2010). Immediately downstream of IGD (RM 190.1), water temperatures are also less variable than those documented farther downstream in the Klamath River (Karuk Tribe of California 2009, 2010).

Farther downstream, the presence of the four dams exert less influence; water temperatures are more influenced by the natural heating and cooling regime of ambient air temperatures and tributary inputs of surface water. Meteorological control of water temperatures result in increasing temperature with distance downstream of IGD. For example, daily average temperatures between June and September are approximately 1–4°C (1.8–7.2°F) higher near Seiad Valley (≈RM 129.4) than those just downstream of the dam (Karuk Tribe of California 2009, 2010). By the Salmon River (RM 66), the effects of the dams on water temperature are not discernable.

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 general, however, the slight decrease in water temperatures in this reach is not sufficient to support cold water fish habitat during summer months. 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) (Yurok Tribe Environmental Program [YTEP] 2005, Sinnott 2010). As is the case farther upstream, MWMTs in the Klamath River downstream of IGD to the Klamath River estuary regularly exceed the range of chronic effects temperature thresholds (13–20°C [55.4–68°F]) for full salmonid support in California (NCRWQCB 2010).

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. 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 water 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).

4.1.5.3 Suspended Sediment

For the purposes of this BA, suspended sediment refers to settleable suspended material in the water column. Bed materials, such as sand, gravel, and larger substrates are considered bedload and are discussed in Section 4.1.6. Two types of suspended material are important to water quality in the Klamath Basin and are discussed below: algal-derived (organic) suspended material and mineral (inorganic) suspended material. Sources of each type of suspended material differ, as do spatial and temporal trends for each, within the Upper and Lower Klamath Basins.

Suspended sediments in the tributaries to UKL are generally derived from mineral (inorganic) materials, with peak values associated with winter and spring high flows. Of the three main tributaries to UKL, the Sprague River has been identified as a primary source of sediment. Because phosphorus is naturally high in Klamath Basin sediments, the Sprague River is also an important source of this nutrient to the lake (Gearheart et al. 1995, Oregon DEQ 2002, Connelly and Lyons 2007). Sources of sediment inputs within the Sprague River drainage include agriculture, livestock grazing and forestry activities, and road-related erosion (Oregon DEQ 2002, Connelly and Lyons 2007, Rabe and Calonje 2009).

Between Link River at Klamath Falls (RM 253.1) and the upstream end of J.C. Boyle Reservoir (RM 224.7), algal-derived (organic) suspended material is the predominant form of suspended material affecting water quality. Summer and fall algal-derived (organic) suspended materials decrease with distance downstream, as algae are exported from UKL and into Lake Ewauna and the Keno Impoundment, where they largely settle out of the water column (Sullivan et al. 2011). Data from June through November during 2000–2005 indicate that the largest relative decrease in mean total suspended solids (TSS) in the upper Klamath River occurs between Link River Dam and Keno Dam. Suspended materials generally continue to decrease through the Hydroelectric Reach (PacifiCorp 2004c), where further interception, decomposition, and retention of algal-derived (organic) suspended materials originating from UKL occurs, as well as dilution from the springs downstream of J.C. Boyle Dam. However, increases in suspended material can occur in Copco 1 and Iron Gate reservoirs due to in situ summertime algal blooms, which can adversely affect beneficial uses. In the winter months, suspended material in the Hydroelectric Reach is dominated by mineral sediment loads transported during high flow events, which can also settle out in the reservoirs as water carries relatively heavy sediment loads during high flow events (see Appendix C of the Klamath Facilities Removal EIS/EIR for more detail).

Just downstream of IGD (RM 190.1), summer and fall SSCs become relatively low. Between IGD and Seiad Valley (RM 129.4), suspended materials can increase due to the transport of in-reservoir algal blooms to downstream reaches of Klamath River, as well as river bed scour and resuspension of previously settled materials (YTEP 2005, Sinnott 2007, Armstrong and Ward 2008, Watercourse Engineering, Inc. 2011). Further downstream, near the confluence with the Scott River (RM 143.0) concentrations of suspended materials tend to decrease with distance as suspended materials gradually settle out of the water column farther downstream or are diluted by tributary inputs (see Appendix C of the Klamath Facilities Removal EIS/EIR for more detail).

Mineral suspended sediments begin to have prominence again in the Klamath River downstream of IGD, as major tributaries to the mainstem contribute large amounts of mineral suspended sediments to the river during winter and spring (Armstrong and Ward 2008) (Figures 4-3 and 4-4). In general, the data indicate that suspended sediment downstream of IGD ranges from less than 5 mg/L during summer low flows to greater than 1,000 mg/L during winter high flows (Figures 4-3 and 4-4). During large winter storms or following landslides in the Klamath Basin, extremely high SSCs have been observed in the Klamath River mainstem and tributaries. SSC generally increases in a downstream direction from the contribution of tributaries, and since IGD currently effectively traps most suspended sediment. Under existing conditions SSCs within the Klamath River Estuary is relatively high.

Steeper terrain and land use activities such as timber harvest and road construction result in high sediment loads during high-flow periods. Two of the three tributaries that contribute the largest amount of sediment to the Klamath River are in this reach: the Scott River (RM 143) (607,300 tons per year or 10% of the cumulative average annual delivery from the basin), and the Salmon River (RM 66.0) (320,600 tons per year or 5.5% of the cumulative average annual delivery from the basin) (Stillwater Sciences 2010). The Trinity River contributes 3,317,300 tons per year of sediment to the Klamath River or 57% of the cumulative average annual delivery from the basin (Stillwater Sciences 2010) (see Appendix C of the Klamath Facilities Removal EIS/EIR for more detail).

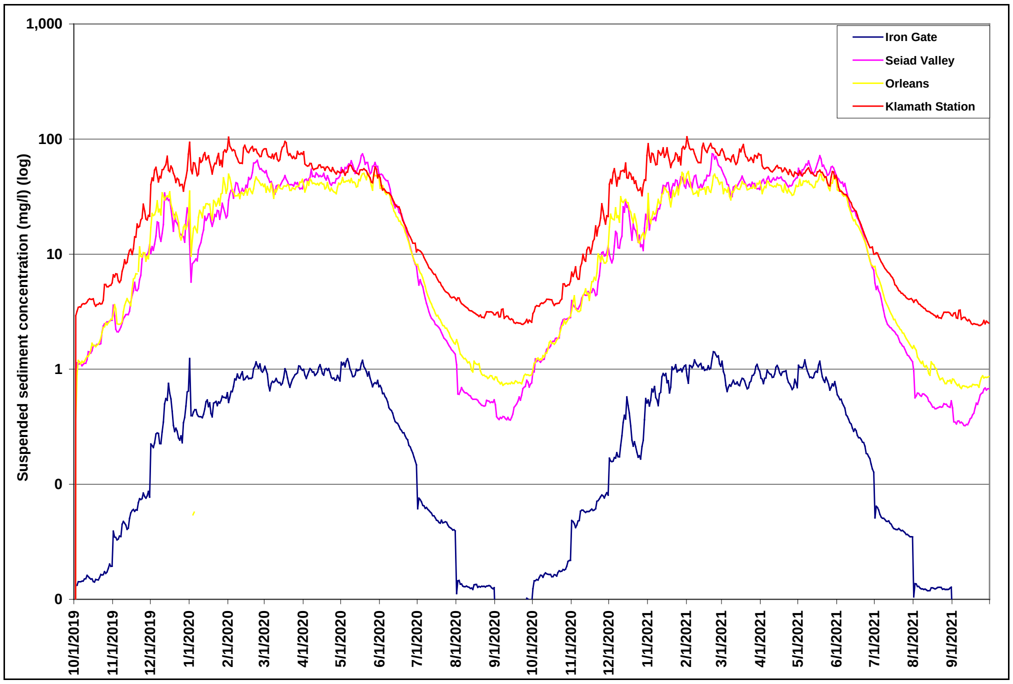


Figure 4-3. Normal Conditions (50% Exceedance Probability) SSCs for Four Locations Downstream of Iron Gate Dam under Existing Conditions, as Predicted using the SRH-1D model

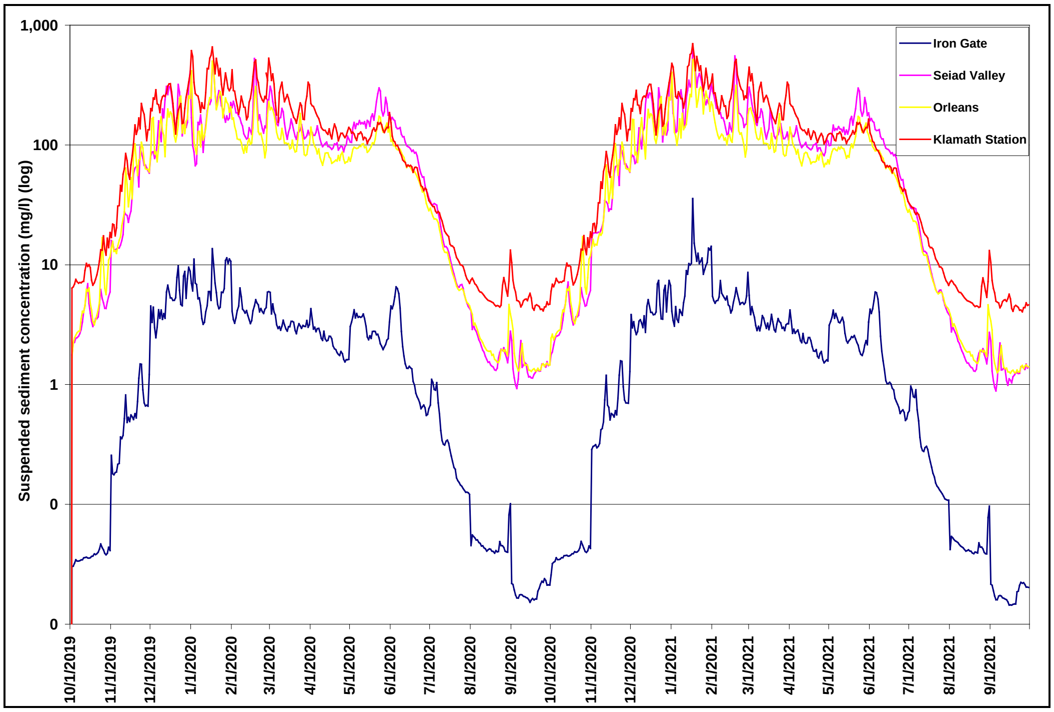


Figure 4-4. Extreme Conditions (10% Exceedance Probability) SSCs for Four Locations Downstream of Iron Gate Dam under Existing Conditions, as Predicted Using the SRH-1D Model

4.1.5.4 Dissolved Oxygen

Dissolved oxygen concentrations in the Klamath Basin depend on several factors, including water temperature (colder water absorbs more oxygen), water depth and volume, stream velocity (as related to mixing and re-aeration), atmospheric pressure, salinity, and the activity of organisms that depend upon dissolved oxygen for respiration. This last factor (respiratory consumption) is strongly influenced by the availability of nitrogen and phosphorus for supporting algal and aquatic plant growth.

In tributaries to UKL, limited data indicate that dissolved oxygen varies from <7 to 13 mg/L (Kann 1993, Oregon DEQ 2002). Concentrations in the lake itself exhibit high seasonal and spatial variability, ranging from less than 4 mg/L to greater than 10 mg/L. High nutrient loading is the primary cause of eutrophication and subsequent low dissolved oxygen levels in UKL. Water quality datasets collected by the Klamath Tribes include periods of weeks during the summer months when dissolved oxygen levels in the lake are continuously below the Oregon DEQ criterion of 5.5 mg/L for support of warm water aquatic life (Kann 2010). Low (0–4 mg/L) dissolved oxygen concentrations occur most frequently in August, the period of declining algal blooms in the lake and warm water temperatures (Oregon DEQ 2002, Walker 2001) (see Appendix C of the Klamath Facilities Removal EIS/EIR for additional details).

Downstream in the Keno Impoundment (including Lake Ewauna), dissolved oxygen reaches very low levels (<1−2 mg/L) during July–October as algae transported from UKL settle out of the water and decay. Four water treatment facilities discharge treated wastewater to the Keno Impoundment; however, these facilities contribute a very small amount (<1.5% of the organic material loading) to the overall oxygen demand in the Keno Reach. Decomposition of algae transported from UKL appears to be the primary driver of low oxygen in the Keno Impoundment (including Lake Ewauna) (Sullivan et al. 2009, 2011; Kirk et al. 2010).

During summer, the reservoirs in the Hydroelectric Reach exhibit varying degrees of dissolved oxygen super-saturation (i.e., >100% saturation) in surface waters (due to high rates of internal photosynthesis by algae) and hypolimnetic oxygen depletion in bottom waters (due to microbial decomposition of dead algae). Although J.C. Boyle Reservoir, a relatively long, shallow reservoir, does not stratify, large variations in dissolved oxygen are observed at its discharge due to conditions in the upstream reach from Link River Dam through the Keno Impoundment (including Lake Ewauna), and in UKL. Copco 1 and Iron Gate reservoirs thermally stratify beginning in April/May and do not mix again until October/November (FERC 2007). Dissolved oxygen in Iron Gate and Copco 1 surface waters during summer months is generally at or, in some cases above, saturation while levels in hypolimnetic waters reach minimum values near 0 mg/L by July (Raymond 2008, 2009. 2010).

Based upon measurements collected immediately downstream of IGD, dissolved oxygen concentrations regularly fall below 8 mg/L (the Basin Plan minimum dissolved oxygen criterion is now based on percent saturation [NCRWQCB 2010]) (Karuk Tribe of California 2001, 2002, 2007, 2009). Continuous Sonde data collected at other Klamath River locations downstream of IGD during the summers of 2004–2006 show that roughly 45 to 65% of measurements immediately downstream of the dam did not achieve 8 mg/L. Daily fluctuations of up to 1–2 mg/L measured in the Klamath River downstream of IGD (RM 190.1) have been attributed to daytime algal photosynthesis and nighttime bacterial respiration (Karuk Tribe of California 2002, 2003; YTEP 2005; NCRWQCB 2010). Farther downstream in the mainstem Klamath River, near Seiad Valley (RM 129.4), dissolved oxygen 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 2001–2002 and 2006–2009 (Karuk Tribe of California 2001, 2002, 2007, 2009).

Measured concentrations of dissolved oxygen 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) continue to be 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 2001, 2002, 2007, 2009; Ward and Armstrong 2010; NCRWQCB 2010). 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 (the Basin Plan minimum dissolved oxygen criterion prior to 2010) have been observed for extended periods of time during late summer/early fall (YTEP 2005, Sinnott 2010). In 2010, minimum dissolved oxygen concentrations remained above 2010 amended Basin Plan minimum dissolved oxygen concentration criteria based on percent saturation (see Appendix C of the Klamath Facilities Removal EIS/EIR for additional details).

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 high rates of growth and subsequent decomposition of algae and macrophytes, which are not abundant elsewhere in the estuary.

4.1.5.5 Nutrients

Primary nutrients including nitrogen and phosphorus are affected by the geology of the surrounding watershed of the Klamath River, upland productivity and land uses, and a number of physical processes affecting aquatic productivity within reservoir and riverine reaches. Nitrogen arriving in UKL has been attributed to upland soil erosion, runoff and irrigation return flows from agriculture, as well as *in situ* nitrogen fixation by cyanobacteria (Oregon DEQ 2002). Although the relatively high levels of phosphorus present in the Upper Klamath Basin's volcanic rocks and soils have been identified as a major contributing factor to phosphorus loading to the lake (Oregon DEQ 2002), land use activities in the Upper Klamath Basin have also been linked to increased nutrient loading (Kann and Walker 1999, Snyder and Morace 1997), subsequent changes in its trophic status, and associated degradation of water quality. Extensive monitoring and research has been conducted for development of the UKL TMDLs (Oregon DEQ 2002) that shows that the lake is a major source of nitrogen and phosphorus loading to the Klamath River (see Appendix of the Klamath Facilities Removal EIS/EIR for additional details).

Allowing for seasonal reservoir dynamics in the Hydroelectric Reach, nutrient levels in the Klamath River generally decrease with distance downstream of UKL due to particulate trapping in reservoirs, dilution, and uptake along the river channel. In a recent study of nutrient dynamics in the Klamath River, May through December nutrients for 2005–2008 followed a decreasing longitudinal pattern, with the highest concentrations (approximately 0.1–0.5 mg/L TP and 1–4 mg/L TN) measured in the Klamath River downstream of Keno Dam (RM 228–233) (Asarian et al. 2010). On an annual basis, nutrients typically decrease through the Hydroelectric Reach due to the dilution by the springs downstream of J.C. Boyle Reservoir and settling of particulate matter and associated nutrients in Copco 1 and Iron Gate reservoirs. On a seasonal basis, TP, and to a lesser degree, TN can increase in this reach due to the release (export) of dissolved forms of phosphorus (ortho-phosphorus) and nitrogen (ammonium) from reservoir sediments during periods of summer and fall hypolimnetic anoxia (see Appendix C of the Klamath Facilities Removal EIS/EIR for additional details). The seasonal nutrient releases can occur during periods of in-reservoir algal growth, or can be transported downstream to the lower Klamath River where they may stimulate periphyton growth.

Downstream of the Four Facilities, TP values typically range 0.1–0.25 mg/L in the Klamath River between IGD and Seiad Valley, with the highest values occurring just downstream of the dam. TN concentrations in the river downstream of IGD generally range from <0.1 to over 2.0 mg/L and are generally lower than those in upstream reaches due to reservoir retention and dilution by springs in the Hydroelectric Reach (Asarian et al. 2009). Further decreases in TN occur in the mainstem river due to a combination of tributary dilution and in-river nitrogen removal processes such as denitrification and/or storage related to biomass uptake (Asarian et al. 2010). Ratios of nitrogen to phosphorus (TN:TP) measured in the Klamath River downstream of IGD suggest the potential for nitrogen-limitation of primary productivity with some periods of co-limitation by both nitrogen and phosphorus. However, concentrations of both nutrients are high enough that other factors (i.e., light, water velocity, or available substrate) may be more limiting to primary productivity than nutrients are, particularly in the vicinity of IGD (FERC 2007, Hoopa Valley Tribe Environmental Protection Agency 2008, Asarian et al. 2010) (see Appendix C of the Klamath Facilities Removal EIS/EIR for additional details). This is particularly important with regard to factors controlling periphyton growth in this portion of the Klamath River.

Downstream of the confluence with the Salmon River, nutrient concentrations continue to decrease in the Klamath River as compared with those measured farther upstream due to tributary dilution and nutrient retention. Contemporary data (2005–2008) indicate that TP concentrations in this reach are generally 0.05–0.1 mg/L with peak values occurring in September and October. For TN, contemporary data indicate that on a seasonal basis, this nutrient increases from May through November, with peak concentrations (<0.5 mg/L) typically observed during September and October. Relative to the higher concentrations measured near IGD, these lower nutrient concentrations may be limiting periphyton growth in this portion of the river.

Nutrient levels in the Klamath Estuary experience inter-annual and seasonal variability. Measured levels of TP in the estuary are typically below 0.1 mg/L during summer and fall (June–September) and TN levels are consistently below 0.6 mg/L (June–September) (Sinnott 2011); however, as with upstream reaches, these levels do not meet the narrative California Basin Plan water quality objective for biostimulatory substances due to the promotion of algal growth at levels that cause nuisance effects or adversely affect beneficial uses (see the Klamath Facilities Removal EIS/EIR for additional details).

4.1.5.6 pH

Levels of pH in the Klamath Basin vary daily, seasonally, and by location. In the Upper Klamath Basin, summertime pH levels are elevated above neutral (i.e., up to 8.2 in the Wood River subbasin and 8.5–9.5 in the Sprague River). These elevated pH levels have been linked primarily to high rates of photosynthesis by periphyton (i.e., benthic or attached algae) (Oregon DEQ 2002). During November–April, pH levels in UKL are near neutral (Aquatic Scientific Resources [ASR] 2005) but increase to very high levels (>10) in summer (Oregon DEQ maximum pH is 9.0). Extended periods of pH greater than 9 have been associated with large summer algal blooms in UKL (Kann 2010). On a daily basis, algal photosynthesis can elevate pH levels by up to 2 pH units over a 24-hour period. Generally, pH in the reach from Link River Dam through the Keno Impoundment increases from spring to early summer and decreases in the fall; however, there are site-dependent variations in the observed trend. Peak values can exceed the Oregon DEQ maximum of 9.0 (see Appendix C of the Klamath Facilities Removal EIS/EIR for additional details).

In the Hydroelectric Reach, pH is seasonally variable, with levels near neutral during the winter, increasing in the spring and summer. Peak values (8–9.2) have been recorded during the months of May and September with lower values documented June through August (7.5–8) (Raymond 2010), where the Oregon DEQ pH maximum is 9 units (for the Klamath River upstream of the Oregon-California state line) and the California pH maximum is 8.5 units (for the river downstream of state line). Longitudinally, the lowest pH values were recorded downstream of J.C. Boyle Reservoir and the highest values in Copco and Iron Gate Reservoirs (Raymond 2008, 2009, 2010). High pH levels typically coincide with high algal photosynthesis rates at or near the water surface during periods of thermal stratification and high nutrient concentrations in the KHPreservoirs (Raymond 2008).

In the Lower Klamath Basin, seasonally high pH values continue to occur, with the highest pH values generally occur during late-summer and early-fall months (August–September). Daily cycles in pH also occur in this reach, with pH usually peaking during later afternoon or early evening, following the period of maximum photosynthesis (NCRWQCB 2010). The California North Coast Basin Plan pH maximum of 8.5 units is regularly exceeded in the Klamath River downstream of IGD for the May–October 2005 dataset (see Appendix C of the Klamath Facilities Removal EIS/EIR for more detail). The most extreme pH exceedances typically occur just upstream of Shasta River; values generally decrease with distance downstream (FERC 2007; Karuk Tribe of California 2007, 2009, 2010). During the summer months, pH values also are elevated in the lower Klamath River from Weitchpec downstream to approximately Turwar Creek (see Appendix C of the Klamath Facilities Removal EIS/EIR for more detail).

In the Klamath Estuary, pH ranges between approximately 7.5 and 9, with peak values also occurring during the summer months (YTEP 2005). Daily variations in pH are typically on the order of 0.5 pH units, and fluctuations tend to be somewhat larger in the late summer and early fall. When large daily fluctuations are observed, they are likely caused by algal blooms that are transported into the estuary.

4.1.5.7 Algae

As primary producers, algae are critical components of riverine and lacustrine ecosystems. Their presence and abundance affect food web dynamics as well as physical water quality parameters (e.g., dissolved oxygen, pH, turbidity, and nutrients), the latter through rates of photosynthesis, respiration, and decay of dead algal cells (Horne and Goldman 1994). Cyanobacteria are also photosynthetic and can often be a nuisance aquatic species, occurring as large seasonal blooms that alter surrounding water quality. Some cyanobacteria species, such as *M. aeruginosa*, produce cyanotoxins (e.g., cyclic peptide toxins that act on the liver such as microcystin, alkaloid toxins such as anatoxin-a and saxitoxin that act on the nervous system) that can cause irritation, sickness, or in extreme cases, death to exposed organisms, including humans (World Health Organization [WHO] 1999).

Chlorophyll-*a*, a pigment produced by photosynthetic organisms including algae and cyanobacteria, is often used as a surrogate measure of algal biomass. Algae suspended in the water column (phytoplankton) can be represented as a concentration of chlorophyll-*a* (mg/L), while algae attached to bottom sediments or channel substrate (periphyton) can be represented as an areal biomass (mg chl-a/m^2).

In the tributaries to UKL, algae are generally present as periphyton (i.e., benthic or attached algae) species. Periphyton in these streams can cause water quality impairments for dissolved oxygen and pH (see Appendix C of the Klamath Facilities Removal EIS/EIR for more detail). In UKL, algae are dominated by phytoplankton or suspended algae. Large summertime blooms of cyanobacteria are typically dominated by *Aphanizomenon flos-aquae*, with smaller amounts of *M. aeruginosa* present. Despite this, *M. aeruginosa* is believed to be responsible for the production of microcystin in the lake, with concentrations in 2007−2008 equal to or greater than the WHO limit for drinking water (1 µg/L) and peaked at 17 µg/L, which is above the Oregon Department of Public Health guidelines for issuing public health advisories. Additional microcystin data collection in UKL is ongoing, including measurement of toxin levels in native suckers (Vanderkooi et al. 2010, see Section 3.3 of the Klamath Facilities Removal EIS/EIR for more detail).

High (i.e., near 300 ug/L) summer chlorophyll-*a* concentrations in the Keno Impoundment (including Lake Ewauna) are due to large populations of algae, predominantly *A. flos-aquae*, entering the Klamath River from UKL in summer (Kann 2006; Sullivan et al. 2008, et al. 2009, et al. 2010, et al. 2011; FERC 2007). Such high concentrations do not persist farther downstream in J.C. Boyle Reservoir; however, in the two largest reservoirs (i.e., Copco 1 and Iron Gate) in the Hydroelectric Reach, chlorophyll-*a* concentrations increase again. Levels in Copco 1 and Iron Gate Reservoirs can be 2 to 10 times greater than those documented in the mainstem river, although they are not as high as those found in the Keno Impoundment (NCRWQCB 2010) (see Appendix C of the Klamath Facilities Removal EIS/EIR for more detail). High levels of microcystin also occur during summer months in Copco 1 and Iron Gate reservoirs; peak measured concentrations exceeded the State Water Resources Control Board (SWRCB)/Office of Environmental Health and Hazard Assessment (OEHHA) public health threshold of 8 µg/L by over 1000 times in Copco 1 Reservoir during 2006–2009 and extremely high concentrations (1,000–73,000 µg/L) were measured during summer algal blooms in both Copco 1 and Iron Gate Reservoirs during 2009 (Watercourse Engineering 2011).

Throughout the Klamath River, high chlorophyll-*a* concentrations have been shown to correlate with the toxigenic cyanobacteria blooms where *M. aeruginosa* was present in high concentrations and sharp increases in microcystin levels above WHO numeric targets (Kann and Corum 2009) and SWRCB, California Department of Public Health, and OEHHA guidelines (*Draft Voluntary Statewide Guidance for Blue-Green Algae Blooms* [SWRCB 2010]). Since 2007, high levels of microcystin have prompted the posting of public health advisories around the reservoirs and along the length of the Klamath River during summer months. In 2010, the KHP reservoirs and the entire river downstream of IGD (including the estuary) were posted to protect public health due to elevated cyanobacteria cell counts and cyanotoxin concentrations.

Microcystin can also bioaccumulate in aquatic biota (Kann 2008, Kann et al. 2011); 85% of fish and mussel tissue samples collected during July through September 2007 in the Klamath River, including Iron Gate and Copco 1 Reservoirs, exhibited microcystin bioaccumulation (Kann 2008) (see Appendix C of the Klamath Facilities Removal EIS/EIR for more detail). Estuarine and marine nearshore effects (e.g., sea otter deaths) from cyanobacteria exposure have been reported in other California waters; however, none have been documented to date for the Klamath Estuary or marine nearshore (Miller et al. 2010).

4.1.6 Sediment Supply

4.1.6.1 Bedload Material Load

Upper Klamath Lake to Keno Dam

The Klamath River is supply-limited for fine material (sands and small gravels), but capacity-limited for large material (cobbles and boulders) (Reclamation 2011b). Practically no substantial sediment is supplied to the Klamath River from the watershed above Keno Dam. This is because UKL, 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. All fluvial sediment supplied to reaches downstream of IGD is delivered to the Klamath River between Keno Dam and IGD. Sources within this reach supply 24,160 tons/year of coarse sediment (1.3% of the cumulative average annual basin-wide coarse sediment delivery) (Stillwater Sciences 2010).

Please refer to Appendix F of the Klamath Facilities Removal EIS/EIR for additional detail regarding bedload sediment supply.

Reservoir substrate composition

In 2010, Reclamation conducted a sediment sampling study in the project reservoirs to describe sediment composition and determine sediment thickness throughout all major sections of the reservoirs. The study found that fine-grained sediment in all of the reservoirs, except Copco 2 Reservoir consisted primarily of elastic silt and clay, with lesser amounts of elastic silt with fine sand. The sediment was determined to be mostly an accumulation of silt-size particles of organic material such as algae and diatoms, and silt-size particles of rock. The average grain size decreases nearer to the dams because smaller particles settle more slowly than larger particles. Accordingly, the upper reaches of each reservoir contained a higher percentage of silt, sand, and gravel than the lower reaches, which contain more clay, sandy elastic silt and elastic silt with trace sand. The elastic silt in all of the reservoirs had the consistency of pudding, and had very high water content (more than double the mass). The fine-grained sediment was also found to have a low cohesion and to be erodible; where water flowed greater than 2.9 to 5.8 ft per second (fps), accumulations of sediment were less than a few inches (Reclamation 2010). Please refer to Appendix F of the Klamath Facilities Removal EIS/EIR for additional detail regarding reservoir substrate composition.

Reclamation (2011b) estimated that there are approximately 13,150,000 cubic yards of sediment stored in the Hydroelectric Reach (Table 4-2). The sediment stored within the reservoirs has a high water content and 85% of the particles are silts and clays (less than 0.063 mm) while 15% are sand or coarser (larger than 0.063 mm) (Gathard Engineering Consultants [GEC] 2006, Stillwater Sciences 2008, Reclamation 2011b).

Table 4-2. Estimated Volume of Sediment Currently Stored within Hydroelectric Reach Reservoirs and Tributary Mouths

Reservoir	Location	Volume (yd^3)
J.C. Boyle	Upper Reservoir	380,000
	Lower Reservoir	620,000
Copco I	Upper Reservoir	810,000
	Lower Reservoir	6,630,000
Iron Gate	Upper Reservoir	830,000
	Lower Reservoir	2,780,000
	Jenny Creek	300,000
	Scott/Camp creeks	800,000
Total		**13,150,000**

Iron Gate Dam to estuary

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 2004b, Reclamation 2011b). The reach from IGD to Cottonwood Creek (RM 182.1) is characterized by coarse, cobble-boulder bars immediately downstream of the dam, transitioning to a cobble bed with pool-riffle morphology farther downstream near Cottonwood Creek (Montgomery and Buffington 1997, PacifiCorp 2004b, Stillwater Sciences 2010). Cottonwood Creek to the Scott River is a confined channel with a cobble-gravel bed and pool-riffle morphology (PacifiCorp 2004b). The median bed material ranges from 45 to 50 mm, but bar substrates become finer in the downstream direction, with median sizes of 49 mm and 25 mm at the upstream and downstream ends, respectively. Downstream of the Scott River, including through the Seiad Valley, the Klamath River is cobble-gravel-bedded with pool-riffle morphology (PacifiCorp 2004b). PacifiCorp (2004b) also noted increasing quantities of sand and fine gravel on the bed surface with distance downstream, likely reflecting the resupply of finer material from tributaries to the Klamath River.

The KHP dams trap most of the finer sediment produced in the low sediment yielding, young volcanic terrain upstream of the dams, which results in coarsening of the channel bed downstream of the dams until tributaries resupply the channel with finer sediment. However, most of the supply from the portion of the watershed upstream of J.C. Boyle Reservoir is trapped in UKL, which is a natural lake. Most (≈98%) of the sediment supplied to the mainstem Klamath River (Stillwater Sciences 2010) is delivered from tributaries downstream of Cottonwood Creek. The effects of the reservoir-interrupted upstream sediment supply are ameliorated to a large degree downstream of Scott River.

4.1.7 Aquatic Diseases

Baseline information on the distribution and occurrence of most salmonid pathogens is limited. Existing data and observations in the Klamath River indicate that the most common pathogens of concern can be grouped into four categories: (1) viral pathogens such as Infectious Haematopoietic Necrosis (IHN); (2) the bacterial pathogens *R. salmoniranrum* (bacterial kidney disease, BKD), *Flavobacterium columnare* (columnaris), and *Aeromonas hydrophila*; (3) external protozoan parasites *Ichthyophthirius* (Ich), *Ichthyobodo,* and *Trichodina*; and (4) the myxozoan parasites *Ceratomyxa shasta* (causes ceratomyxosis) and *Parvicapsula minibicornis*. There is a lack of information concerning the presence of IHN and BKD either above or below IGD (Administrative Law Judge 2006). *Columnaris* is common worldwide and present at all times in the aquatic environment. *Columnaris* disease in cold water fishes is generally seen at water temperatures above 15°C. In natural infections, the disease is often chronic to subacute, affecting skin and gills (CDFG 2003). Ich infestation of gill tissue results in hyperplasia, a condition that reduces the ability of the fish to obtain oxygen. Death is by asphyxiation. Ich can be found on any fish at any temperature, but typically only cause disease and mortality at water temperatures above 14°C and in crowded conditions (CDFG 2003). Other common pathogens are likely present in the Klamath River, but are reported rarely.

Observations below IGD indicate that *C. shasta* has the potential to infect large portions of the juvenile salmon population below Iron Gate Dam and cause significant mortality in some years. The life cycles of both *P. minibicornis* and *C. shasta* involve an invertebrate and a fish host, where these parasites complete different parts of their life cycle. In the Klamath River, *P. minibicornis* and *C. shasta* share the same invertebrate host: an annelid polychaete worm, *Manayunkia speciosa* (Bartholomew et al. 2006, et al. 1997). Once the polychaetes are infected, they release *C. shasta* actinospores into the water column. Temperature and actinospore longevity are inversely related. In one study, actinospores remained intact the longest at 4°C, but were short-lived at 20°C. Actinospores are generally released when temperatures are above 10°C. Actinospores remain viable (able to infect salmon) from 3 to 7 days at temperatures ranging from 11 to 18ºC (Foott et al. 2006). They are viable for shorter periods of time when temperatures are outside of this range. As actinospores viability increases, actinospore distribution may increase, raising the infectious dose for salmon over a larger area of the river (Bjork and Bartholomew 2010). Actinospore abundance is controlled by the number of infected polychaetes and their infection levels (prevalence and severity), and actinospore abundance is a primary determinant of infectious dose.

Salmon become infected when the actinospores enter the gills, eventually reaching the intestines. At that point, the parasite replicates and matures to the myxospore stage. Myxospores are shed by the dying and dead salmon, and the cycle continues with infection of polychaete worms by the myxospores (Bartholomew and Foott 2010). Transmission of the *C. shasta* and *P. minibicornis* parasites is limited to areas where the invertebrate host is present.

Susceptibility to *C. shasta* is also influenced by the genetic type of *C. shasta* that a fish encounters. Atkinson and Bartholomew (Atkinson and Bartholomew 2010a, 2010b) conducted analyses of the genotypes of *C. shasta* and the association of these genotypes with different salmonid species, including Chinook and coho salmon, steelhead, rainbow trout, and redband trout. In the Williamson River, although parasite densities had been found to be high, Chinook salmon were resistant to infection because the genotype specific to Chinook salmon was absent. In a genetic analysis, the *C. shasta* genotypes were characterized as Type 0, Type I, Type II and Type III:

- The Type 0 genotype occurs in both the Upper and Lower Klamath Basin and native rainbow/redband trout and steelhead are susceptible to infection with Type 0. However, in most situations, this genotype occurs in low densities and it is not very virulent. Infection generally leads to minimal or no mortality.
- The Type I genotype of *C. shasta* occurs in the Lower Klamath Basin and affects Chinook salmon. This genotype causes significant mortality to Chinook salmon below IGD. However, if it were to move above IGD, it would affect only Chinook salmon.
- The Type II genotype occurs in and above UKL and below IGD, and at low levels between the dams, and affects coho salmon and nonnative rainbow trout. However, it appears that the biotype of this parasite in the upper basin does not affect coho salmon. Risks to native rainbow/redband trout from this genotype are low (J. Bartholomew, Oregon State University, pers. comm.).
- Type III appears widespread based on fish infections, but was not detected in water samples. Type III appears to infect all salmonid species (Atkinson and Bartholomew 2010b). Prevalence of this genotype is low and it infects fish but does not appear to cause mortality.

The invertebrate host for *C. shasta* is present in a variety of habitat types, including runs, pools, riffles, edge-water, and reservoir inflow zones, as well as sand, gravel, boulders, bedrock, aquatic vegetation, and is frequently present with a periphyton species: *Cladophora* (a type of algae) (Bartholomew and Foott 2010). Slow-flowing habitats may have higher densities of polychaetes, and areas that are more resistant to disturbance, such as eddies and pools with sand and *Cladophora*, may support increased densities of polychaete populations (Bartholomew and Foott 2010), especially if flow disturbance events are reduced or attenuated.

Salmonids and their associated pathogens historically migrated to the upper Klamath Basin; both salmon and these pathogens are native to the upper basin (Administrative Law Judge 2006) and available information suggests that the risk of potential reintroduction of pathogens to Klamath River native fish upstream of the dams would be low. Movement of recently discovered *C. shasta* genotypes upstream of the dams would affect only the host species that transported the genotype (Hamilton et al. 2011).

While it is possible that the current infections nidus (reach with highest infectivity) for *C. shasta* and *P. minibicornis* may move upstream where salmon spawning congregations occur and there is uncertainty associated with the formation of a disease zone above Iron Gate Dam, the likelihood of this happening appears to be remote. Any creation of an infections zone (or zones) would be the result of the synergistic effect of numerous factors, such as those that occur within the current disease zone in the Klamath River in the reach from the Shasta River downstream to Seiad Valley (factors noted by FERC (2007)). Establishment of flows that mimic natural conditions, combined with reestablishment of natural sediment transport rates, would restore natural geomorphic channel forming processes (Hetrick et al. 2009) necessary to create diverse habitat and reduce the influence of those synergistic factors that currently create conditions favorable for disease. Under a dams out alternative, those conditions that are believed to result in development of an infectious nidus below Iron Gate Dam, or a could result in development of a potential infectious nidus above Iron Gate Dam, are unlikely to occur.

FERC (2007) concluded that dam removal would enhance water quality and reduce the cumulative water quality and habitat effects that contribute to disease-induced salmon die-offs in the Klamath River downstream of Iron Gate Dam. In general, improvements to water quality, diversity of flows, reduction in water temperature thermal lag caused by reservoirs, reduced concentration of adult salmon carcasses below migration barriers, bedload movement, and reduced planktonic drift from reservoirs with dam removal and KBRA implementation would likely alleviate many of the conditions that stimulate disease outbreaks, which currently occur downstream of Iron Gate Dam (Hamilton et al. 2011). In particular, disease conditions for outmigrants from tributaries downstream of Iron Gate Dam would be improved under this scenario, whereas *C. shasta* would continue to be an issue with dams remaining.

4.1.8 Estuarine and Near-Shore Marine Environment

Wallace (1998) surveyed the Klamath River Estuary, and noted the formation of a sand berm at the river mouth each year in the late summer or early fall, raising the water level in the estuary, reducing tidal fluctuation, and restricting saltwater inflow. The surveys found that the brackish water layer along the bottom of the estuary may be extremely important to rearing juvenile salmonids, as they appeared to be more abundant near the freshwater/saltwater interface.

The Klamath River Estuary supports a wide array of fish species and may also serve as breeding and foraging habitat for marine and estuarine species. These species include, but are not limited to, all of the anadromous fish mentioned previously, federally threatened Southern DPS green sturgeon, Pacific herring, surf smelt, longfin smelt, eulachon, top smelt, starry flounder and other flatfish, Klamath speckled dace, Klamath smallscale sucker, prickly and Pacific staghorn sculpin, northern anchovy, saddleback gunnel, and bay pipefish.

Water temperatures in the Klamath River estuary are linked to temperatures and flows entering the estuary. The salinity of the estuary and resulting density stratification is related to the timing and duration of the formation of a sand berm across the estuary mouth. When the estuary mouth is open, denser salt water from the ocean sinks below the lighter fresh river water, resulting in a salt 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 water near the surface. Under low-flow summertime conditions, when the mouth can 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).

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 high rates of growth and subsequent decomposition of algae and macrophytes, which are not abundant elsewhere in the estuary.

Under existing conditions, a freshwater plume exists within the nearshore environment in the vicinity of the Klamath River mouth. This freshwater plume is affected by winter runoff events. These effects include low-salinity, high levels of suspended particles, high sedimentation, and low light (and potential exposure to land-derived contaminants). The extent and shape of plume is variable, and influenced by wind patterns, upwelling effects, shoreline topography (especially at Point Saint George), and longshore currents. High SSC events contribute to the plume, especially during floods. In a recent study of the Eel River nearshore sediment plume, located approximately 80 mi south of the Klamath River, *in situ* measurements of plume characteristics indicated no relationship with SSCs, turbulent-kinetic-energy, time from river mouth, wind speed, wave height, or discharge. A relationship apparently did exist between effective settling velocity (bulk mean settling velocity) of plume sediments and wind speed/direction, as well as with tides (Curran et al. 2002).

4.1.9 Climate Change

4.1.9.1 Terrestrial Ecosystem

Recent scientific research and opinions regarding climate change have focused on the effects of changing temperature and annual precipitation records, wildfire events, and insect and disease outbreaks on forest ecosystems.

In the Pacific Northwest, mean annual temperatures and are expected to rise 0.1–0.6°C (0.2–1.0°F) per decade (Mote and Salathe 2010, as cited in USFWS 2011b) warmer drier summers, warmer wetter autumns and winters, resulting in increase in extreme precipitation events and heat waves (Salathe et al. 2009, as cited in USFWS 2011b). Also, recent evidence supports that as summer temperatures are rising, the elevation of the tree line in high-elevation Pacific Northwest forests may be increasing (Graumlich et al. 1989 and Case and Peterson 2009, as cited in USFWS 2011b) while the productivity of tree growth in lower elevations is likely to decrease due to the prolonged warmer summer season.

In Oregon, an increase in fire activity is expected to occur over all major forest types (Shafer et al. 2010, as cited in USFWS 2011b), and in the Pacific Northwest, areas burned by wildfire are expected to increase (Hessburg et al. 2005, 2007, Kennedy and Wimberly 2009, Littell et al. 2009, 2010, Shafer et al.

2010; all as cited in USFWS 2011b). However, on the east side of the Cascade Mountains, late-successional forests persisted longer in high-elevation areas with increased precipitation, near streams or valley bottoms with perched water tables, high soil and fuel moisture, and where terrain was shaded (Camp et al. 1997, as cited in USFWS 2011b).

A loss of pine species is projected in the eastern Cascades as early as the 2040s due to a combination of mountain pine beetle outbreaks and increased tree susceptibility resulting from an increase in hot and dry weather conditions (Littell et al. 2010, as cited in USFWS 2011b).

The change in forest productivity, tree composition, and elevation range may change the amount of suitable habitat that is available and initiate a change in the composition of species that use the habitat. The change in forest composition would likely occur over a timespan of 100–500 years where events such as fire and insect outbreaks have a shorter time scale of 25–100 years (McKenzie et al. 2009, as cited in USFWS 2011b).

4.1.9.2 Aquatic Ecosystem

This section was taken in its entirety from Hamilton et al. (2011).

The range of anadromous fish populations is restricted in large part by climate. Salmonid restoration efforts in the Klamath watershed cannot ignore the effects of climate change. The Intergovernmental Panel on Climate Change concluded that warming of the climate is unequivocal (Intergovernmental Panel on Climate Change [IPCC] 2007). The global average temperature since 1900 has risen by about 0.9°C. By 2100, global average temperature is projected to raise another 2 to 11.5°F. The U.S. average temperature is likely to rise more than the global average over this century, with some variation from place to place (USGS 2009).

The effects of climate change on coldwater fishes (i.e., salmonids) are likely to be especially severe in the southern part of their ranges, such as in the Klamath River watershed. Increasing temperatures will change conditions in all aquatic habitats, from rivers to estuaries to the Pacific Ocean. In rivers, climate change is expected to alter flow patterns, including the seasonality and magnitude of droughts and floods. Consequently, the suitability of rivers in the United States for supporting salmon and trout is expected to decrease four to 20% by 2030 and by as much as 60% by 2100 (Eaton and Scheller 1996), with the greatest losses projected for California and Oregon (O'Neal 2002).

Water temperatures in the Pacific Northwest warmed by approximately 0.72°C in the 20th century (based on conversions by Eaton and Scheller 1996 and see (Mote et al. 2003). Anadromous salmonids, depending on the species and location, tolerate water temperatures in the range of 0–25°C (Brett 1971, Richter and Kolmes 2005). However, salmonid survival and reproduction may become impaired by water temperatures higher than 18°C (EPA 2003). Thus, although the increase in water temperature seems small, it can result in water temperatures that are suboptimal or lethal to salmonids already residing in rivers where summer temperatures often exceed 20°C (McCullough 1999).

Streams are also expected to be warmer and drier during the summer and fall months due to a reduction in snowpack levels and seasonal retention. Elevations below 9,900 ft. will suffer the most (~80%) reduction in snow pack (Hayhoe et al. 2004). In California, losses are expected to be most significant in the southern Sierra and Cascade Mountains (Mote et al. 2005), the source of snowmelt for most streams in the lower Klamath River Basin. Increased temperatures also will increase the incidence of winter floods and summer droughts (Anderson et al. 2008; Edwards 1991; Field et al. 1999). Peak flows have already shifted to earlier in the year by 10 to 30 days in much of the western U.S. (Stewart et al. 2004). Predictions are that future peak flows may shift even earlier in the year by 30 to 40 days (Stewart et al.

2004). In the Klamath River Basin, these impacts will be more marked in streams which are primarily fed by snow-melt (i.e., Salmon and Scott rivers) than those fed by springs (the Williamson and Wood rivers in the upper basin; the Shasta River below IGD).

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 (Van Kirk and Naman 2008) found statistically significant declines in April 1 Snow Water Equivalent since the 1950s at several snow measurement stations throughout the Klamath River Basin, particularly those at lower elevations (<6,000 ft.). There is strong evidence that winter precipitation in the upper Klamath River Basin has declined (Mayer and Naman 2011b, in press). Climatic factors are likely responsible for much of the decline in long-term UKL net inflows during the period 1961 to 2007 (Mayer 2008).

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 Klamath Reclamation 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. Rain on snow events may increase the frequency of late winter and early spring flooding causing destruction of salmonid redds and thereby reducing survival of salmonids.

The Klamath estuary will likely be impacted by more frequent and extreme tides and storms (Cayan et al. 2008), and likely will experience altered salinity concentrations as sea level rises (Scavia et al. 2002). These changes, in combination with increasing temperatures, can result in seasonally anoxic conditions (Moore et al. 1997) and altered food availability in at least some parts of the estuary. Impacts to salmonids using the Klamath estuary may be modulated by their rearing strategy. For example, impacts to juvenile Chinook salmon in the Klamath River may not be significantly impacted as they do not appear to use the estuary extensively for rearing (Sullivan 1989).

In the Pacific Ocean, localized increases in California Current primary productivity may favor growth for some salmonids, but benefits to populations will largely depend on movement patterns dictated by currents (Brodeur et al. 2007, Huyer et al. 2007, Wells et al. 2008). The California Current is a Pacific Ocean current that moves south along the western coast of North America, beginning off southern British Columbia, and ending off southern Baja California. The movement of northern waters southward makes the coastal waters cooler than the coastal areas of comparable latitude on the east coast of the United States. The cold water is highly productive due to the upwelling, which brings to the surface nutrient-rich waters, supporting marine life and important fisheries. Furthermore, recent research estimates that upwelling has been delayed by as much as one month, perhaps disrupting predator-prey relationships and adversely impacting food availability to juveniles at ocean entry (Di Lorenzo et al. 2008; Scheuerell et al. 2009).

A connection between salmon abundance and a North Pacific climate variation, named the Pacific Decadal Oscillation (PDO), has been demonstrated (Mantua and Hare 2002). Warm phase PDO is generally associated with reduced abundance of coho and Chinook salmon in the Pacific Northwest, while cool phase PDO is linked to above average abundance of these fish. The El Niño Southern Oscillation (ENSO) and North Pacific Gyre Oscillation (NPGO) (Di Lorenzo et al. 2008) also influence habitat quality in the Pacific Ocean (Garcia-Reyes and Largier 2010), as well as inland aquatic habitats by influencing precipitation events. Unfavorable ocean conditions (e.g., warm phase PDO) are believed to be partially responsible for the poor survival of salmon stocks in California in 2006 (NMFS 2007a) and 2008 (Lindley et al. 2009).

In a paper published in The National Academy of Sciences of the USA, Battin et al. (Battin et al. 2007) used a series of linked models of climate, land cover, hydrology, and salmon population dynamics, to investigate the impacts of climate change on the effectiveness of proposed habitat restoration efforts designed to recover depleted Chinook salmon populations in a Pacific Northwest river basin. Model results indicated that climate change will have a large negative effect on freshwater salmon habitat. Additionally, (Battin et al. 2007) concluded that climate change will make salmon recovery targets much more difficult to attain.

These changing conditions have profound implications for restoration of anadromous fish populations over the next 50 years. Water temperature in all habitats is predicted to steadily increase throughout the 21st century, perhaps beyond salmonid tolerances. As a result, the abundance of some salmonid populations in the Klamath River Basin may decrease by as much as 60% by 2100 (based on estimates in (Chatters et al. 1992), unless climate change is actively incorporated into conservation efforts.
As adverse as climate change predictions appear for the future of anadromous fish habitat, there are mitigating circumstances associated with the upper Klamath basin. Contrary to the commonly accepted view that snowpack storage is the dominant source of late summer water, recent research has revealed that the source of late summer water in western and central Oregon and northern California is almost exclusively immense groundwater storage in the Cascade Range. The volume of water stored as groundwater in permeable lava flows in the Cascade Range is seven times that stored as snow (Thompson 2007). Under a climate change scenarios, streams fed by groundwater are predicted to continue to flow in the summer, due to an extended storage effect, but at a reduced volume (Tague et al. 2008, Thompson 2007). The hydrograph of groundwater fed systems is expected to reflect higher winter flows and decreased spring and summer flows as snowmelt peaks earlier in the year and flows are mediated by geologic drainage rates (Thompson 2007, Jefferson et al. 2007, Tague et al. 2008). Flow in streams fed by springs should continue to be more stable (less interannual variability) than streams dominated by surface runoff (Jefferson et al. 2007).

While the hydrology and temperature regime of the Klamath River generally is dominated by surface water runoff. The upper Klamath basin and the Shasta River have substantial regional groundwater flow. Much of the inflow to UKL can be attributed to groundwater discharge to streams and major spring complexes within a dozen or so miles from the lake. This large component of groundwater buffers the lake somewhat from climate cycles (Gannett et al. 2007). In absolute terms, decreases in summer base flows may be greater in groundwater basins than in surface dominated basins (Mayer and Naman 2011a; Thompson 2007). However, this does not change the fact that these groundwater basins, such as the upper Klamath, will have under climate change, more streamflow in late summer than those basins with little sub surface flow (Thompson 2007).

In terms of temperature, groundwater is generally cooler in the summer and warmer in the winter than surface water. Because of the groundwater influence, stream water temperatures in the upper Klamath basin are less likely to be altered than those in the lower basin in response to climate change over the 50 year time scale of this analysis. Temperatures of springs generally reflect the temperature of their water source (aquifer). Consequently, spring water in the summer is farther from equilibrium with air temperature than ambient stream water, taking it longer (in time and distance) to warm (Tague et al. 2007).

Groundwater temperatures respond to climate change to a lesser degree than groundwater flows. While hydraulic pulses can move through a groundwater system relatively rapidly, on the time scale of months or years, the actual advective travel time of water is much longer (Gannett 2010). Large scale springs, such as in the Cascades, with travel times on the order of decades to centuries, can be expected to damp climatic temperature variations on the order of decades (Manga 1999). Large amounts of groundwater discharge into the Wood River subbasin, the lower Williamson River area, and along the margin of the

Cascade Range (Gannett et al. 2007). Temperature benefits to the mainstem Klamath River below UKL from upper Klamath basin groundwater inputs would continue to be diminished as water passes through UKL, where it can warm before flowing downstream. However, Big Springs provides significant high quality water below J.C. Boyle Dam and the Shasta River was historically a groundwater-dominated system (NRC 2004) with considerable potential to provide groundwater benefits currently.

Under climate change, late summer drought conditions will likely increase in frequency, further restricting the suitable rearing habitat of juvenile salmonids and the holding waters of adult spring Chinook without thermal refugia. These late summer drought conditions may further restrict the distribution and abundance of salmonids in currently marginal habitats near the southern limit of the range. Climate change is likely to have deleterious effects on salmonid populations and consequently an undesirable effect on harvest of salmonids during the 50-year period of interest. Carefully planned habitat restoration projects (such as conservation and acquisition of groundwater) offer one of the few strategies that will be likely to mitigate the short-term effects of climate change (i.e., decades) (Independent Scientific Advisory Board [ISAB] 2007).

4.2 Status of the Species

4.2.1 Species Considered and Excluded from Further Consideration (No Effect Only)

The following species have the potential to occur in the Action Area. However, based on habitat associations, proximity to proposed activities, and/or protective measures, these species have been determined to not be affected by the Proposed Action (Table 4-3). These species will be excluded from further analysis in this BA.

Table 4-3. Federally Listed and Proposed Species Considered and Excluded from Further Analysis

Scientific name (common name)	Federal status	Critical habitat	Distribution	Habitat associations	Data sources	Likely to be affected by the Proposed Action?
Plants						
Astralagus applegatei (Applegate's milk vetch)	Endangered	None	A narrow endemic, known to occur only in southern Klamath County, Oregon, with four sites a few miles south of the city of Klamath Falls (USFWS 2011b). Documented during PacifiCorp surveys at Keno Reservoir. Elevation range: found at 4,100 ft (USFWS 2011b)	Flat, seasonally moist, strongly alkaline soils that are sparsely vegetated (USFWS 2011b).	USFWS	No effect; habitat and the species occur at the Keno Impoundment; therefore, perform protocol-level surveys prior to construction; buffer any identified locations.
Fritillaria gentneri (Gentner's fritillary)	Endangered	None	Restricted to a few localities in southwest Oregon all within a 30 mi radius around Jacksonville, Oregon (USFWS 2011b). Elevation range: 3,297–3,675 ft (CNPS 2011)	Chaparral and cismontane woodland; soils sometimes serpentinite (CNPS 2011).	CNPS, CNDDB, USFWS	No effect; habitat is present along the outer edge of the 1.5 mile buffer around Copco and Iron Gate reservoirs, however, no activities are planned in the vicinity.
Phlox hirsuta (Yreka phlox)	Endangered	None	Known from only four locations in and near Yreka, Siskiyou County, California (CNPS 2011). Elevation range:(2,690–4,921 ft (CNPS 2011)	Lower montane coniferous forest and upper montane coniferous forest in serpentinite soils and on talus (CNPS 2011).	CNPS, CNDDB, USFWS	No effect; serpentine soils occur within 2 mi of Copco Reservoir, but not within the 1.5 mile buffer surrounding the Hydroelectric Reach. Suitable habitat is present crossing the Klamath River downstream of IGD; however, the alluvial geology of the 100 year floodplain does not contain suitable soils.

Scientific name (common name)	Federal status	Critical habitat	Distribution	Habitat associations	Data sources	Likely to be affected by the Proposed Action?
Fish						
Eucyclogobius newberryi (tidewater goby)	Endangered	The closest designated critical habitat is located near Lake Talawa (21 mi) north of the Klamath Estuary, Stone Lagoon (21 mi) south of the Klamath Estuary, and Big Lagoon (23 mi) south of the Klamath Estuary. (USFWS 2008c)	Tillas Slough (mouth of the Smith River, Del Norte County) to Agua Hedionda Lagoon (northern San Diego County).	Coastal lagoons and the uppermost zone of brackish large estuaries; found in water less than 3 ft deep and salinities less than 12 ppt (USFWS 2005).	CNDDB, USFWS	No effect; species not documented within Proposed Action and the only potential suitable habitat within the Klamath River and Estuary may be located within tributaries to the estuary (L/ Roberts, Biologist, USFWS Fish and Wildlife, pers. comm., June 14, 2011). The sediment release is not expected to impact these tributaries; therefore, the effects of the Project are not expected to overlap with the species or designated critical habitat.
Reptiles						
Caretta caretta (loggerhead turtle)	Threatened	None	Warm waters of the Pacific coast, primarily from the Channel Islands south; does not nest in California. The presence of loggerhead turtles in the North Pacific and in Baja California is likely a result of developmental migrations from the main nesting areas in Japan (Bowen et al. 1995).	Uses the open ocean near-shore zone; nests on high energy, relatively narrow, steep coarse-grained beaches. Loggerheads are circumglobal, inhabiting continental shelves, bays, estuaries and lagoons in the temperate, subtropical, and tropical waters of the Atlantic, Pacific and Indian oceans (Dodd 1988).	NMFS	No effect; the effects of the Proposed Action are outside of the preferred distribution of the species.
Chelonia mydas (incl. agassizi) (green turtle)	Threatened	Designated in Culebra Island, Puerto Rico (NMFS 2011)	Warm waters of the Pacific coast, primarily from San Diego south. Uncommon along the California coast (California Herps 2011); does not nest in California.	Uses convergence zones in the open ocean and benthic feeding grounds in coastal areas; nests on sandy ocean beaches (NMFS 2011),	NMFS	No effect; the effects of the Proposed Action are outside of the preferred distribution of the species.
Dermochelys coriacea (leatherback turtle)	Endangered	Designated in the coastal waters adjacent	Temperate and cool waters of the Pacific coast. Seasonal occurrences	Pelagic, though also forages near coastal	NMFS	No effect; If species is present in the Pacific Ocean, off the

Scientific name (common name)	Federal status	Critical habitat	Distribution	Habitat associations	Data sources	Likely to be affected by the Proposed Action?
		to Sandy Point, St. Croix, U.S. Virgin Islands (44 FR 17710) Proposed for designation includes the California coast from Point Arena to Point Vincente (200 mi south of the Klamath Estuary); and from Cape Flattery, Washington to the Umpqua River (Winchester Bay), Oregon (145 mi north of the Klamath Estuary).(75 FR 319)	during summer and fall months along the Pacific coast result from the trans-Pacific migration from Western Pacific nesting beaches, when large aggregations of jellyfish form (Bowlby 1994, Starbird et al. 1993, Benson et al. 2007b, Graham 2009; all as cited in 75 FR 319). Majority of occurrences are documented in central and southern California from boats out at sea, telemetry studies, and aerial surveys. Does not nest in California.	waters (NMFS 2011).		Northern California coast, it is likely migrating through the area during the summer and fall months. Any effects on water quality from January–March 2020 would occur outside of the seasonal distribution of the species.
Lepidochelys ovilavcea (olive (=Pacific) ridley sea turtle)	Threatened	None	Warm waters of the Pacific coast, primarily from southern California south (e.g., Point Loma, La Jolla, and Encinitas in San Diego County); however, species has been documented in off Mendocino and Humboldt counties, and as far north as Oregon and possibly Alaska during warm-water El Niño years (California Herps 2011). Species does not nest in California.	Associated with the pelagic zone; however, has been documented along coastal areas, including bays and estuaries; nests on sandy ocean beaches (NMFS 2011).	NMFS	No effect; the effects of the Proposed Action are outside of the preferred distribution of the species.
Birds						

Scientific name (common name)	Federal status	Critical habitat	Distribution	Habitat associations	Data sources	Likely to be affected by the Proposed Action?
Charadrius alexandrinus nivosus (western snowy plover)	Threatened	The closest designated critical habitat is located near Lake Talawa (21 mi north of the Klamath Estuary) and Big Lagoon (23 mi south of the Klamath Estuary). The closest proposed critical habitat is at Gold Bluffs Beach (7 mi north of the Klamath Estuary), Stone Lagoon (21 mi south of the Klamath Estuary), and near Lake Talawa (21 mi north of the Klamath Estuary) (76 FR 16046).	Nests in locations along Washington, Oregon, and California coasts (including Del Norte, Humboldt, and Mendocino counties) (USFWS 2007a).	Nests on barren to sparsely vegetated dune-backed beaches, barrier beaches, and salt-evaporation ponds, infrequently on bluff-backed beaches.	CNDDB, USFWS	No effect; effects from suspended sediment within the water column from the Proposed Action is not expected to affect this species, nesting habitat, or critical habitat, because suspended sediment will be deposited offshore. Contamination of prey base as a result of flushing sediment is likely to be consistent with exposing aquatic biota to an "average" water column chemical concentration and with respect to bioaccumulation potential, there are no exceedances of applicable marine bioaccumulation screening levels (CDM 2011).
Phoebastris albatrus (short-tailed albatross)	Endangered	None	During the non-breeding season, range along the continental shelf margins of the Pacific Rim from southern Japan to northern California (USFWS 2008d). Species does not nest in California.	North Pacific marine ocean. Foraging habitat includes regions of upwelling and high productivity (e.g., Gulf of Alaska, along the Aleutian Chain, and along the Bering Sea shelfbreak from the Alaska Peninsula out towards St. Matthew Island) (Suryan et al. 2007a, Tickell 2000; both as cited in USFWS 2008d).	USFWS	No effect; outside of the preferred distribution for foraging. Contamination of prey base as a result of flushing sediment is likely to be consistent with exposing aquatic biota to an "average" water column chemical concentration and with respect to bioaccumulation potential, there are no exceedances of applicable marine bioaccumulation screening levels (CDM 2011).

Scientific name (common name)	Federal status	Critical habitat	Distribution	Habitat associations	Data sources	Likely to be affected by the Proposed Action?
Mammals						
Balaenoptera borealis (sei whale)	Endangered	None	Pacific Ocean; wide range of subtropical, temperate, and subpolar waters around the world. Species may migrate to higher latitudes during the summer and lower latitudes during the winter; however, this species is unpredictable (NMFS 2011).	Deep ocean waters far from the coastline (NMFS 2011).	NMFS	No effect; effects from suspended sediment within the water column from the Proposed Action are located outside of the preferred distribution (deep ocean habitat)..
Balaenoptera musculus (blue whale)	Endangered	None	The North Pacific population extends throughout the Pacific Ocean and includes deep ocean waters off California. In general, species migrate towards the subtropics in the fall and sub-polar areas in the spring, however evidence suggests some individuals reside in areas year-round. (NMFS 2011)	Deep ocean offshore waters; also can be found in coastal waters (NMFS 2011).	NMFS	No effect; effects from suspended sediment within the water column from the Proposed Action are located outside of the preferred distribution (deep ocean habitat).
Balaenoptera physalus (fin whale)	Endangered	None	Pacific Ocean; species is distributed year-round in a wide range of longitudes and latitudes, but primarily found in temperate to polar latitudes, and less commonly in the tropics. Specific migration patterns are complex; however, migration to foraging areas in high-latitude marine environments has been documented. (NMFS 2011)	Deep ocean waters (NMFS 2011).	NMFS	No effect; effects from suspended sediment within the water column from the Proposed Action are located outside of the preferred distribution (deep ocean habitat).
Megaptera novaengliae (humpback whale)	Endangered	None	Pacific Ocean; the California/Oregon/Washington stock resides from southern British Columbia to California in the summer and fall; winters in Central America and Mexico (NMFS 2011).	Deep ocean waters (NMFS 2011).	CNDDB, NMFS	No effect; effects from suspended sediment within the water column from the Proposed Action are located outside of the preferred distribution (deep ocean habitat) and seasonal occurrence for the species.
Physeter	Endangered	None	Pacific Ocean between about 60° N	Deep ocean waters	CNDDB,	No effect; effects from

Scientific name (common name)	Federal status	Critical habitat	Distribution	Habitat associations	Data sources	Likely to be affected by the Proposed Action?
macrocephalus (sperm whale)			and 60° S latitudes. California-Oregon-Washington stock have been documented in California year-round and in Washington and Oregon from March through November. (NMFS 2011)	(NMFS 2011).	NMFS	suspended sediment within the water column from the Proposed Action are located outside of the preferred distribution (deep ocean habitat) for the species.
Eubalaena japonica (North Pacific right whale)	Endangered	Designated critical habitat is located in the North Pacific Ocean (Bering Sea and Gulf of Alaska) where feeding is known or believed to occur (73 FR 19000)	North Pacific right whales inhabit the Pacific Ocean with recent sightings in sub-Artic waters to the north, Bering Sea, central North Pacific, Hawaii, and south to Baja California. Continually found in the summer in Bristol Bay and Bering Sea. Migration is believed to occur from high-latitude feeding grounds in the summer to temprate waters during the winter; however, migratory patters are unknown (NMFS 2011).	They primarily occur in coastal or shelf waters and appear to follow prey which consists of zooplankton, including copepods, euphausiids, and cyprids (NMFS 2011).	NMFS	No effect; the effects of the Proposed Action are outside of the preferred distribution of the species.

4.2.1.1 Applegate's Milk Vetch (*Astralagus applegatei*)

Applegate's milk-vetch (*Astragalus applegatei*) is a perennial herb in the pea family (Fabaceae) and was federally listed as endangered without critical habitat in 1993 (USFWS 2011b). This species is a narrow endemic, known to occur only in southern Klamath County, Oregon, with most occupied sites a few miles south of the city of Klamath Falls at an elevation of 4,100 ft (USFWS 2011c). It is found in flat, seasonally moist, strongly alkaline soils that are sparsely vegetated (USFWS 2011b). Applegate's milk-vetch was discovered during relicensing surveys within 45–100 ft of Keno Reservoir. This site is approximately 2 ft above the surface water elevation and, as such, could potentially be affected by reservoir water level fluctuations (FERC 2007). However, water level fluctuations at Keno Reservoir are expected to be similar to the existing conditions. This species does not occur within or downstream of the Action Area. **Therefore, the Proposed Action will have no effect on this species.**

4.2.1.2 Gentner's Fritillary (*Fritillaria gentneri*)

Gentner's fritillary was federally listed as endangered without critical habitat in 1993 (64 FR 69195). It is found in chaparral and cismontane woodland and sometimes in serpentinite soils (CNPS 2011). This species is restricted to a few localities in southwest Oregon, all within a 30-mi radius around Jacksonville, Oregon (USFWS 2011b) at elevations of 3,297–3,675 ft (CNPS 2011). This species has also been observed along the edge of the 1.5 mile buffer surrounding the Hydroelectric Reach. No project-related activities are planned in the vicinity of the occurrence. **Therefore, the Proposed Action will have no effect on this species.**

4.2.1.3 Yreka Phlox (*Phlox hirsuta*)

The Yreka phlox was listed as endangered without critical habitat in 2000 (65 FR 5268). It is known from only four locations in and near Yreka, Siskiyou County, California. This species grows on serpentine soils and on talus at elevations of 2,690–4,921 ft, in association with Jeffrey pine, incense cedar, and western juniper. This species does not occur in the Action area, but suitable habitat is present in a band that crosses the Klamath River downstream of IGD. However, the Action Area in this location is restricted to the 100-year floodplain, which is of an alluvial nature and does not contain appropriate soils for this species. In addition, no project-related activities are planned for this area. **Therefore, the Proposed Action will have no effect on this species.**

4.2.1.4 Tidewater Goby (Eucyclogobius newberryi)

The tidewater goby was listed as threatened in 1994 (59 FR 5494). Critical habitat for this species was redesignated in 2008 (73 FR 5920). Critical habitat occur in Del Norte and Humboldt counties, California. The Klamath River and estuary have not been designated as critical habitat for this species. Tidewater gobies are a small, short-lived, estuarine/lagoon adapted species that may infrequently disperse via marine habitat, but with no dependency on marine habitat for its life cycle (Swift et al. 1989, Lafferty et al. 1999). Reproduction and spawning typically occurs during spring and summer in slack shallow waters of seasonally disconnected or tidally muted lagoons, estuaries, and sloughs. The preferred juvenile/adult habitat is also slack, shallow water in seasonally disconnected or tidally muted lagoons, estuaries, and sloughs. Substrate preference is for sand, mud, gravel, and silt. Isolated populations of tidewater gobies exist in lagoon habitat in the Eel River in Humboldt County, Humboldt Bay, Big Lagoon, and Lake Earl and Lake Tolowa in Del Norte County. There are no documented occurrences of tidewater gobies within the Action Area, but potential habitat is available in the lower reaches of Klamath River estuary tributaries. This species is unlikely to inhabit the mainstem Klamath River due to the high winter and spring flows, which would greatly exceed the preferred habitat criteria. Suspended sediment released during reservoir drawdown and dam removal will stay within the mainstem Klamath River. Any suspended sediment encroaching into the mouths of tributaries streams would not settle and will be flushed by flows in those streams. **Therefore, the Proposed Action will have no effect on tidewater gobies.**

4.2.1.5 Loggerhead Turtle (*Caretta caretta*)

The loggerhead turtle was listed as threatened throughout its range in 1978 (43 FR 32800). Critical habitat is currently not designated. It inhabits the warm waters of the Pacific coast, primarily from the Channel Islands south, but does not nest in California. The presence of loggerhead turtles in the North Pacific and in Baja California is likely a result of developmental migrations from the main nesting areas in Japan (Bowen et al. 1995). This species uses the open ocean near-shore zone and nests on high energy, relatively narrow, steep coarse-grained beaches. Loggerheads are circumglobal, inhabiting continental shelves, bays, estuaries and lagoons in the temperate, subtropical, and tropical waters of the Atlantic, Pacific and Indian oceans (Dodd 1988). It forages on whelks and conches. The effects of the Proposed Action are outside of the preferred distribution of the species. **Therefore, the Proposed Action will have no effect on loggerhead turtles.**

4.2.1.6 Green Turtle (*Chelonia mydas (incl. agassizi)*)

The green turtle was listed as threatened throughout its range in 1978 (43 FR 32800). Critical habitat for this species is designated in Culebra Island, Puerto Rico. It inhabits the warm waters of the Pacific coast, primarily from San Diego south, but does not nest in California. It is uncommon along the California coast. This species uses convergence zones in the open ocean and benthic feeding grounds in coastal areas. It forages on seagrasses and algae. It nests on sandy ocean beaches. The effects of the Proposed Action are outside of the preferred distribution of the species. **Therefore, the Proposed Action will have no effect on green turtles.**

4.2.1.7 Leatherback Turtle (*Dermochelys coriacea*)

The leatherback turtle was listed as endangered in 1970 (35 FR 8491). Critical habitat was designated in the coastal waters adjacent to Sandy Point, St. Croix, U.S. Virgin Islands (44 FR 17710). Critical habitat is currently proposed for designation along the California coast from Point Arena to Point Vincente (200 mi south of the Klamath Estuary); and from Cape Flattery, Washington to the Umpqua River (Winchester Bay), Oregon (145 mi north of the Klamath Estuary). This species inhabits the temperate and cool waters of the Pacific coast. Seasonal occurrences during summer and fall months along the Pacific coast result from the trans-Pacific migration from Western Pacific nesting beaches, when large aggregations of jellyfish form. It is a pelagic species, although it also forages near coastal waters. Its diet includes soft-bodied animals, such as jellyfish and salps. The majority of occurrences are documented in central and southern California from boats out at sea, telemetry studies, and aerial surveys. This species does not nest in California.

If species is present in the Pacific Ocean, off the Northern California coast, it is likely migrating through the area during the summer and fall months. Any effects on water quality from January to March 2020 would occur outside of the seasonal distribution of the species. **Therefore, the Proposed Action will have no effect on the leatherback turtle.**

Designated critical habitat for this species is located over 100 mi to the north and south of the Klamath River mouth. **Therefore, the Proposed Action will have no effect on critical habitat.**

4.2.1.8 Olive (=Pacific) Ridley Sea Turtle (*Lepidochelys ovilavcea*)

The olive ridley sea turtle was listed as threatened throughout its range in 1978 (43 FR 32800). Critical habitat is currently not designated. It inhabits the warm waters of the Pacific coast, primarily from southern California south (e.g., Point Loma, La Jolla, and Encinitas in San Diego County). However, this species has been documented off Mendocino and Humboldt counties and as far north as Oregon and possibly Alaska during warm-water El Niño years. It is associated with the pelagic zone, but has been documented along coastal areas, including bays and estuaries. It nests on sandy ocean beaches and forages on algae, lobster, crabs, tunicates, mollusks, shrimp, and fish. It does not nest in California. The effects of the Proposed Action are outside of the preferred distribution of the species. **Therefore, the Proposed Action will have no effect on olive ridley sea turtles.**

4.2.1.9 Western Snowy Plover (*Charadrius alexandrinus nivosu*)

The Pacific coast population of the western snowy plover was listed as threatened in 1993 (58 FR 12864). Critical habitat was redesignated along the coasts of California, Oregon, and Washington in 2005 (70 FR 56970). The closest designated critical habitat is located near Lake Talawa (21 mi north of the Klamath Estuary) and Big Lagoon (23 mi south of the Klamath Estuary). The closest proposed critical habitat is at Gold Bluffs Beach (7 mi) north of the Klamath Estuary, Stone Lagoon (21 mi south of the Klamath Estuary), and near Lake Talawa (21 mi north of the Klamath Estuary). This species nests in locations along Washington, Oregon, and California coasts (including Del Norte, Humboldt, and Mendocino counties). The nesting season extends from early March through late September. Nests on barren to sparsely vegetated dune-backed beaches, barrier beaches, salt-evaporation ponds, and infrequently on bluff-backed beaches. A small inland population, consisting of less than 1,000 birds in Oregon, is known to nest along the margin of alkaline lakes in southern Klamath County, Oregon, and the species is a rare fall migrant at the Klamath Wildlife Area. PacifiCorp did not locate any western snowy plovers during field surveys and no suitable breeding habitat was observed in the project area (FERC 2007).

Suspended sediment within the water column from the Proposed Action is not expected to affect this species, nesting habitat, or critical habitat (located 7 mi from the Klamath River), because suspended sediment will be deposited offshore. Contamination of prey base as a result of flushing sediment is likely to be consistent with exposing marine biota to an “average” water column chemical concentration and with respect to bioaccumulation potential, there are no exceedances of applicable marine bioaccumulation screening levels (CDM 2011). **Therefore, the Proposed Action will have no effect on snowy plovers or their designated or proposed critical habitat.**

4.2.1.10 Short-Tailed Albatross (*Phoebastris albatrus*)

The short-tailed albatross was listed as endangered in 2000 (65 FR 46643). Critical habitat has not been designated. During the non-breeding season, this species ranges along the continental shelf margins of the Pacific Rim from southern Japan to northern California. This species does not nest in California. This species primarily occupies the North Pacific Ocean, outside of the Action Area. Foraging habitat includes regions of upwelling and high productivity (e.g., Gulf of Alaska, along the Aleutian Chain, along the Bering Sea shelfbreak from the Alaska Peninsula out towards St. Matthew Island) (Suryan et al. 2007a, Tickell 2000; both as cited in USFWS 2008d). Contamination of prey base as a result of flushing sediment is likely to be consistent with exposing marine biota to an “average” water column chemical concentration and with respect to bioaccumulation potential, there are no exceedances of applicable marine bioaccumulation screening levels (CDM 2011). **Therefore, the Proposed Action will have no effect on the short-tailed albatross.**

4.2.1.11 Sei Whale (*Balaenoptera borealis*)

The sei whale was listed as endangered in 1970 (35 FR 18319). No critical habitat has been designated. The species is found in the Pacific Ocean and has a wide range of subtropical, temperate, and subpolar waters around the world. It may migrate to higher latitudes during the summer and lower latitudes during the winter. It inhabits deep ocean waters far from the coastline and forages on plankton, small schooling fish, and cephalopods.

This species' preferred distribution is outside of the nearshore area that could be affected by the Proposed Action-related suspended sediment. **Therefore, the Proposed Action will have no effect on sei whales.**

4.2.1.12 Blue Whale (*Balaenoptera musculus*)

The blue whale was listed as endangered in 1970 (35 FR 18319). No critical habitat has been designated. The North Pacific population extends throughout the Pacific Ocean and includes deep ocean waters off California. In general, species migrate towards the subtropics in the fall and sub-polar areas in the spring; however, evidence suggests some individuals reside in areas year-round. This species is generally found in deep ocean offshore waters, but will also venture into coastal waters. Blue whales forage mainly on krill. Fish and copepods are unlikely to contribute significantly to their diet.

This species' preferred distribution is outside of the nearshore area that could be affected by the Proposed Action-related suspended sediment. **Therefore, the Proposed Action will have no effect on blue whales.**

4.2.1.13 Fin Whale (*Balaenoptera physalus*)

The fin whale was listed as endangered in 1970 (35 FR 18319). No critical habitat has been designated. This species inhabits the deep ocean waters of the Pacific Ocean and is distributed year-round in a wide range of longitudes and latitudes. However, it is primarily found in temperate to polar latitudes and less commonly in the tropics. The specific migration patterns of the fin whales are complex, but migration to foraging areas in high-latitude marine environments has been documented. This species forages on krill, small schooling fish, and squid.

This species' preferred distribution is outside of the nearshore area that could be affected by the Proposed Action-related suspended sediment. **Therefore, the Proposed Action will have no effect on fin whales.**

4.2.1.14 Humpback Whale (*Megaptera novaengliae*)

The humpback whale was listed as endangered in 1970 (35 FR 18319). No critical habitat has been designated. This species resides in oceans around the world. In the Pacific Ocean, the California/Oregon/Washington stock resides from southern British Columbia to southern California in the summer and fall and winters in Central America and Mexico. It inhabits deep ocean waters, but can also be observed near the coast. It forages on tiny crustaceans (mostly krill), plankton, and small fish.

This species' preferred distribution during the winter period is outside of the nearshore area that could be affected by the Proposed Action-related suspended sediment. **Therefore, the Proposed Action will have no effect on humpback whales.**

4.2.1.15 Sperm Whale (*Physeter macrocephalus*)

The sperm whale was listed as endangered in 1970 (35 FR 18319). No critical habitat has been designated. This species resides in oceans around the world. In the Pacific Ocean, sperm whales range between about 60° N and 60° S latitudes. Sperm whales are found year-round in California waters, but they reach peak abundance from April through mid-June and from the end of August through mid-November. They have been seen in every season except winter (December–February) in Washington and Oregon. Because sperm whales spend most of their time in deep waters, their diet consists of many larger organisms that also occupy deep waters of the ocean. Their principal prey are large squid weighing between 3.5 ounces and 22 pounds, but they will also eat large demersal and mesopelagic sharks, skates, and fishes.

This species' preferred distribution is outside of the nearshore area that could be affected by the Proposed Action-related suspended sediment. In addition, the species' abundance off the California coast is at a low point during the winter period. **Therefore, the Proposed Action will have no effect on sperm whales.**

4.2.1.16 North Pacific Right Whale

The North Pacific right whale was listed as endangered in 1970 (35 FR 18319). Designated critical habitat is located in the North Pacific Ocean (Berring Sea and Gulf of Alaska) where feeding is known or believed to occur (73 FR 19000). The species' preferred distribution is along coastal or shelf waters and appear to follow prey which consists of zooplankton, including copepods, euphausiids, and cyprids (NMFS website). The species inhabitats the Pacific Ocean with recent sightings in sub-Artic waters to the north, Bering Sea, central North Pacific, Hawaii, and south to Baja California. Migration is believed to occur from high-latitude feeding grounds in the summer to temperate waters during the winter (NMFS 2011). **The Proposed Action will have no effect on North Pacific right whales.**

4.2.2 Species Subject to Further Analysis

The following species will be included for further analysis of the effect of the Proposed Action due to their occurrence in the Action Area, proximity to the activities, or potential to be affected by the project (Table 4-4). These species include the bull trout, Lost River and shortnose suckers, Southern DPS green sturgeon, SONCC coho salmon, Southern DPS eulachon, marbeled murrelet, NSO, Steller sea lion, and Southern Resident DPS killer whale.

Table 4-4. Federally Listed Species that May be Affected by the Proposed Action

Scientific name (common name)	Federal status	Critical habitat	Distribution	Habitat associations	Data sources	Likely to affected by the Proposed Action?
Fish						
Acipenser medirostris (Southern DPS green sturgeon)	Threatened	Designated	Sacramento-San Joaquin Delta and Estuary, Sacramento and Klamath rivers. Only known spawning habitat is in the Sacramento River. Most of their life is spent in marine waters. May use the Klamath River estuary in summer and fall months for feeding, but presence has not been recorded.	Rivers, estuaries, and near coastal waters	NMFS	Yes; may be affected by reservoir drawdown sediment release.
Deltistes luxatus (Lost River sucker)	Endangered	Proposed	Resident fish observed in the Upper Klamath Basin. Primary habitats are in UKL, Tule Lake, Gerber and Clear Reservoirs and their tributary streams. A few individuals have been observed in the Copco 1 and Iron Gate Reservoirs.	Warm slow-moving waters or lakes. Spawning occurs along shorelines of lakes or tributaries.	CNDDB, USFWS	Yes; loss of habitat in Hydrelectric Reach resulting from the Proposed Action.
Chasmistes brevirostris (shortnose sucker)	Endangered	Proposed	Resident fish observed in the Upper Klamath Basin. Primary habitats are in UKL, Tule Lake, Gerber and Clear Reservoirs and their tributary streams. A few individuals have been observed in the Copco 1 and Iron Gate Reservoirs.	Warm slow-moving waters or lakes. Spawning occurs along shorelines of lakes or tributaries.	CNDDB, USFWS	Yes; loss of habitat in Hydrelectric Reach resulting from the Proposed Action.
Oncorhynchus kisutch (SONCC coho salmon)	Threatened	Designated	Elk River, Oregon south to, and including, the Mattole River in northern California	Coastal drainages; spawn in areas where there are beds of loose, silt-free, coarse gravel, and nearby cover.	NMFS	Yes; may be affected by reservoir drawdown sediment release, fish relocation, facilities demolition and other activities associated with the Proposed Action.

Scientific name (common name)	Federal status	Critical habitat	Distribution	Habitat associations	Data sources	Likely to affected by the Proposed Action?
Salvelinus confluentus (bull trout)	Threatened	Designated	Occur in the headwaters of four tributaries to the Sprague River, four tributaries of the Sycan River, and two tributaries of UKL.	Resident species found primarily in cold headwater lakes and streams and rivers that drain high mountainous areas.	USFWS	No effect in the short-term; bull trout are not found within the Action Area. Yes in the long-term due to potential predation, disease effects, competition for food and space, and marine-derived nutrient introduction.
Thaleichthys pacificus (Southern DPS eulachon)	Threatened	Designated	Skeena River in British Columbia (inclusive) south to the Mad River in Northern California (inclusive)	An anadromous fish that historically used the Klamath River estuary and lowest portions of the river to spawn. Few to no individuals currently use the estuary. Most of their life is spent in the ocean.	NMFS	Yes; may be affected by reservoir drawdown sediment release.
Birds						
Brachyramphus marmoratus (marbled murrelet)	Threatened	Designated; closest critical habitat is located 44 mi west of IGD.	Nesting marbled murrelets in California mostly concentrated on coastal waters near Del Norte and Humboldt counties, and in lesser numbers near San Mateo and Santa Cruz counties; winter throughout nesting range, and in small numbers in southern California.	Most time spent on the ocean; nests inland in old-growth conifers with suitable platforms, especially redwoods near coastal areas.	USFWS	Yes; may be affected by reservoir drawdown sediment release and associated contaminants.
Strix occidentalis caurina (northern spotted owl)	Threatened	Designated and Proposed Revision; closest designated critical habitat is located 0.1 mi from the Copco 1 Reservoir.	Cascade Mountains and coastal ranges in Washington, Oregon, and California.	Typically in mature forested habitats; nests in complex stands dominated by conifers, especially coastal redwood, with hardwood understories; some open areas are important for foraging.	USFWS	Yes; suitable nesting roosting and foraging habitat and critical habitat is present near project features (e.g., haul roads, transmission lines, reservoirs) and may be disturbed by project activities.

Scientific name (common name)	Federal status	Critical habitat	Distribution	Habitat associations	Data sources	Likely to affected by the Proposed Action?
Mammals						
Eumetopias jubatus (Steller (=northern) sea lion)	Threatened	Designated; closest designated habitat is at Pyramid Rock 65 mi north of Klamath River Estuary and Sugarloaf Island, Cape Mendocino, about 80 mi south of the Klamath River Estuary	Open coastal waters of California and Oregon	Colder waters; haul outs and rookeries usually consist of beaches, ledges, or rocky reefs. (NMFS 2011). A sea lion diet study identified that the species are opportunistic foragers and consume variety of prey; the majority including pollock, herring, hake, flounder, skate, cephlapod, cod, salmonids, and rockfish (Sigler et al. 2009). A seasonal distribution and prey-based study in Southeast Alaska documented that seasonal foraging patterns reflected seasonal changes in prey abundance: forage on herring in winter, spawning forage fish in spring, salmon in summer and autumn, and Pollock and Pacific hake year-round. (Womble et al. 2009, Sigler et al. 2009)	NMFS	Yes; food resources may by affected by reservoir drawdown sediment release.

Scientific name (common name)	Federal status	Critical habitat	Distribution	Habitat associations	Data sources	Likely to affected by the Proposed Action?
Orcinus orca (Southern Resident DPS killer whale)	Endangered	Designated; marine waters in northwest Washington (about 400 mi north of Klamath River Estuary) identified as the Summer Core Area, Puget Sound Area, and Strait of Juan de Fuca Area (71 FR 69054)	Southern Resident populations are found in Puget Sound, Washington, during summer, summer and fall seasons. Winter migration distribution is relatively unknown. Documented off the coast of California and Oregon (NMFS 2011).	Coastal waters and bays, The North Pacific “resident" killer whale mainly forage on salmonids (e.g., Chinook salmon and chum salmon) (NMFS 2011)	NMFS	Yes; food resources may by affected by reservoir drawdown sediment release.

4.2.2.1 Bull Trout (*Salvelinus confluentus*)

Bull trout (*Salvelinus confluentus*) populations in the Columbia River and Klamath River basins were defined as distinct population segments (DPS) and federally listed as threatened on June 10, 1998 (63 FR 31647). The Jarbidge River population segment of bull trout were proposed to be listed on June 10, 1998 (63 FR 31693). Bull trout throughout the coterminous U.S. were listed as threatened on November 1, 1999 (64 FR 58910). The coterminous listing added bull trout of the Coastal-Puget Sound (Olympic Peninsula and Puget Sound regions), Jarbridge River, and Saint Mary-Belly River populations (east of the continental divide in Montana) to the previous listing action. The USFWS determined that there has been no change in the distribution of core areas for bull trout since the ESA listing, although there may have been changes at the smaller, local level (USFWS 2008e).

Critical habitat
Final critical habitat for the bull trout DPS in the Klamath and Columbia River was designated by USFWS on October 6, 2004 (69 FR 59996) and for the species in the coterminous U. S. on September 26, 2005 (70 FR 56212). A final revision of critical habitat for this species was designated by USFWS on October 18, 2010 (75 FR 63898). The Klamath River Basin Critical Habitat Unit (CHU) is located in south-central Oregon and includes three CHSUs: (1) UKL CHSU; (2) Sycan River CHSU; and (3) Upper Sprague River CHSU. The Klamath River Basin CSU covers 276.6 mi of river and 9,329.4 acres of reservoirs or lakes designated as critical habitat.

Species life history and ecology
Bull trout exhibit two basic life history strategies: resident and migratory. Most bull trout are migratory, although the Klamath River basin population is not (USFWS, pers. comm., 23 May 2011) Migratory bull trout live in larger river (fluvial) and lake systems (adfluvial) where juvenile fish usually rear from one to four years before migrating to either a larger river or lake where they spend their adult life, returning to the tributary stream to spawn (Fraley and Shepard 1989). In general, migratory fish are larger than resident fish. Stream-resident bull trout complete their entire life-cycle in the tributary streams where they spawn and rear. Research indicates that resident and migratory forms may be found together, and interbred at times, which helped maintain viable populations throughout the range (Rieman and McIntyre 1993).

Bull trout reach sexual maturity in five to seven years and spawn from the end of August through November (McPhail and Baxter 1996). Spawning may occur annually for some populations, and every other year for the rest. Migration for spawning is initiated by warming water temperatures in downstream reaches. The distances traveled by migratory bull trout to spawn are on average farther than other nonanadromous salmonids (Fraley and Shepard 1989). Bull trout require particularly clean gravel substrates to build their redds. Increased sediment suffocates eggs by reducing dissolved oxygen (Rieman and McIntyre 1996). Bull trout eggs incubate over the winter and hatch in the late winter or early spring. Emergence usually requires an incubation period of 120 to 200 days.

Juveniles migrate to areas upstream from spawning beds to grow and take advantage of cool headwater temperatures. Bull trout less than one year old are generally found in areas along stream margins and in side channels. Most migratory juvenile bull trout remain in headwater tributaries for one to three years before emigrating downstream to larger stream reaches. Emigration usually takes place from June to August (Rieman and McIntyre 1996).

Migration is important for the persistence of many local subpopulations of bull trout. Migratory corridors that allow bull trout to move from spawning and rearing habitat to foraging and overwintering habitat result in larger, more reproductively successful bull trout (McPhail and Baxter 1996), and also result in increased dispersion, which improves gene flow. Local populations that are extirpated during catastrophic events can be re-established as a result of bull trout movement through migration corridors (Rieman and McIntyre 1996).

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993). Habitat components that particularly influence their distribution and abundance include water temperature, cover, channel form and stability, spawning and rearing substrate conditions, and migratory corridors (Fraley and Shepard 1989). Bull trout require especially clean and cold water with temperatures below 59° Fahrenheit (F). They live primarily in cold headwater lakes and streams and rivers that drain high mountainous areas, especially where snowfields and glaciers are present. Like all salmonids, bull trout require diverse, yet well-connected, habitats with structural components that provide good hiding cover (McPhail and Baxter 1996).

Distribution and abundance

Bull trout are members of the char subgroup of the family Salmonidae and are native to waters of western North America. Historically, bull trout occurred throughout the Columbia River Basin; east to Montana, south to the Jarbidge River in northern Nevada, the Klamath Basin in Oregon, and the McCloud River in California; and north to Alberta, British Columbia, and possibly southeastern Alaska. The range of the bull trout has decreased compared with the known historical range. Bull trout are now extirpated in northern California (Moyle et al. 2008). In areas where bull trout populations occur, many are reduced in size, fragmented, or have been eliminated from the main stems of large rivers (USFWS 2002b).

In Oregon, bull trout occurrences represent a fraction of the species' historical distribution. A total of 85 bull trout populations in 12 basins are currently identified in Oregon (ODFW 2005). These basins include the Klamath River, Willamette River, Hood River, Deschutes River, John Day River, Umatilla River, Walla Walla River, Grande Ronde River, Imnaha River, Pine Creek, Powder River, and Malheur River. Within these basins, bull trout populations are highly fragmented and in some cases only exist within a small portion of the basin.

Threats

The factors that have contributed to the decline of bull trout include: restriction of migration routes; poorforest management practices; grazing; agricultural practices; road construction; mining; introduction of non-native species (including brook trout); and residential development contributing to habitat modification (USFWS 2002b). Bull trout can no longer be legally harvested in many areas, but misidentification of bull trout as brook trout or lake trout is resulting in some fish being killed accidentally.

Overall, interspecific interactions, including predation, with non-native species may exacerbate stresses on bull trout from habitat degradation, fragmentation, isolation, and species interactions (Rieman and McIntyre 1993). Brook trout readily spawn with bull trout creating a hybrid that is often sterile (Markle et al. 1992). Lake trout have out-competed and replaced adfluvial populations of bull trout in some lakes.

Warmer temperature regimes associated with global climate change represent another risk factor for bull trout. Increased stream temperature is a recognized effect of a warming climate (ISAB 2007). Species at the southern margin of their range that are associated with colder water temperatures, such as the bull trout, are likely to become restricted to smaller more disjunct habitat patches or become extirpated as the climate warms (Rieman et al. 2007). Climate warming is projected to result in the loss of 22 to 92% of suitable bull trout habitat in the Columbia River basin (ISAB 2007).

Status in the Action Area

The current spawning distribution of bull trout is highly fragmented and concentrated in a few isolated headwater streams of Upper Klamath Lake, upper Sprague River, and upper Sycan River above Sycan

Marsh (DOI 2002, USFWS 2004, ODFW 2005). The Klamath River population of bull trout is currently comprised of eight populations that are located in Sun Creek, Threemile Creek, Long Creek, Dixon Creek, Boulder Creek, Deming Creek, Leonard Creek, and Brownsworth Creek (USFWS, pers. comm., March 4, 2011). It is currently unknown how many local populations have been extirpated from the upper Klamath basin due to a lack of survey data. However, at least four local populations (Upper Sycan River, Sevenmile, Cherry, and Coyote creeks) have been extirpated (ODFW 2005).

Few data exist to accurately assess abundance of bull trout in the Klamath Basin. Population estimates were initially conducted between 1989 and 1991 (Buchanan et al. 1997, Ziller 1992) and have occurred more recently (Moore 2006, Hartill and Jacobs 2007). Barriers, poor water quality, and lack of a migratory life history prevent bull trout in each watershed (Sprague, Sycan, and Upper Klamath Lake) from mixing. Only bull trout in Leonard and Brownsworth creeks (Sprague watershed) have the potential to mix (ODFW 2005), but culvert barriers currently prevent them from doing so (USFWS, pers. comm., March 4, 2011).

Efforts to reduce hybridization with nonnative fish, competition, changes in fishing regulations, and habitat restoration projects have improved several local populations (e.g., Threemile, Sun, and Long Creek; Hamilton et al. 2010). However, the overall status of Klamath River bull trout continues to be depressed.

4.2.2.2 Lost River (*Deltistes luxatus*) and Shortnose Sucker (*Chasmistes brevirostris*)

Species status

Lost River (LRS) and shortnose suckers (SNS) were designated as endangered under the ESA by the USFWS in July 1988 (53 FR 27130), as a result of threats to the population including: the damming of rivers, instream flow diversions, hybridization, competition and predation by exotic species, dredging and draining of marshes, water quality problems associated with timber harvest, the removal of riparian vegetation, livestock grazing, and agricultural practices (53 FR 27130; July 18, 1988). Reduction and degradation of lake and stream habitats in the upper Klamath Basin is considered by USFWS as the most important factor in the decline of both species (USFWS 1993). UKL was historically eutrophic, and is now hypereutrophic (Eilers et al. 2004, Kann et al. 2004). The USFWS published a recovery plan for LRS and SNS in 1993. Both the LRS and SNS were petitioned for delisting. The USFWS found that the petition did not present substantial scientific or commercial information indicating that either species warranted delisting (67 FR 34422).

Critical habitat

In 1994 the USFWS proposed critical habitat for the SNS and LRS but was never finalized. On December 7, 2011 the USFWS re-proposed critical habitat for LRS of approximately 146 miles of streams and 117,848 acres of lakes and reservoirs, and approximately 128 miles of streams and 123,590 acres of lakes and reservoirs for SNS (76 FR 76338). The proposed critical habitat is located in Klamath and Lake Counties, Oregon, and Modoc County, California.

The new proposal for LRS critical habitat includes two units comprised of the 1) Upper Klamath Unit, including UKL and tributaries as well as the Link River and Keno Reservoir, and the 2) Lost River Basin Unit, including Clear Lake Reservoir and tributaries. The new proposal for SNS critical habitat includes two units comprised of the 1) Upper Klamath Lake Unit, including UKL and tributaries as well as the Link River and Keno Reservoir, and the 2) Lost River Basin Unit, including Clear Lake Reservoir and tributaries, and Gerber Reservoir and tributaries (76 FR 76345). Critical habitat for either species is not proposed below Keno Dam.

Only the Upper Klamath Unit for both SNS and LRS occurs in the Proposed Action area. This unit is the same for both species with the following exceptions: 1) for LRS, the unit includes the lower Wood River and Crooked Creek and extends up the Sprague River to the Beatty Gap east of Beatty near RM 75; 2) for SNS, the unit does not include the Wood River or Crooked Creek and extends up the Sprague River only as far as Braymill near RM 8.

The PCEs indentified in the critical habitat proposal for self-sustaining populations of SNS and LRS are (76 FR 76342):

- PCE 1- *Water.* Areas of sufficient quantity and depth within lakes, reservoirs, streams, marshes, springs, groundwater sources, and refuge habitats with minimal physical, biological, or chemical impediments to connectivity. Water should exhibit depths ranging from less than 3.28 feet up to 14.8 feet to accommodate each life stage. Water quality characteristics should include temperatures of less than 28° C; pH less than 9.75; dissolved oxygen levels greater than 4.0 mg/L; algal toxins (less than 1.0 µg/L); and un-ionized ammonia (less than 0.5 mg/L). Elements also include natural flow regimes that provide flows during the appropriate time of year or, if flows are controlled, minimal flow departure from a natural hydrograph.
- PCE 2 - *Spawning and Rearing Habitat.* Streams and shoreline springs with gravel and cobble substrate at depths typically less than 4.3 feet with adequate velocity to allow spawning to occur. Areas identified in PCE 1 containing emergent vegetation adjacent to open water that provides habitat for rearing. This facilitates growth and survival of suckers, as well as protection from predation and protection from currents and turbulence.
- PCE 3- *Food.* Areas containing an abundant forage base, including a broad array of small aquatic invertebrates especially midges, cladocerans, and copepods.

Life history

Lost River suckers may survive up to 43 years of age, while shortnose suckers may live as long as 25 years (Buettner and Scoppettone 1990). Reproductive maturity for female Lost River suckers is reached at six to nine years of age; shortnose suckers may reach reproductive maturity as early as four years of age (Perkins et al. 2000a). Fecundity in both LRS and SNS is variable and likely associated with the size of the individual female (Perkins et al. 2000a). Lost River sucker females typically produce 44,000 to 236,000 eggs per spawning season, while shortnose sucker females produce 18,000 to 72,000 eggs (Perkins et al. 2000a).

Sucker population in UKL appears to consist of two distinct stocks: 1) Several thousand LRS and a few SNS that spawn along shoreline springs, and 2) tens of thousands LRS and SNS fish that spawn in the Williamson and Sprague rivers (Perkins et al. 2000a; Hayes et al. 2002, Barry et al. 2007a, b; Janney et al. 2009). Mark-recapture data show that the two stocks maintain a high degree of fidelity to spawning areas and therefore seldom interbreed (Hayes et al. 2002, Barry et al. 2007a, b). Suckers in the Clear Lake and Gerber Reservoir drainages spawn primarily, if not entirely, in the tributary streams (Buettner and Scoppettone 1991, Koch and Contreras 1973, Perkins and Scoppettone 1996, BLM 2000). Refugial areas of relatively good water quality are important for fish in Upper Klamath Lake during the summer and early fall when dissolved oxygen and pH levels can be stressful or lethal in much of the lake (Coleman and McGie 1988). There is evidence that adult suckers utilize Pelican Bay of the UKL, an area considered relatively shallow, during poor water quality events (Banish et al. 2007).

Both LRS and SNS primarily reside in lakes but may enter tributaries to spawn (NRC 2004). Whether spawning occurs at shoreline areas in lakes or in lake tributaries, both species begin spawning as early as February and may continue through early June. The timing of spawning migration is somewhat variable from year to year and apparently depends on age, species, sex, and environmental conditions, most notably water temperature (Andreasen 1975, Ziller 1985, Buettner and Scoppettone 1990, Klamath Tribes 1996, Perkins and Scoppettone 1996, Markle et al. 2000, Shively et al. 2000, BLM 2000, Barry and Scott 2007, Barry et al. 2007a).

Lost River suckers and shortnose suckers typically spawn at night in shallow areas with gravel substrate where eggs are broadcast or slightly buried (Bienz and Ziller 1987, Buettner and Scoppettone 1990, 1991; Klamath Tribes 1995; Perkins and Scoppettone 1996; Perkins et al. 2000a). When spawning occurs over cobble and armored substrate, eggs fall between crevices or are swept downstream (Buettner and Scoppettone 1990). Water depth at spawning sites has been reported as 0.1 to 0.7 m (0.33 to 2.3 ft) for shortnose suckers and 0.2 to 0.8 m (0.65 to 2.6 ft) for Lost River suckers, with most spawning occurring at a depth close to 0.5 m (1.6 ft) for both species (Buettner and Scoppettone 1990).

Larvae produced in UKL tributaries migrate to the lake shortly after emergence from natal gravels, typically in May and early June (Buettner and Scoppettone 1990, Cooperman and Markle 2003). Seasonal timing of larval sucker migration from the natal areas in the tributaries is determined by the timing of adult spawning and variable between sites (Tyler et al. 2007, Ellsworth et al. 2007). Larval suckers entering the drift peaked earliest at sites in the upper Sprague River, typically late March through April. Peak migration of larvae at the lower reaches of the Williamson and Sprague rivers occurred during mid-May, but larvae were present in the drift as early as March and as late as early July (Ellsworth et al. 2008). Recent evidence indicates that some larvae may rear to the juvenile stage in the riverine environment, as juvenile suckers have been captured in the Williamson and Sprague rivers through the summer months (Parrish 2007, Ellsworth et al. 2008).

Larval sucker ecology and habitat use within the Lost River watershed, particularly Tule Lake, Lost River, and both Clear Lake and Gerber reservoirs, have not been directly studied. Given the lack of direct observations, larval sucker ecology in the Lost River watershed is assumed similar as the observations from UKL, except for the use of emergent vegetation in lake environments. Permanent emergent vegetation is generally scarce or absent along the shorelines of Clear Lake and Gerber reservoirs (Reclamation 2002). However, some vegetative cover may be provided to larval suckers by flooded annual grasses and herbs remaining from the previous growth season on the lake bed prior to lake level rising in the spring (USFWS 2002c). Also, the lower reaches of the primary spawning tributaries do provide some emergent and submerged shoreline vegetation during the spring and early summer when larvae would be present (USFWS 2002c). Additional cover may be provided by high turbidity and through the use of shallow shoreline areas. Juvenile suckers occupy shoreline habitats in these systems that lack shoreline emergent vegetation (Scoppettone et al. 1995, Reclamation 2001a).

In mid-summer, juveniles are concentrated in the northern and eastern sections of UKL, near the mouth of the Williamson River and along the eastern shoreline. In late summer and fall, most juveniles are concentrated in the south end of UKL and along the eastern shoreline (Simon et al. 2000, Simon and Markle 2001, Terwilliger et al. 2004, Hendrixson et al. 2007a, 2007b). Rocky bottoms occur along the shoreline primarily in the southern portion of UKL while emergent shoreline vegetation occurs primarily in the northern half of the lake, and soft, mucky bottoms occupy the vast majority of the deeper offshore areas.

There is evidence that juvenile sucker emigration from UKL into the Link River, including the east and west power canals that parallel the Link River, increases during the period between July and October at the south end of the lake (Gutermuth et al. 1999, 2000, Foster and Bennetts 2006, Tyler 2007). The cause of emigration by juvenile suckers is not currently understood. Plausible hypotheses include natural emigration, avoidance of poor water quality events, and diminished habitat in the north end of UKL which concentrates suckers in the southern end of UKL near the outlet (USFWS 2002c). The fate of emigrant suckers is not fully understood but it has been hypothesized that UKL is a better environment for suckers due to its food-rich environment, presence of a water quality refuge in Pelican Bay and access to spawning areas; the loss of connectivity between habitats below the Link River, and frequent poor water quality events in the Link to Keno reach of the Klamath River, limit the value of the Keno Reservoir for sucker habitat (Reithel 2006, USFWS 2008a).

Adult Lost River suckers are generally limited to lake habitats when not spawning, and no large populations are known to occupy stream habitats. Shortnose suckers have resident populations in both lake and some riverine habitats, including Lost River, Willow Creek, and other tributaries of Clear Lake and Gerber Reservoir (Reclamation 2002). Lakes are the primary habitat for both species however. Stream and lake spawning populations appear to rarely exchange individuals and may be reproductively isolated (Perkins et al. 2000a, Shively et al. 2000, Hayes and Shively 2001, Hayes et al. 2002, 2004).

Geographic distribution

Historically, both Lost River and shortnose suckers occurred throughout the Upper Klamath Basin, with the exception of the higher elevation, cooler temperature tributaries, which are dominated by resident trout, and the upper Williamson River, which is isolated by the Williamson Canyon. The general range of Lost River suckers and shortnose suckers had been reduced from its historical extent by the loss of the Lower Klamath Lake, including Sheepy Lake populations and reduction in population size of Tule Lake (USFWS 1988). New lake habitat was created by construction of the Gerber Dam and more habitat was created in Clear Lake with the construction of the Clear Lake Dam (USFWS 2008a).

Two additional populations of shortnose suckers and one additional population of Lost River suckers have been recognized since 1988. Each additional population occurs in isolated sections of the Lost River drainage, within the historical ranges of the species. These include an isolated population of shortnose suckers in Gerber Reservoir and a small population (limited to approximately 500 adults) of each species in Tule Lake (USFWS 2008a). Currently, the Klamath River reservoir populations receive individuals carried downstream from upper reaches of the river, but they are isolated from the Upper Klamath Basin by dams and show no evidence of self-sustaining reproduction (Desjardins and Markle 2000).

Threats

A Recovery Plan has been written for both species (USFWS 1993). Predominant threats to these suckers are lack of spawning habitat, continued loss of habitat, water diversions, competition and predation by introduced species, hybridization with other sucker species, isolation of remaining habitat, and drought (USFWS 1988, CDFG 2005). Decreases in water quality resulting from timber harvest, dredging activities, removal of riparian vegetation, and livestock grazing may also cause problems for these species (USFWS 1988).

The UKL watershed is a naturally eutrophic (nutrient rich and supporting high abundances phytoplankton) system, which is consistent with its shallow depth, deep organic-rich sediments, and large watershed consisting of phosphorus-rich soils (Eilers et al. 2004). However, in recent decades, the lake has become hypereutrophic and now experiences extremely poor water quality that has resulted in massive fish die-offs (Bortleson and Fretwell 1993, Kann 1998, Risley and Laenen 1999, Perkins et al. 2000b, Eilers et al. 2001, Bradbury et al. 2004, Eilers et al. 2004, Wood et al. 2006, Kuwabara et al. 2007, Morace 2007). Hypereutrophic conditions result from excessive nutrients, which enable dense blooms of *Aphanizomenon flos-aquae* (AFA) to develop in UKL. AFA, nearly absent from UKL a century ago, has showed major increases during the twentieth century, in particular since the 1950s, and is now the dominant phytoplankton species (Kann and Walker 1999, Geiger 2001, Geiger et al. 2005, Wood et al. 2006, Kuwabara et al. 2007, Morace 2007).

The poor water quality associated with massive algae blooms has likely contributed to major declines in UKL sucker populations over the last several decades (Perkins et al. 2000b, Wood et al. 2006, Kuwabara et al. 2007, Morace 2007). There are many interrelated factors contributing to the complex water quality dynamics and the current conditions observed within the Klamath River watershed.

Status of the species within the Klamath Basin

This section describes the status of the species within the upper Klamath Basin and Action Area. No differentiation between population's status within the entire Basin and Action Area was made since the only part of the Klamath Basin outside of the outside of the Action Area occurs upstream of Clear Lake Dam and Gerber Reservoir.

Both Lost River sucker and shortnose sucker are endemic to the upper Klamath River Basin, including the Lost River and Lower Klamath Lake sub-basins. Historical distribution of these species is known primarily from incidental records by early explorers and newspaper reports, and so it is often difficult to precisely estimate historical distribution. We do know that the quantity of suitable stream/river, lake, and marshland habitats has been drastically reduced (USFWS 2007a, b). Currently the total area of lake habitat available for Lost River sucker and shortnose sucker is about 32,000 hectares (79,000 acres), of which approximately 80% is in Upper Klamath Lake, which covers approximately 26,000 hectares (64,000 acres).

At the time of listing, Lost River sucker and shortnose sucker were known from Upper Klamath Lake and its tributaries and outlet (Klamath Co., Oregon), including a "substantial population" of shortnose sucker in Copco Reservoir (Siskiyou Co., California), as well as collections of both species from Iron Gate Reservoir (Siskiyou Co., California) and J.C. Boyle Reservoir (Klamath Co., Oregon), and Lost River sucker from Sheepy Lake and Lower Klamath Lake (Siskiyou Co., California). Remnants and/or highly hybridized populations were also stated to occur in the Lost River system (Klamath Co., Oregon, and Modoc and Siskiyou Co., California) including both species in Clear Lake Reservoir (Modoc Co., California) and Lost River sucker in Tule Lake (Siskiyou Co., California; USFWS 1988). Although not stated explicitly, the reference in the listing to "highly hybridized populations" (USFWS 1988:27130) in the Lost River Basin probably refers to shortnose sucker within Gerber Reservoir (Klamath Co., Oregon). At the date of this revision the overall distribution has not changed at the sub-basin scale, but occurrences of shortnose sucker within Tule Lake have also been documented. Currently, Clear Lake Reservoir and Upper Klamath Lake and their tributaries support the largest populations. Populations in Klamath River below Keno Dam and in the Lost River drainage below Clear Lake Dam are comprised mostly of adults. These populations are probably functioning as sink populations, as they are not likely self-sustaining because of low recruitment due to the lack of access to spawning habitats (Moyle 2002, NRC 2004). All life stages of listed suckers have been found in Link River, the outlet of Upper Klamath Lake, in recent years (Reclamation 2000, Piaskowski 2003, PacifiCorp 2004d).

The largest populations of both species are found within Upper Klamath Lake. Between 1999 and 2008, roughly 10,000 Lost River sucker were captured and tagged at shoreline-spring spawning sites, with another 15,000 handled as part of the spawning run up the Williamson River (Janney et al. 2009). During a similar time period, 1995 – 2008, approximately 14,000 shortnose sucker were captured, predominantly associated with the Williamson River spawning runs (Janney et al. 2009). Nevertheless, the size of Upper Klamath Lake and the relative scarcity of Lost River sucker and shortnose sucker in the lake make it difficult to accurately estimate their abundance.

At the time of listing, Upper Klamath Lake spawning populations of Lost River sucker, and presumably shortnose sucker, received little recruitment and were dominated by older individuals (Scoppettone and Vinyard 1991, Janney and Shively 2007, Janney et al. 2008). A 1986 survey of 190 Lost River sucker opercles from Upper Klamath Lake revealed an age distribution of individuals between 8 and 43 years (Scoppettone and Vinyard 1991). The majority of individuals were 16 to 30 years old, and only 9 were less than 16 years old. Similarly, ages, determined from opercles, of 19 shortnose sucker from Copco

Reservoir in 1987 ranged from 16 to 33 (mean = 23 years) suggesting that shortnose sucker populations were also comprised primarily of older individuals (Scoppettone and Vinyard 1991).

Recent size distribution trends in reveal that Upper Klamath Lake spawning populations are comprised mostly of similarly-aged, older individuals. Lost River and shortnose sucker spawning populations in Upper Klamath Lake transitioned from populations dominated by old, larger adult fish with little size diversity in the late 1980s and early to mid-1990s, to populations dominated by young, smaller adult fish and very few large individuals by the late 1990s (Janney et al. 2008). This marked shift in size structure to smaller individuals can only be explained by substantial recruitment to these populations sometime during the mid-1990s in combination with adult mortality that accounts for the rapid decline in the frequency of large and presumably old individuals. However, since the late 1990s populations of both species have exhibited an increasing trend in length (5 to 12 millimeters increase in median fork length per year; Janney and Shively 2007, Janney et al. 2008). During this period, 1995 through 1997, significant fish kills of suckers in Upper Klamath Lake were documented each year. Over 7,000 dead suckers, ranging in age from 2 years old to 33 years old were collected during the late summer months of these three years (D. Hewitt, USGS, unpubl. data. 2010, Perkins et al. 2000b). Collections of dead suckers were comprised predominantly of adult-sized suckers, with the exception of 1997, which included relatively smaller Lost River sucker (330 to 400 millimeters fork length) and shortnose sucker (290 to 330 millimeters fork length; Perkins et al. 2000b).

Since 1995, more detailed demographic information has been compiled through an extensive mark-recapture program using Passive Integrated Transponder tags in Upper Klamath Lake and more recently in Clear Lake Reservoir (Janney et al. 2008, Janney et al. 2009). This program is designed to monitor demography of adult spawning populations of Lost River sucker and shortnose sucker and detect trends in spawning population size and composition. Mark-recapture studies in Upper Klamath Lake from 2002 to 2007 produce annual survival probabilities for shoreline spring-spawning Lost River sucker that range between 0.80 and 0.95 (mean = 0.90). Lost River sucker spring-spawning abundance in 2007 is estimated to be 56% and 75% of 2002 abundances for males and females respectively, although the exact abundances are unknown. Estimates of river-spawning shortnose sucker annual survival probabilities are even lower; from 2001 to 2007 annual survival probabilities of river-spawning shortnose sucker ranged between 0.68 and 0.94 (mean = 0.82). The spawning population abundances in 2007 of male and female river-spawning shortnose sucker were 42% and 48% relative to 2001. The population of Lost River sucker that spawns in the Williamson and Sprague rivers is estimated to have declined up to 33 (females) to 39% (males) over the same time period (Hewitt et al. 2011).

Known areas of concentrated Lost River sucker spawning in the Williamson and Sprague rivers include the lower Williamson River from RM 6 to the confluence of the Sprague River (RM 11), lower Sprague River below Chiloquin Dam area, and in the Beatty Gap area of the upper Sprague River (RM 75; Buettner and Scoppettone 1990, Tyler et al. 2004, Ellsworth et al. 2007). Other areas in the Sprague River watershed where Lost River sucker may spawn include the lower Sycan River and in the Sprague River near the Nine Mile area (Ellsworth et al. 2007). A smaller but significant number of Lost River sucker also spawn over gravel at shoreline springs along the margins of Upper Klamath Lake (Buettner and Scoppettone 1990, NRC 2004). Mark-recapture data indicate that the two stocks maintain a high degree of fidelity to spawning areas and seldom interbreed (Hayes et al. 2002, Barry et al. 2007a), although lack of genetic distinction suggests that some mixing may occur (Dowling 2005). Historically, suckers were known to spawn at many shoreline springs, including Harriman Springs and Barkley Spring (Andreasen 1975, NRC 2004). However, significant spawning aggregations currently occur at Sucker Springs, Cinder Flats, Silver Building Springs, and Ouxy Springs. Fewer individuals are also known to spawn at Boulder Springs. Spawning at these springs is very sensitive to lake levels; as levels decline much of the spawning habitat quickly becomes unavailable.

Shortnose sucker from Upper Klamath Lake also currently spawn primarily in the lower Williamson and Sprague rivers (Tyler et al. 2004, Ellsworth et al. 2007). However, the few adult shortnose sucker captured at shoreline spawning areas in Upper Klamath Lake indicate that some shortnose sucker spawning is likely to still occur at these locations (Hayes et al. 2002, Barry et al. 2007a, b). A small number of suckers, approximately 70 individuals and primarily shortnose suckers, were captured during spring sampling in 1996, 1999, and 2000 near the mouth of the Wood River in Agency Lake, presumably preparing to spawn (Reclamation 2001b). Investigations have not located suckers in Upper Klamath Lake tributaries other than the Williamson, Sprague, and Wood rivers; although, some have reported much broader historical distribution of spawning among Upper Klamath Lake tributaries (Stine 1982).

A small group of Lost River sucker apparently resides in the Sprague River near Beatty. A few adult Lost River sucker were first encountered during the summer of 2001 during fish survey work in the Sprague River (L. Dunsmoor, Klamath Tribes, pers. comm. 2007). In 2007 and 2008, we located small groups of adult Lost River sucker above the confluence of the Sycan River and below Beatty Gap and near the community of Sprague River (M. Buettner, USFWS, pers. comm. 2009). Although a substantial fish survey effort was conducted on the Sprague River in 2007 by us and Oregon State University, no adult shortnose sucker were collected.

Clear Lake Reservoir currently supports the only known spawning populations of both the Lost River sucker and shortnose sucker in the Lost River system. Adults of both species occur in other portions of the drainage, but spawning is irregular or populations are potentially hybridized with Klamath largescale suckers, as is the case for shortnose sucker in Gerber Reservoir. Less is known about shortnose sucker and Lost River sucker demography and trends in Clear Lake Reservoir than in Upper Klamath Lake because monitoring studies have been sporadic over the past 35 years, and studies similar to those conducted by Janney *et al.* (2008) in Upper Klamath Lake were not initiated in Clear Lake Reservoir until 2006 (Barry et al. 2009). Combined, more than 10,000 Lost River sucker and shortnose sucker have been captured and tagged in Clear Lake Reservoir since 1993. These data exhibit periods of recruitment failure and success, similar to patterns in Upper Klamath Lake populations (Barry et al. 2009). Populations in the early- to mid-1990s showed little evidence of recruitment and consisted mostly of large fish, but apparent recruitment events occurred in the late-1990s and early-2000s. Length-frequencies from 2005 – 2009 reveal evidence of shortnose sucker recruitment, but recruitment into the Lost River sucker population has been sparse over that period. Populations of Lost River sucker and shortnose sucker residing in Clear Lake Reservoir are known to spawn in Willow Creek (Buettner and Scoppettone 1991, Barry et al. 2007a); however it is also possible, but currently unknown, if areas other than Willow Creek are used for spawning. There is limited evidence, however, of resident populations in the river (above Malone Dam for example) and Clear Lake Reservoir tributaries (Buettner and Scoppettone 1991).

Fisheries surveys in Keno Reservoir have been conducted infrequently and have generally been short in duration (Oregon Department of Fish and Wildlife [ODFW]1996, Piaskowski 2003, PacifiCorp 2004). The only intensive monitoring effort was conducted by Terwilliger *et al.* (2004). Larvae and age 0 suckers were generally most abundant in the upper part of Keno Reservoir and decreased downstream. Based on recent sampling efforts conducted by the Bureau of Reclamation (2008–2010) juvenile, sub-adult and adult suckers may occur in higher numbers than previously thought (T. Tyler, Klamath Basin Area Office, Bureau of Reclamation, pers. comm. 2010).

Historically, large sucker spawning migrations occurred from Tule Lake up the Lost River to near Olene and Big Springs near Bonanza (Bendire 1889, Howe 1969). Such migrations are currently blocked by Anderson Rose Dam. Little information exists on the spawning areas for populations from Gerber Reservoir; however surveys of spawning areas in during the spring 2006 detected more than 1,700 suckers ascending Ben Hall Creek and Barnes Valley Creek (Barry et al. 2007a).

Kyger and Wilkens (2010) reported that in 2010, twenty six Passive Integrated Transponder (PIT) tagged suckers were detected by the Lost River Diversion (LRD) fish ladder PIT antenna array. Over 60% of the suckers detected were females. Nearly 75% of the sucker detections in the fish ladder occurred in June 2010. Sucker use of the ladder peaked during the period from June 3 through June 9 when 10 tagged suckers were detected, with the greatest daily use of the ladder occurring on June 8 when four suckers were detected. A similar increase in sucker use of the LRD fish ladder occurred in late May 2009. Kyger and Wilkens (2010) reported that these spikes in sucker movement through the ladder in late spring may coincide with increases in temperature and decreases in water quality that typically occur in Lake Ewauna at that time of year. As water quality deteriorates in late spring and early summer, suckers may be utilizing the LRD fish ladder to move to the more suitable habitat in UKL. Water quality data suggests, anecdotally, that sucker movement and use of the ladder may peak as water temperature approaches 18ºC (65ºF).

Salvage operations conducted below the Link River Dam (Reclamation 2000a) and in the irrigation canals below Upper Klamath River such as the Lost River Diversion Channel consistently capture juvenile suckers (Reclamation, unpubl. data). In 2006, which was a high-production year, young-of-the-year juvenile suckers have been captured in relatively high numbers in a screw trap operated during summer months on the Link River (Foster and Bennetts 2006, Tyler 2007). The lower Link River is probably crucial to suckers and other fish below UKL, since it may be the best habitat now available in the reach upstream of Keno, Oregon. The lower Link River probably serves as a critical refuge for fish during periods of deteriorating water quality conditions (USFWS 2002c).

Shortnose sucker is the only lake sucker that occurs in abundance in the Klamath drainage below Keno, and adults have consistently been collected in all three reservoirs. Copco II reservoir is so small that it likely has few if any suckers and for that reason it has not been sampled. Although shortnose sucker adults are more abundant in Copco Reservoir, both Copco and Iron Gate reservoirs contain primarily larger individuals than J.C. Boyle Reservoir which appears populated with subadults with fork lengths of 100 to 300 mm (~4 to 12 inches, USFWS 2002c). Unidentified larval suckers have been caught in all three reservoirs, and shortnose sucker spawning behavior has been observed in Copco Reservoir, but there is no evidence that shortnose suckers consistently survive past lengths of 50 to 100 mm (~2 to 4 inches) in the reservoir (Beak Consultants Inc. 1987, Buettner and Scoppettone 1991, Desjardins and Markle 2000). Large populations of non-native predatory fish are likely partially responsible for the lack of survival of young suckers. The populations within any of the Klamath River reservoirs are not considered self-sustaining (Hamilton et al. 2010).

Considerable efforts are ongoing to restore habitat in the upper Klamath River Basin. The USFWS and its partners have supported approximately 400 habitat restoration projects in the upper Klamath River Basin to recover the Lost River sucker and the shortnose sucker (Hamilton et al. 2010).

4.2.2.3 Southern DPS Green Sturgeon (*Acipenser medirostris*)

Species status

NMFS published a final rule listing the southern DPS of green sturgeon as threatened in 2006 (71 FR 17757). There are two Distinct Population Segments (DPSs) defined for green sturgeon – a southern DPS that spawns in the Sacramento River and a northern DPS with spawning populations in the Klamath and Rogue rivers (NMFS 2008a). The southern DPS includes all spawning populations of green sturgeon south of the Eel River in California, of which only the Sacramento River currently contains a spawning population. The southern DPS of green sturgeon has been listed as threatened under the ESA (71 FR 17757), whereas the northern DPS is a Species of Concern. McLain (2006) noted that southern DPS green sturgeon were first determined to occur in Oregon and Washington waters in the late 1950s when tagged San Pablo Bay green sturgeon were recovered in the Columbia River estuary (CDFG 2002a).

Critical habitat

Critical habitat for the southern DPS of green sturgeon was designated in 2009 (74 FR 52300). The specific PCEs essential for the conservation of the southern DPS of green sturgeon in freshwater riverine systems include:

- **Food resources:** abundant prey items for larval, juvenile, sub-adult, and adult life stages.
- **Substrate:** substrates suitable for egg deposition and development, larval development, and sub-adults and adults. Spawning is believed to occur over substrates ranging from clean sand to bedrock, with preferences for cobble (Emmett et al. 1991, Moyle et al. 1995).
- **Water:** a flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) necessary for normal behavior, growth, and survival of all life stages.
- **Water quality:** suitable water quality for normal behavior, growth, and viability of life stages, including temperature, salinity, oxygen content, and other chemical characteristics.

The Klamath River estuary and 1.6 km of the coastal marine areas adjacent to the Yurok Tribal land are **excluded** from the critical habitat designation. Except for the 1.6 km adjacent to Yurok Tribal land, the coastal marine areas around the Klamath River are designated as critical habitat for the southern DPS green sturgeon.

Life history

Green sturgeon are believed to spend the majority of their lives in nearshore oceanic waters, bays, and estuaries. Early life-history stages reside in fresh water, with adults returning to freshwater to spawn when they are more than 15 years of age and more than 4 ft in size. Spawning is believed to occur every 2–5 years (Moyle 2002). Adults typically migrate into fresh water beginning in late February; spawning occurs in March–July, with peak activity in April–June (Moyle et al. 1995). Females produce 60,000–140,000 eggs (Moyle et al. 1992). Juvenile green sturgeon spend 1–4 years in fresh and estuarine waters before dispersal to saltwater (Beamesderfer and Webb 2002). They disperse widely in the ocean after their out-migration from freshwater (Moyle et al. 1992).

Geographic distribution

Green sturgeon is a widely distributed and marine-oriented species found in nearshore waters from Baja California to Canada (NMFS 2008a), but its estuarine/marine distribution and the seasonality of estuarine use range-wide are largely unknown. Southern DPS green sturgeon are known to congregate in coastal waters and estuaries, including non-natal estuaries, such as the Rogue River. Beamis and Kynard (1997) suggested that green sturgeon move into estuaries of non-natal rivers to feed. Information from fisheries-dependent sampling suggests that green sturgeon only occupy large estuaries during the summer and early fall in the northwestern U.S. Green sturgeon are known to enter Washington estuaries during summer (Moser and Lindley 2007). Commercial catches of green sturgeon peak in October in the Columbia River estuary, and records from other estuarine fisheries (Willapa Bay and Grays Harbor, Washington) support the idea that sturgeon are only present in these estuaries from June until October (Moser and Lindley 2007). This information suggests that southern DPS green sturgeon are likely to use the Klamath River estuary only during the summer and fall months. As southern DPS sturgeon spend the majority of their life in the ocean, and individuals spend some time in a number of estuaries along the West Coast in the summer and fall, only a small proportion of the southern DPS green sturgeon would be expected to be present in the Klamath River estuary in any given year.

Population trends

Population size and trends for green sturgeon in the Southern DPS have been estimated by comparing the relative size of the Sacramento-San Joaquin green sturgeon population (Southern DPS) with the Klamath River population (Northern DPS) (Beamesderfer et al. (2005). Using Klamath River tribal fishery harvest rate data and assuming that adults represent 10% of the population at equilibrium, a rough estimate of the Klamath population (Northern DPS) was determined to be approximately 19,000 fish with an annual recruitment of 1,800 age 1 fish. Given the relative abundance of the two stocks in the Columbia River estuary based on genetic samples, it is assumed that abundance of the Southern DPS may equal or exceed the Klamath population estimate. Based on genetic data from juvenile green sturgeon trapped above Red Bluff Diversion Dam (RBDD) on the lower Sacramento River, Israel and May (2010) identified five to 14 families, indicating the presence of ten to 28 adult spawners in this reach. This can only be a small portion of the spawners in the Southern DPS, because the gates at RBDD are lowered by May 15th of each year, before most migrating adults have moved that far upstream. Based on tagging data and visual observations of adults in pools further downstream, Woodbury (2010, as cited in NMFS 2010a) estimates a total of 1,500 spawners. Assuming that spawners represent 10% of the population, the number of individuals in the Southern DPS would be about 15,000, or somewhat smaller than the estimate for the Klamath population.

No good data on current population sizes exist and trend data are lacking (NMFS http://www.nmfs.noaa.gov/pr/species/fish/greensturgeon.htm#population)

Threats

The principal factor in the decline of the Southern DPS is the reduction of the spawning habitat to a limited section of the Sacramento River (NMFS 2006a). The potential for catastrophic events to affect such a limited spawning area increases the risk of the southern DPS green sturgeon's extirpation. Insufficient freshwater flow rates in spawning areas, contaminants (e.g., pesticides), bycatch of green sturgeon in fisheries, potential poaching (e.g., for caviar), entrainment of juveniles by water projects, influence of exotic species, small population size, impassable migration barriers, and elevated water temperatures in the spawning and rearing habitat likely also pose threats to this species (NMFS 2006a). In the past, take of green sturgeon may have occurred from direct harvest in sport and commercial fisheries and from catch-and-release mortality in commercial fisheries. In more recent years, the take of green sturgeon in the Columbia River was bycatch taken during the white sturgeon fishery. The reduced catch of green sturgeon in recent years is believed to be the result of collective management actions by Washington, Oregon, and California state agencies, resulting in lower catch, and is not considered indicative of lower abundance of the stock (Oregon Technical Advisory Team 2008). Incidental take of green sturgeon primarily occurs during the early-fall (August) and late-fall (September–November) seasons, concurrent with peak abundance of green sturgeon in the lower Columbia River. Sturgeon angler effort and catch in the estuary increased steadily during the 1990s and peaked in 1998 when anglers made 86,400 trips and caught 30,300 white sturgeon, or 73% of the total catch below Bonneville Dam (Oregon Technical Advisory Team 2008). Beginning in 2006, and in response to the ESA listing of the Southern DPS, retention of green sturgeon in the commercial fisheries was disallowed (Oregon Technical Advisory Team 2008). Beginning in January 2007, the states changed the regulations in the recreational fishery to also disallow retention of green sturgeon (Oregon Technical Advisory Team 2008). The delay in the implementation of non-retention requirements in the recreational fishery was related to the prescribed process for changing sport regulations and the need for a concurrent public education process.

Status within the Action Area

Both Southern and Northern green sturgeon DPSs likely use the Klamath River (74 FR 52300). Although Southern DPS green sturgeon may enter West Coast estuaries to feed in the summer and fall, there has been no evidence of them entering the Klamath River estuary (75 FR 30714). However, if they do enter the Klamath River, they are not anticipated to migrate beyond the estuarine habitat.

4.2.2.4 SONCC Coho Salmon (*Oncorhynchus kisutch*)

Species status

The SONCC coho salmon ESU was listed as threatened under the ESA on May 6, 1997 (62 FR 24588). The SONCC coho salmon ESU includes all natural-origin populations of coho salmon in coastal streams between Cape Blanco, Oregon, and Punta Gorda, California. The SONCC coho salmon ESU includes the Klamath River drainage up to Spencer Creek. Three artificial propagation programs are considered to be part of the ESU: the Cole River Hatchery, Trinity River Hatchery, and IGH (NMFS 2001). NMFS has determined that these artificially propagated stocks are no more divergent relative to the local natural-origin populations than what would be expected between closely-related natural-origin populations within the ESU (70 FR 37160; June 28, 2005).

Critical habitat

Critical habitat was designated for SONCC coho salmon in May 1999 (64 FR 24049). Critical habitat includes all river reaches accessible to listed coho salmon between Cape Blanco, Oregon and Punta Gorda, California, and includes water, substrate, and adjacent riparian zones of estuarine and riverine reaches, including off-channel habitat. Accessible reaches are defined as those within the historical range of the ESU that can still be occupied by any life stage of coho salmon. Specifically, in the Klamath Basin, all river reaches downstream of IGD on the Klamath River and Lewiston Dam on the Trinity River are designated as critical habitat (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. PCEs of habitat considered essential for the conservation of the SONCC ESU include: 1) spawning sites, 2) food resources, 3) water quality and quantity, and 4) riparian vegetation (62 FR 62741, November 1997).

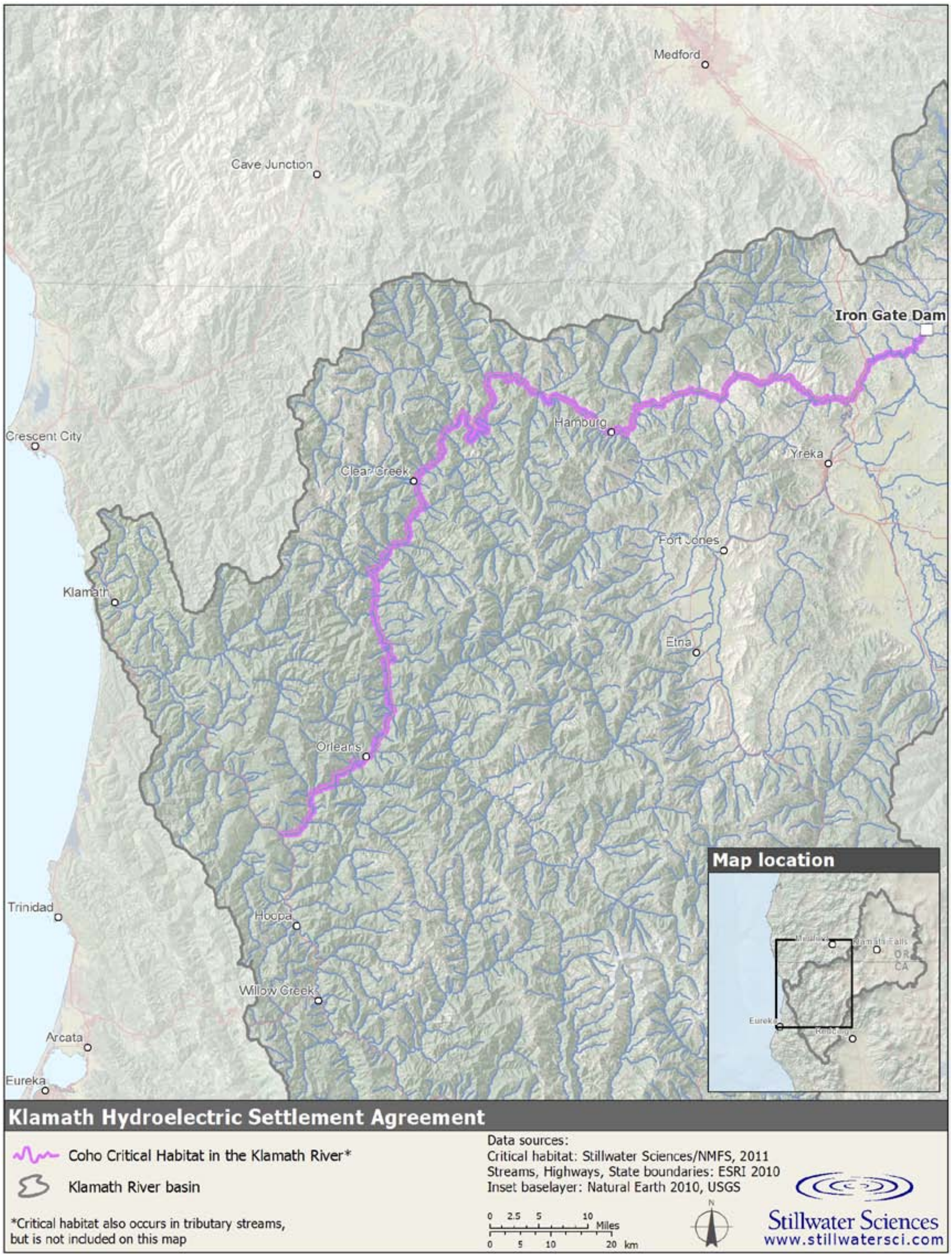


Figure 4-5. Designated Critical Habitat for Coho Salmon in the Mainstem Klamath River

Life history

Coho salmon have an anadromous life history in which juveniles are born and rear in freshwater, migrate to the ocean, grow to maturity, and return to fresh water as adults to spawn. Coho salmon adults migrate upstream from September through late December, peaking in October and November. Spawning occurs mainly in November and December, with fry emerging from the gravel in the spring, approximately 3 to 4 months after spawning. Coho salmon tend to spawn in small streams that flow directly into the ocean, or tributaries and headwater creeks of larger rivers (Moyle 2002, Sandercock 1991). Juveniles 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). Emigration from streams to the estuary and ocean generally takes place from February through June, with the peak period being the end of April through May. The majority of coho salmon within the Klamath River have a three-year life cycle with their time being spent about equally between fresh and salt water. Some two-year old males, known as "jacks" also return as spawners. Juveniles typically rear in freshwater for one full year, then migrate to the sea in the spring after their first winter of life.

Geographic distribution

Coho salmon are distributed throughout the Klamath River downstream of IGD, and spawn primarily in tributaries (Trihey and Associates 1996, NRC 2004). Rearing has also been observed in tributary confluence pools in the mainstem Klamath River (T. Shaw, USFWS, 2002, unpubl. data; as cited in NRC 2004). During their upstream migration, adult coho salmon from the Upper Klamath River Population Unit may travel upstream as far as IGD (RM 190.1) and were formerly known to occupy mainstem and tributary habitat at least as far upstream as Spencer Creek at RM 228 (NRC 2004). Thus, the mainstem Klamath River functions primarily as a migration corridor for coho salmon, but also likely provides rearing habitat for the Upper Klamath River and Mid-Klamath River population units, and allows for movement of juvenile fish between tributaries.

The vast majority of coho salmon that spawn in the Klamath Basin are believed to be of hatchery origin. Indirect estimates indicate 90% of adult coho salmon in the system return directly to hatcheries or spawning grounds in the immediate vicinity of hatcheries (Brown et al. 1994). This analysis of SSC effects pertains to the adults and progeny of both hatchery-returning adults and those that spawn in the river, differentiating between the two where possible.

Population trends

For the latest status review of SONCC coho salmon, NMFS gathered a core group of scientists from the NMFS Northwest and Southwest Fisheries Science Centers, supplemented by experts on particular species from NMFS and other federal agencies, known as Biological Review Teams (BRTs). In a vote on the status of SONCC coho salmon, a majority (67%) of the BRT votes fell in the "likely to become endangered" category, and votes in the endangered category outnumbered those in the "not warranted" category by 2 to 1 (Good et al. 2005). Good et al. (2005) determined that the BRT remained concerned about low population abundance throughout the SONCC coho salmon ESU relative to historical numbers and long-term downward trends in abundance; however, the paucity of data on escapement of naturally produced spawners in most basins continued to hinder risk assessment. Less-reliable indices of spawner abundance in several California populations reveal no apparent trends in some populations and suggest possible continued declines in others. Additionally, the BRT considered the relatively low occupancy rates of historical coho salmon streams (between 37% and 61% from brood years 1986 to 2000) as an indication of continued low abundance in the California portion of this ESU.

Reliable current time series of naturally produced adult migrants or spawners are not available for SONCC ESU rivers (Good et al. 2005). For a summary of historical and current distributions of SONCC coho salmon in northern California, refer to CDFG's (2002b) coho salmon status review, historical population structure by Williams et al. (2006), as well as the presence and absence update for the northern California portion of the SONCC coho salmon ESU (Good et al. 2005).

The main stocks in the SONCC coho salmon ESU (Rogue River, Klamath River, and Trinity River) remain heavily influenced by hatcheries and have little natural production in mainstem rivers (Weitkamp et al. 1995, Good et al. 2005). The listing of SONCC coho salmon includes all within-ESU hatchery programs (70 FR 37160; June 28, 2005). Trinity River Hatchery maintains high production, with a significant number of hatchery SONCC coho salmon straying into the wild population (NMFS 2001). Straying of IGH coho salmon into important tributary streams is a frequent occurrence, with hatchery fish making up an average of 16% of recovered carcasses in the Shasta River (Ackerman and Cramer 2006). Weitkamp et al. (1995) estimated that the rivers and tributaries in the California portion of the SONCC coho salmon ESU had “recently” produced 7,080 naturally spawning coho salmon and 17,156 hatchery returns, including 4,480 "native” fish occurring in tributaries having little history of supplementation with nonnative fish. Combining the California run-size estimates with Rogue River estimates, Weitkamp et al. (1995) arrived at a rough minimum run-size estimate for the SONCC coho salmon ESU of about 10,000 natural fish and 20,000 hatchery fish.

All SONCC coho salmon stocks between Punta Gorda and Cape Blanco are depressed relative to past abundance (Weitkamp et al. 1995, Good et al. 2005). In the latest status review by NMFS, Ly and Ruddy (2011) concluded that many coho salmon populations in this ESU are low in abundance, may well be below their depensation thresholds, and that their risk of extinction may also be increasing. Ly and Ruddy (2011) also concluded that the best available updated information on the biological status of this ESU and the threats facing this ESU indicate that it continues to remain threatened and there is cause for concern.

Threats to SONCC coho salmon

Major activities

The major activities identified as 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 (62 FR 24588; May 6, 1997). Existing regulatory mechanisms, including land management plans (e.g., National Forest Land and Resource Management Plans, State Forest Practice Rules), CWA section 404 activities, urban growth management, and harvest and hatchery management all contributed by varying degrees to the decline of coho salmon due to the lack, or inadequacy, of protective measures. Below, some of these major activities are covered in more detail.

Disease and predation

Disease and predation were not believed to have been major causes in the species decline; however, they may have had substantial impacts in local areas. Recent data on disease infection, such as ceratomyxosis, on juvenile coho salmon suggest it may have impacts on populations in the Klamath Basin. Higgins et al. (1992) and CDFG (1994) reported that Sacramento River pikeminnow have been found in the Eel River basin and are considered major threats to native coho salmon.

Artificial propagation

The authors of this document acknowledge that issues relating to hatchery operations, such as the role of hatchery fish in the recovery of SONCC coho salmon, effects of hatchery releases on the overall productivity and abundance of SONCC coho salmon, and the goals of hatchery programs can be confusing. In writing this opinion, and subjecting it to outside review, it has become clear that hatchery operations have the potential to conflict with the wider goal of SONCC coho salmon 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 large mitigation hatcheries annually release approximately 14,215,000 hatchery salmonids into the rivers of the SONCC coho salmon ESU. Additionally, a few smaller hatcheries, such as Mad River Hatchery and Rowdy Creek Hatchery (Smith River) add to the production of hatchery fish in the SONCC coho salmon ESU. Both intra- and inter-specific interactions between hatchery salmonids and SONCC coho salmon may occur in the freshwater and saltwater environments.

Spawning by hatchery salmonids in rivers and streams is often not controlled (ISAB 2002). Hatchery fish also stray into rivers and streams, transferring genes from hatchery populations into naturally spawning populations (Pearse et al. 2007). 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. These 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 outbreeding depression (Reisenbichler and Rubin 1999, Hatchery Scientific Review Group 2004).

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 because naturally produced 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. 1997a, Levin et al. 2001, Sweeting et al. 2003).

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). Widespread declines in springtime snow water equivalent (SWE) have occurred in much of the North American West since the 1920s, especially since mid-century (Knowles and Cayan 2004, Mote 2006). This decrease in SWE can be largely attributed to a general warming trend in the western United States since the early 1900s (Mote et al. 2005, Regonda et al. 2005, Mote 2006), even though there have been modest upward precipitation trends in the western United States since the early 1900s (Hamlet et al. 2005). The largest decreases in SWE are taking place at low to mid elevations (Mote 2006, Van Kirk and Naman 2008) because the warming trend overwhelms the effects of increased precipitation (Hamlet et al. 2005, Mote et al. 2005, Mote 2006). These climactic changes have resulted in earlier onsets of springtime snowmelt and streamflow across western North America (Hamlet and Lettenmaier 1999, Regonda et al. 2005, Stewart et al. 2005), as well as lower flows in the summer (Hamlet and Lettenmaier 1999, Stewart et al. 2005).

The projected runoff-timing trends over the course of the 21st century are most pronounced in the Pacific Northwest, Sierra Nevada, and Rocky Mountain regions, where the eventual temporal centroid of streamflow (i.e., peak streamflow) change amounts to 20–40 days in many streams (Stewart et al. 2004). Although climate models diverge with respect to future trends in precipitation, there is widespread agreement that the trend toward lower SWE and earlier snowmelt will continue (Zhu et al. 2005, Vicuna et al. 2007). Thus, availability of water resources under future climate scenarios is expected to be most limited during the late summer (Gleick and Chalecki 1999, Miles et al. 2000). A one-month advance in timing centroid of streamflow would also increase the length of the summer drought that characterizes much of western North America, with important consequences for water supply, ecosystem, and wildfire management (Stewart et al. 2004). These changes in peak streamflow timing and snowpack will negatively impact salmonid populations due to habitat loss associated with lower water flows, higher stream temperatures, and increased human demand for water resources.

The global effects of climate change on river systems and salmon are often superimposed upon the local effects within river systems of logging, water utilization, harvesting, hatchery interactions, and development (Bradford and Irvine 2000, Mayer 2008, Van Kirk and Naman 2008). For example, total water withdrawal in California, Idaho, Oregon and Washington increased 82% between 1950 and 2000, with irrigation accounting for nearly half of this increase (MacKichan 1951, Hutson et al. 2004), while during the same period climate change was taking place. Climate change will likely complicate the recovery of SONCC coho salmon and make habitat conditions for SONCC coho salmon less favorable for survival, reproduction and growth.

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. Beamish et al. (1997b) noted decadal-scale changes in the production of Fraser River sockeye salmon that they attributed to changes in the productivity of the marine environment. Warm ocean regimes are characterized by lower ocean productivity (Behrenfeld et al. 2006, Wells et al. 2006), which may effect salmon by limiting the availability of nutrients regulating the food supply, thereby increasing competition for food (Beamish and Mahnken 2001). Data from across the range of coho salmon on the coast of California and Oregon reveal there was a 72% decline in returning adults in 2007/08 compared with the same cohort in 2004/05 (MacFarlane et al. 2008). The Wells Ocean Productivity Index, an accurate measure of Central California ocean productivity, revealed poor conditions during the spring and summer of 2006, when juvenile coho from the 2004/05 spawn entered the ocean (McFarlane et al. 2008). Data gathered by NMFS suggests that strong upwelling in the spring of 2007 may have resulted in better ocean conditions for the 2007 coho salmon cohort (NMFS 2010a). In 2008 the coldest winter sea surface temperatures of the past 12 years were observed (and probably since the 1970s) and the earliest biological spring transition and highest northern copepod biomass of the past 13 years (NMFS 2010b). However, the strong negative PDO began to weaken in June 2009 and abruptly turned positive in August; signaling a change from the very productive ocean conditions of the past two years to poor ocean conditions (NMFS 2010b). After June 2009, the ocean began to warm significantly, leading to detrimental changes in the pelagic food web and likely high mortality of juvenile salmonids (NMFS 2010b). As a result, expectations for returns of coho in 2010 are considerably lower due to warm sea–surface conditions throughout August 2009 (NMFS 2010b). The quick response of salmonid populations to changes in ocean conditions (MacFarlane et al. 2008) strongly suggests that density dependent mortality of salmonids is a mechanism at work in the ocean (Beamish et al. 1997a, Levin et al. 2001, Greene and Beechie 2004).

Marine-derived nutrients

Marine-derived nutrients (MDN) are nutrients that are accumulated in the biomass of salmonids while they are in the ocean and are then transferred to their freshwater spawning sites where the salmon die. The return of salmonids to rivers makes a significant contribution to the flora and fauna of both terrestrial and riverine ecosystems (Gresh et al. 2000), and has been shown to be vital for the growth of juvenile salmonids (Bilby et al. 1996, et al. 1998). Evidence of the role of MDN and energy in ecosystems suggests this deficit may result in an ecosystem failure contributing to the downward spiral of salmonid abundance (Bilby et al. 1996). Reduction of MDN to watersheds is a consequence of the past century of decline in salmon abundance (Gresh et al. 2000).

Risk of extinction of SONCC coho salmon

A prerequisite for predicting the effects of a Proposed Action on a species includes an understanding of the condition of the species in terms of their chances of surviving and recovering, and whether the Proposed Action can be expected to reduce these likelihoods. In order to determine the current risk of extinction of the SONCC coho salmon ESU, we used the historical population structure of SONCC coho salmon presented in Williams et al. (2006) and the concept of viable salmonid population (VSP) for evaluating populations described by McElhany et al. (2000). The work performed by Williams et al. (2006) is simply an extension of McElhany et al. (2000). While McElhany et al. (2000) introduced and described the concept of VSP, Williams et al. (2006) applied the concept to the SONCC coho salmon ESU. Williams et al. (2006) identified 45 historical populations within the SONCC coho salmon ESU, and further categorized the historical populations based on their distribution and demographic role (i.e., independent, dependent, or ephemeral; Figure 4-5). Nineteen historical populations were characterized as Functionally Independent, defined as those sufficiently large to be historically viable-in isolation and whose demographics and extinction risk were minimally influenced by immigrants from adjacent populations. Twelve historical populations were characterized as Potentially Independent, defined as those that were potentially viable-in-isolation, but that were demographically influenced by immigrants from adjacent populations. Seventeen historical populations were characterized as Dependent, which are believed to have had a low likelihood of sustaining themselves over a 100-year time period in isolation. These populations received sufficient immigration to alter their dynamics and extinction risk. Finally, two historical populations were characterized as Ephemeral, defined as populations that were both small enough and isolated enough that they were only intermittently present.

Williams et al. (2008) calculated the minimum number of spawners for each SONCC coho population in order for a given population to be categorized at low risk for extinction, or considered a viable salmonid population (based on spatial structure and diversity). The abundance of spawners is just one of several criteria that must be met for a population to be considered viable. A population must meet all the low-risk thresholds to be considered viable. Williams et al. (2008), however, acknowledged that a viable salmonid population at the ESU scale is not merely a quantitative number that needs to be attained. Rather, for an ESU to persist, populations within the ESU must be able to track changes in environmental conditions. When the location or distribution of an ESU's habitat changes, a species can avoid extinction either by adapting genetically to the new environmental conditions, or by spatially tracking the environmental conditions to which it is adapted (Pease et al. 1989, as cited in Williams et al. 2008). An ESU persists in places where it is able to track environmental changes, and becomes extinct if it fails to keep up with the shifting distribution of suitable habitat (Thomas 1994. Williams et al. 2008). Therefore, Williams et al. (2006) provides a set of rules that will result in certain configurations of populations that will result in a viable ESU. First, using the historical populations, Williams et al. (2008) organized the independent and dependent populations of coho salmon in the SONCC ESU into seven diversity strata largely based on the geographical arrangement of the populations and basin-scale environmental and ecological characteristics.

In order for the SONCC coho salmon ESU to be viable, each of the diversity strata needs to be viable. Second, in order for a diversity stratum to be viable, at least two, or 50% of the independent populations (Functionally Independent or Potentially Independent), whichever is greater, must be viable, and the abundance of these viable independent populations collectively must meet or exceed 50% of the abundance predicted within the diversity stratum when it is at low risk of extinction (Table 4-4). Third, all dependent and independent populations not expected to meet the low-risk threshold within a diversity stratum must exhibit occupancy patterns that indicate sufficient immigration is occurring from the "core populations." Finally, the distribution of extant populations, both dependent and independent, needs to maintain connectivity within and among diversity strata.

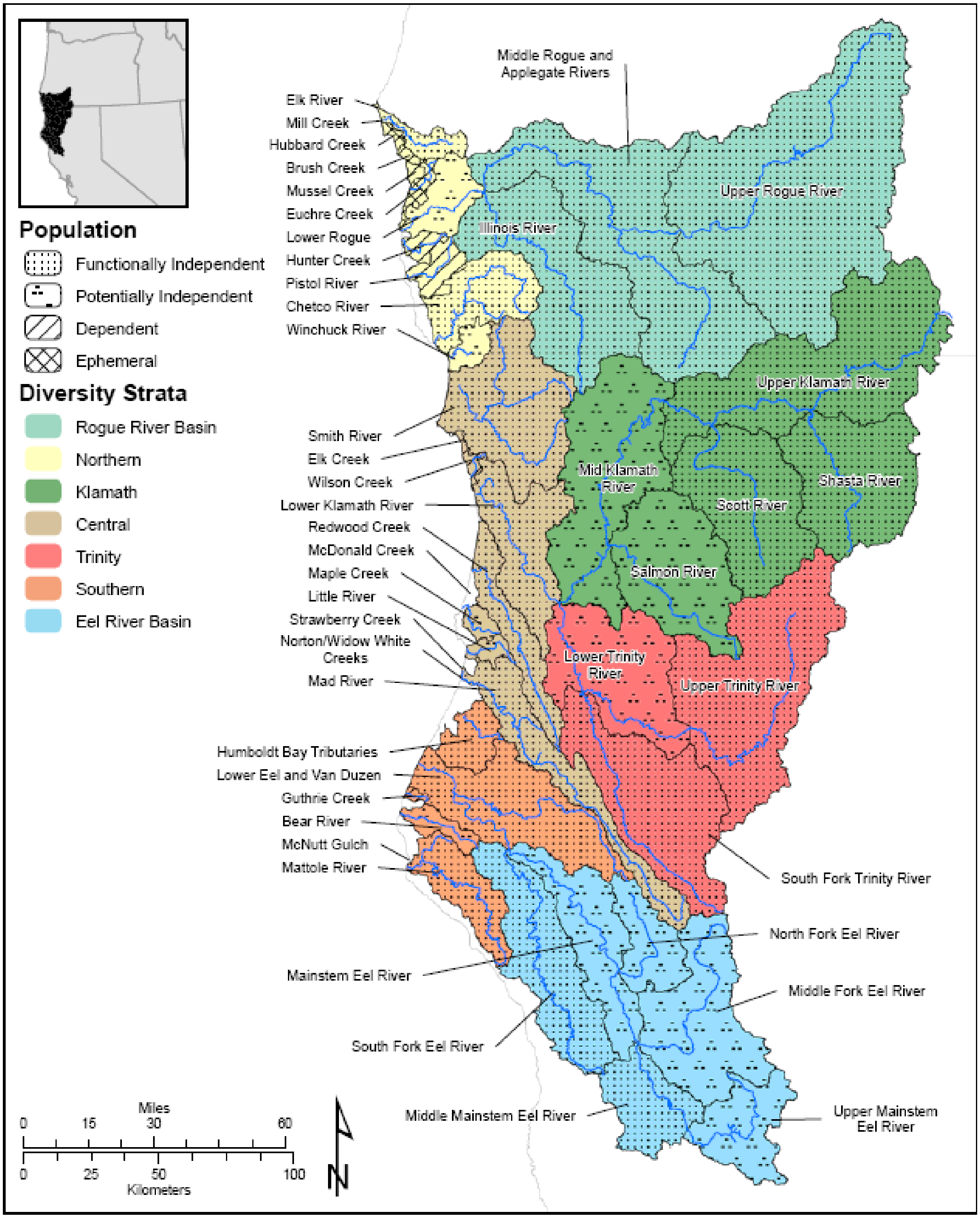


Figure 4-6. Diversity Strata for Populations of Coho Salmon in the SONCC ESU (From Williams et al. 2008)

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

Table 4-5. Diversity Strata of the SONCC Coho Salmon ESU, Including the Number of Population Types and the Number of Spawners Needed to Satisfy 50% of the Total number of spawners in a strata needed to meet stratum viability (These data were taken from Williams et al. 2008)

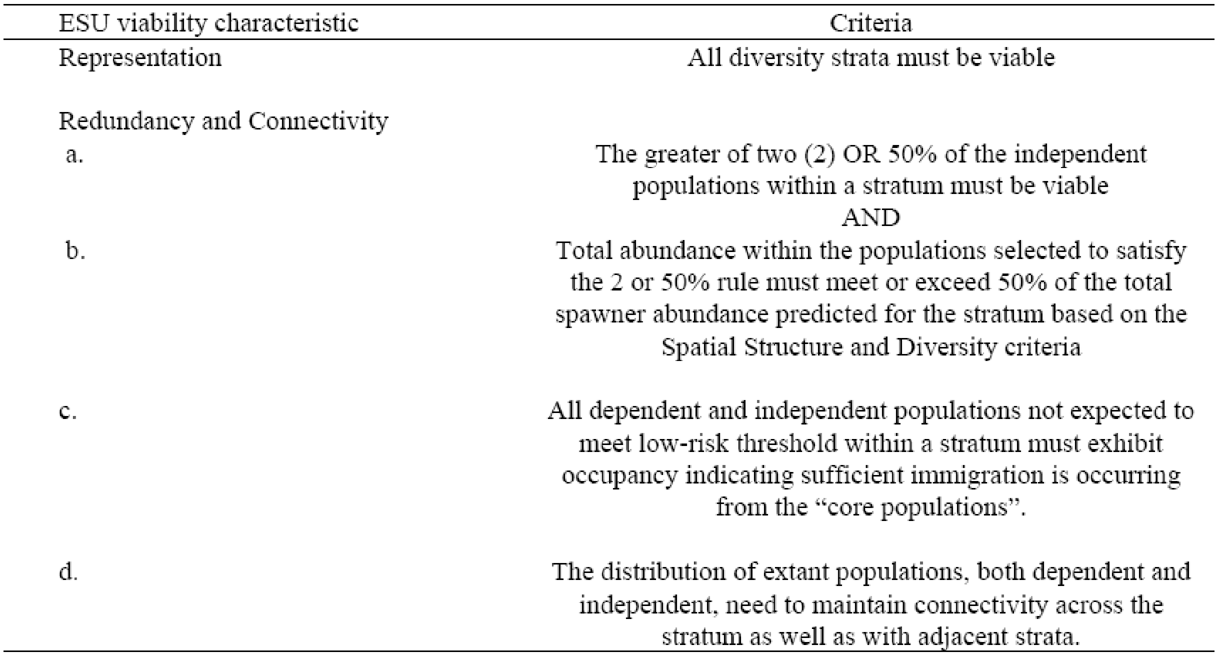
Diversity strata	Population types (*n*)				50% Total stratum spawners
	F	P	D	E	
Northern Coastal Basins	2	2	3	2	6,050
Central Coastal Basins	4	2	5	0	13,200
Southern Coastal Basins	3	1	2	0	11,000
Interior-Rogue River	3	0	0	0	22,650
Interior-Klamath	3	2	0	0	17,900
Interior-Trinity	2	1	0	0	6,350
Interior-Eel	2	4	0	0	13,950

(F: functionally independent, P: potentially independent, D: dependent, and E: ephemeral)

Data compiled by Good et al. (2005) and CDFG (2002b) indicate that the population abundance of virtually all diversity strata in the SONCC coho salmon ESU fall below 50% of the total number of spawners needed to meet stratum viability proposed by Williams et al. (2008). For an ESU to be viable, all the diversity strata within the ESU must be viable (Table 4-5).

While Williams et al. (2008) provided the number of spawners needed to meet stratum viability, quantitative metrics related to the VSP parameters other than population abundance were not given. However, to some extent, the condition of each individual VSP parameter is manifested in the current population abundance, because it is the keystone measure of viability; and Spatial Structure and Diversity criteria are embedded within the 50% total spawner abundance predicted for any given stratum (Table 4-5).

Table 4-6. Summary of ESU Viability Criteria for SONCC Coho Salmon



ESU viability characteristic	Criteria
Representation	All diversity strata must be viable
Redundancy and Connectivity	
a.	The greater of two (2) OR 50% of the independent populations within a stratum must be viable AND
b.	Total abundance within the populations selected to satisfy the 2 or 50% rule must meet or exceed 50% of the total spawner abundance predicted for the stratum based on the Spatial Structure and Diversity criteria
c.	All dependent and independent populations not expected to meet low-risk threshold within a stratum must exhibit occupancy indicating sufficient immigration is occurring from the "core populations".
d.	The distribution of extant populations, both dependent and independent, need to maintain connectivity across the stratum as well as with adjacent strata.

Population size

Information about population size provides an indication of the type of extinction risk that a population faces. For instance, smaller populations are at a greater risk of extinction than large populations because the processes that affect populations operate differently in small populations than in large populations (McElhany et al. 2000). One risk of low population sizes is depensation. Depensation occurs when populations are reduced to very low densities and per capita growth rates decrease as a result of a variety of mechanisms [e.g., failure to find mates and therefore reduced probability of fertilization, failure to saturate predator populations (Liermann and Hilborn 2001). Depensation results in a negative feedback that accelerates a decline toward extinction (Williams et al. 2008).

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). As a result, the higher the proportion of hatchery-born spawners, the lower the productivity of the population, as demonstrated by Chilcote (2003). Chilcote (2003) examined the actual number of spawners and subsequent recruits over 23 years in 12 populations of Oregon steelhead with varying proportions of hatchery-origin spawners and determined ". . . a spawning population comprised of equal numbers of hatchery and wild fish would produce 63% fewer recruits per spawner than one comprised entirely of wild fish." Williams et al. (2008), considered a population to be at least at a moderate risk of extinction if the fraction of naturally spawning hatchery fish exceeds 5%. Populations have a lower risk of extinction if no or negligible ecological or genetic effects resulting from past or current hatchery operations can be demonstrated.

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

Population productivity

The productivity of a population (i.e., production over the entire life cycle) can reflect conditions (e.g., environmental conditions) that influence the dynamics of a population and determine abundance. In turn, the productivity of a population allows an understanding of the performance of a population across the landscape and habitats in which it exists and its response to those habitats (McElhany et al. 2000). In general, declining productivity equates to declining population abundance. The most recent status review for the SONCC coho salmon ESU concluded data were insufficient to set specific numeric population productivity targets for viability (Spence et al. 2007, Williams et al. 2008). McElhany et al. (2000) suggested a population's natural productivity should be sufficient to maintain its abundance above the viable level (a stable or increasing population growth rate). This guideline seems a reasonable goal in the absence of numeric abundance targets.

SONCC coho salmon have declined substantially from historical levels. Experts consulted during the status review gave this ESU a risk score of 3.8 (out of 5, with 5 being the highest risk) for the growth rate/productivity VSP category (Good et al. 2005), indicating its current impaired productivity level contributes significantly to long-term risk of extinction and may contribute to short-term risk of extinction in the foreseeable future. As productivity does not appear sufficient to maintain viable abundances in many SONCC coho salmon populations, NMFS concludes this ESU is not currently viable in regards to the population productivity VSP parameter.

Spatial structure

In general, there is less information available on how spatial processes relate to salmonid viability than there is for the other VSP parameters (McElhany et al. 2000). Understanding the spatial structure of a population is important because the population structure can affect evolutionary processes and, therefore, alter the ability of a population to adapt to spatial or temporal changes in the species' environment (McElhany et al. 2000). The most recent status review for the SONCC coho salmon ESU concluded data were insufficient to set specific population spatial structure targets (Spence et al. 2007, Williams et al. 2008). In the absence of such targets, McElhany et al. (2000) suggested the following: "As a default, historical spatial processes should be preserved because we assume that the historical population structure was sustainable but we do not know whether a novel spatial structure will be."

An ESU persists in places where it is able to track environmental changes, and becomes extinct if it fails to keep up with the shifting distribution of suitable habitat (Thomas 1994, as cited in Williams et al. 2008). If freshwater habitat shrinks due to climate change (Battin et al. 2007), certain areas such as inland rivers and streams could become inhospitable to coho salmon, which would change the spatial structure of the SONCC coho salmon ESU, having implications for the risk of species extinction.

Relatively low levels of observed presence in historically occupied coho salmon streams (32 to 56% from 1986 to 2000) indicate continued low abundance in the California portion of the SONCC coho salmon ESU. The relatively high occupancy rate of historical streams observed in 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%) still supported coho salmon runs while 42 (36%) did not. The streams Brown et al. (1994) identified as presently lacking coho salmon runs were all tributaries of the Klamath River and Eel River systems. The BRT was also concerned about the loss of local populations in the Trinity, Klamath, and Rogue River basins (70 FR 37160; June 28, 2005). CDFG (2002b) reported a decline in SONCC coho salmon occupancy, with the percent reduction dependent on the data sets used. Although there is considerable year-to-year variation in estimated occupancy rates, it appears that there has been no dramatic change in the percent of coho salmon streams occupied from the late 1980s and early 1990s to 2000 (Good et al. 2005). In summary, recent information for SONCC coho salmon indicates that their distribution within the ESU has been reduced and fragmented, as evidenced by an increasing number of previously occupied streams from which they are now absent (NMFS 2001). However, extant populations can still be found in all major river basins within the ESU (70 FR 37160; June 28, 2005).

Experts consulted during the status review gave this ESU a mean risk score of 3.1 (out of 5, with 5 being the highest risk) for the spatial structure and connectivity VSP category (Good et al. 2005), indicating its current spatial structure contributes significantly to long-term risk of extinction but does not in itself constitute a danger of extinction in the near future. As the 'default' historical spatial processes described by McElhany et al. (2000) have likely not been preserved, due to the habitat fragmentation described above, NMFS concludes this ESU is not currently viable in regards to the spatial structure VSP parameter.

Diversity

Diversity, both genetic and behavioral, is critical to success in a changing environment. Salmonids express variation in a suite of traits, such as anadromy, morphology, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, and physiology and molecular genetic characteristics. The more diverse these traits (or the more these traits are not restricted), the more diverse a population is, and the more likely that individuals, and therefore the species, would survive and reproduce in the face of environmental variation (McElhany et al. 2000). However, when this diversity is reduced due to loss of entire life history strategies or to loss of habitat used by fish exhibiting variation in life history traits, the species is in all probability less able to survive and reproduce given environmental variation.

The primary factors affecting the diversity of SONCC coho salmon appear to be the influence of hatcheries and out-of-basin introductions. In addition, some brood years have abnormally low abundance levels or may even be absent in some areas (e.g., Shasta River and Scott River), further restricting the diversity present in the ESU. Experts consulted during the most recent status review gave this ESU a mean risk score of 2.8 (out of 5, with 5 being the highest risk) for the diversity VSP category (Good et al. 2005). This score indicates the ESU's current genetic variability and variation in life history factors contribute significantly to long-term risk of extinction but do not, in themselves, constitute a danger of extinction in the near future. NMFS concludes the current phenotypic diversity in this ESU is much reduced compared with historical levels, so by McElhany and others (2000) criteria it is not currently viable in regards to the diversity VSP parameter.

SONCC coho salmon status summary

Abundance

In general, smaller populations face a variety of risks intrinsic to their low abundance levels. Our review of the status of SONCC coho salmon indicates that populations have declined well below historical levels. None of the seven diversity strata have enough returning adults to satisfy the low risk abundance threshold. A host of factors has been responsible for these declines. Rating VSP parameters on a scale from 1 to 5 (5 being the highest risk), the BRT found moderately a high risk of extinction related to species abundance with a mean matrix score of 3.5.

Population productivity

The most recent data indicate continued declines in several populations of the SONCC coho salmon ESU (reduced or negative population growth rate), and an increase in Rogue River coho salmon populations. On a scale from 1 to 5 (5 being the highest risk), the BRT found a moderately high risk of extinction related to species population growth rates, with a mean matrix score of 3.8.

Population spatial structure

Recent information for SONCC coho salmon indicates that their distribution within the ESU has been reduced and fragmented, as evidenced by an increasing number of previously occupied streams from which they are now absent (NMFS 2001). However, extant populations can still be found in all major river basins within the ESU (69 FR 33102; June 14, 2004). The BRT considered extinction risk to the species due to its spatial structure to be moderate (mean score = 3.1), on a scale from 1 to 5 (5 being the highest risk).

Diversity

The primary factors affecting the diversity of SONCC coho salmon appear to be the influence of hatcheries and out-of-basin introductions (Good et al. 2005). In addition, some brood years have abnormally low abundance levels or may even be absent in some areas (e.g., Shasta River), further restricting the diversity present in the ESU (Good et al. 2005, Williams et al. 2008). The BRT considered extinction risks related to diversity (mean score = 2.8) to be moderate. The BRT's concern for the large number of hatchery fish in the Rogue, Klamath, and Trinity river systems was evident in the risk rating of moderate for diversity (Good et al. 2005).

Risk of extinction of the SONCC coho salmon ESU

The precipitous decline in abundance from historical levels and the poor status of population viability metrics in general are the main factors behind the extinction risk faced by SONCC coho salmon. The cause of the decline is likely from the widespread degradation of habitat, particularly those habitat attributes that support the freshwater rearing life-stages of the species. A majority (67%) of BRT votes fell in the "likely to become endangered" category, although votes in the endangered category outnumbered those in the "not warranted" category by 2 to 1. The viability of an ESU depends on several factors, including the number and status of populations, spatial distribution of populations, the characteristics of large-scale catastrophic risk, and the collective diversity of the populations and their habitat (Lindley et al. 2007). Due to data limitations, Williams et al. (2008) were not able to assess the viability of the SONCC coho salmon ESU with the quantitative approach they proposed, however, they agree with the previous assessments in CDFG (2002b), Good et al. (2005), and Weitkamp et al. (1995) that SONCC coho salmon are likely to become endangered in the foreseeable future. Based on the above descriptions of the population viability parameters, and qualitative viability criteria presented in Williams et al. (2008), NMFS concludes that the SONCC coho salmon ESU is currently not viable and is at moderate risk of extinction.

SONCC coho salmon critical habitat analysis

Summary of designated critical habitat

Critical habitat for SONCC coho salmon includes all accessible waterways, substrate, and adjacent riparian zones between the Mattole River in California, and the Elk River in Oregon, inclusive (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 historical 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).

Factors affecting critical habitat

a. **Timber harvesting:** Substantial timber harvesting has occurred throughout the SONCC coho salmon ESU. In many SONCC coho salmon streams, lack of large woody debris results in decreased cover and reduced storage of gravel and organic debris. Lack of large woody debris (LWD) has also resulted in loss of pool habitat and a reduction in overall habitat and hydraulic complexity in a variety of coho salmon streams (CDFG 2002b). LWD also provides cover from predators and shelter from high flow events. Timber harvest actions combined with rainfall events can cause stream bank erosion, landslides, and mass wasting, resulting in higher sedimentation rates than historical amounts throughout the SONCC coho salmon range. This can cause a reduction in food supply, increases in fine sediments which can destroy spawning gravels, and increase severity of peak flows during storm season. The removal of overhead canopy cover results in increased solar radiation reaching the stream, which results in increased water temperatures (Spence et al. 1996). For example in Redwood Creek, in Humboldt County California, altered riparian function and channel aggradation due to land use have caused high water temperatures, making the mid-mainstem inhospitable for coho salmon rearing (Madej et al. 2006).

b. **Migration barriers:** Stream crossings, such as culverts, that were not designed with fish passage truncate stream habitat on virtually all SONCC coho salmon river systems. Dry stream reaches due to changes in streamflow, diversions, or channel aggradation can also present seasonal barriers to migration.

c. **Agricultural operations:** Conversion of many lowland areas for agricultural use has dramatically altered the form and function of streams. Agricultural operations have degraded habitat and limited both water quality and quantity, especially for interior population units in the Rogue and Klamath rivers. Channelization and stream straightening associated with flood control or agricultural operations reduces habitat by limiting stream complexity and increases stream velocities, which can be detrimental to both adult and juvenile coho salmon life stages.

   Consumptive water use on many SONCC coho salmon streams has reduced stream flows in the summer and fall months, fragmented habitats, increased stream temperatures, interrupted geomorphological processes that maintain stream health, and created physical barriers to adult and juvenile migration. For example, water use in the Scott River Valley, California, has been associated with reductions in summer and fall base flow (Van Kirk and Naman 2008), which has been cited as a limiting factor in coho production in this stream (NRC 2004). Consumptive water use has also lowered the water table near affected streams, which has limited the ability of riparian plant species to proliferate, thereby exacerbating water temperature problems by increasing thermal radiation. Summer "pushup" dams are still utilized in agricultural and rural communities in the SONCC coho salmon ESU. These temporary dams can alter the streambed, create migration barriers, change stream temperature profiles, and temporarily increase sedimentation.

d. **Rural and urban development:** Substantial development and urbanization in the Rogue River Valley, coastal areas, and other parts of the SONCC coho salmon ESU contribute to habitat impairment. Loss of riparian vegetation, loss of tidal wetlands and floodplains, pollution, stream simplification, and consumptive water use are some of the aspects of urbanization that have degraded habitat of coho salmon near urban centers. Straightening and diking of once braided stream channels to facilitate flood control have reduced the amount of available habitat to rearing coho salmon juveniles, which is common throughout the ESU near small towns and cities. This has resulted in the loss of off-channel rearing and habitat areas that were once available to coho salmon. Riparian vegetation, which once helped shade small streams and rivers, has been removed, elevating stream temperatures. Runoff from city streets and urban lawns has increased nutrient loads in several streams and rivers, creating algae blooms that can eventually deplete the oxygen in a waterway.

e. **Road construction:** Roads are a pervasive feature throughout the ESU and reflect a legacy of land use activities. For example, nearly all of the historical populations comprising the SONCC ESU are characterized by high road densities used to harvest timber. In many instances, ongoing maintenance of these roads is lacking or non-existent, leading to continuing impact. Where roads cross salmonid-bearing streams, improperly placed culverts have blocked access to many stream reaches. Landslides and chronic surface erosion from road surfaces are large sources of sediment across the range of the species. Roads also have the potential to increase peak flows with consequent effects on the stability of stream substrates and banks. The consequent impacts on habitat include reductions in spawning, rearing and holding habitat, and increases in turbidity. Cederholm et al. (1981) reported that the percentage of fine sediments in spawning gravels increased above natural levels when more than two and one-half percent of a basin area was covered by roads. Across the ESU, this excessive sediment has contributed to decreased survival to emergence as spawning gravels are filled with fine sediments, reduced carrying capacity for juvenile salmonids due to pool filling and reduced feeding and growth due to high turbidity levels.

   Spawning areas have been degraded due to sedimentation, alteration of stream flows, and migration barriers. Across the ESU, this excessive sediment has contributed to decreased egg to fry survival as spawning gravels are filled with fine sediments. Mass wasting, or the catastrophic and generally episodic delivery of large volumes of sediment to streams, is a major component of sediment delivery to streams (Spence et al. 1996), which can negatively affect spawning areas. Alteration of runoff, due to land use activities, can accelerate surface flows from hillsides to stream channels (Chamberlin et al. 1991, McIntosh et al. 1994). These accelerated flows can increase summer base (low) flows (Keppeler 1998) and increase peak flows during rainstorms (Ziemer 1998). Removal of vegetation reduces evapotranspiration, which can increase the amount of water that infiltrates the soil and ultimately reaches the stream. One possible effect is increased scour of redds, reducing the success of adult salmonid spawners, as peak flows are increased due to management activities and legacy roads.

f. **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 critical habitat conditions in some areas, especially on Federal lands. For instance 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. 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.

Current condition of critical habitat at the ESU 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 SONCC coho salmon 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 has 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 SONCC coho salmon 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 critical habitat summary:** The current function of critical habitat in the SONCC coho salmon 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, 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 base flows, which limits the establishment of several essential features such as water quality and water quantity.

4.2.2.5 Southern DPS Eulachon (*Thaleichthys pacificus*)

Species status

Eulachon, commonly called smelt, candlefish, or hooligan) are a small, anadromous fish from the eastern Pacific Ocean. On March 18, 2010, NMFS listed the southern DPS of eulachon as threatened under the ESA (75 FR 13012). This DPS encompasses all populations within the states of Washington, Oregon, and California and extends from the Skeena River in British Columbia (inclusive) south to the Mad River in Northern California (inclusive). The DPS is divided into four sub-areas: Klamath River, Columbia River, Fraser River, and British Columbia coastal rivers south of the Nass River.

Critical habitat

Critical habitat for the Southern DPS eulachon in the Klamath River was designated by NMFS on October 20, 2011 (76 FR 65324). NMFS designated approximately 539 miles of riverine and estuarine habitat in California, Oregon, and Washington within the geographical area occupied by the Southern DPS of eulachon. The designation includes 16 rivers and creeks extending from and including the Mad River, California to the Elwha River, Washington. NMFS did not identify any unoccupied areas as being essential to conservation and thus, did not designate any unoccupied areas as critical habitat. The designated critical habitat areas contain one or more of the physical or biological features essential to the conservation of the species that may require special management considerations or protection. NMFS excluded from designation all lands of the Lower Elwha Tribe, Quinalut Tribe, Yurok Tribe, and Resighini Rancheria, upon a determination that the benefits of exclusion outweigh the benefits of designation. In the Klamath River, designated critical habitat extends from the mouth of the Klamath River upstream to Omogar Creek, a distance of 10.7 miles, and includes only the Federal, state, and private lands within the Yurok Reservation and Resighini Rancheria. The physical or biological features essential for conservation of this species are:

1. Freshwater spawning and incubation sites with water flow, quality, and temperature conditions and substrate supporting spawining and incubation.

2. Freshwater and estuarine migration corridors free of obstructions 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.
3. Nearshore and offshore marine foraging habitat with water quality and available prey, supporting junveniles and adult survival.

Life history

Eulachon are short-lived, high-fecundity, high-mortality forage fish, and tend to have extremely large population sizes. Eulachon typically spend three to five years in saltwater before returning to fresh water to spawn. Spawning grounds in the Klamath River may extend up to Omogar Creek (RM 10.7) (76 FR 65324). Spawning generally occurs at between 0ºC to 10ºC throughout the range of the species (Willson et al. 2006). Adult eulachon have been observed in the Klamath River in January and April (Larson and Belchik 1998). Spawning occurs in January, February, and March in the northern part of the DPS, and later in the spring in the southern parts of the DPS. Males appear to enter rivers prior to females (Spangler 2002 *in* Willson et al. 2006). Females may be present on spawning grounds for only one or two days (Eulachon Research Council 2000 *in* Willson et al. 2006). Males may be present between one and four days (Spangler 2002 *in* Willson et al. 2006). Most eulachon adults die after spawning. Eggs are fertilized in the water column, sink, and adhere to the river bottom typically in areas of gravel and coarse sand. Eggs are fertilized by milting males and the eggs adhere to stream substrates where they incubate for 30-40 days before the emergence of larvae (0.1-0.2 inches in length) (Hart 1973 *in* HDR Alaska 2008). Freshets rapidly move eulachon eggs and larvae to estuaries, it is likely that eulachon imprint and home to an estuary into which several rivers drain rather than to individual spawining rivers (Hay and McCarter 2000). Newly hatched young, transparent and 0.16-0.27 inches in length, are drift downstream passively to the ocean (Hay and McCarter 2000).

Once juvenile eulachon enter the ocean, they move from shallow nearshore areas to deeper areas over the continental shelf. Larvae and young juveniles become widely distributed in coastal waters, where they are typically found near the ocean bottom in waters 20–150 m deep (66–292 ft) (Hay and McCarter 2000) and sometimes as deep as 182 m (597 ft) (Barraclough 1964). There is currently little information available about eulachon movements in nearshore marine areas and the open ocean. However, eulachon occur as bycatch in the pink shrimp fishery (Hay et al. 1999, Olsen et al. 2000, NWFSC 2008, Hannah and Jones 2009), which indicates that the distribution of these organisms overlaps in the ocean.

Geographic distribution

Adult Pacific eulachon to have been recorded from several locations on the Washington and Oregon coasts, and were previously common in Oregon’s Umpqua River, and the Klamath River in northern California (Hay and McCarter 2000, Willson et al. 2006, NMFS 2010d).

Population trends

There are few direct estimates of abundance available for eulachon, and there is an absence of monitoring programs for them in the United States. Most population data come from fishery catch records. However, the combination of catch records and anecdotal information indicate that eulachon were present in large annual runs in the past and that significant declines in abundance have occurred. The Columbia River, estimated to have historically represented fully half of the taxon’s abundance, experienced a sudden decline in its commercial eulachon fishery landings in 1993–1994 (Washington Department of Fish and Wildlife [WDFW] and ODFW 2001, JCRMS 2007). Similar declines in abundance have occurred in the Fraser River and other coastal British Columbia rivers (Hay and McCarter 2000, Moody 2008). In the Klamath River and the Umpqua River, eulachon were once abundant, but have declined to the point where detecting them has become difficult (NMFS 2010d).

There has been no long-term monitoring program targeting eulachon in California, making the assessment of historical abundance and abundance trends difficult (Gustafson et al. 2008).

Threats

Habitat loss and degradation threaten eulachon, particularly in the Columbia River basin. Hydroelectric dams block access to historical eulachon spawning grounds and affect the quality of spawning substrates through flow management, altered delivery of coarse sediments, and siltation. The release of fine sediments from behind a U.S. Army Corps of Engineers sediment retention structure on the Toutle River has been negatively correlated with Cowlitz River eulachon returns 3 to 4 years later and is thus implicated in harming eulachon in this river system, though the exact cause of the effect is undetermined. Dredging activities in the Cowlitz and Columbia rivers during spawning runs may entrain and kill fish or otherwise result in decreased spawning success.

Eulachon have been shown to carry high levels of chemical pollutants, and although it has not been demonstrated that high contaminant loads in eulachon result in increased mortality or reduced reproductive success, such effects have been shown in other fish species. Eulachon harvest has been curtailed significantly in response to population declines. However, existing regulatory mechanisms may be inadequate to recover eulachon stocks.

Global climate change may threaten eulachon, particularly in the southern portion of its range where ocean warming trends may be the most pronounced and may alter prey availability as well as spawning and rearing success.

Status within the Action Area

Historically, large aggregations of eulachon were reported to have consistently spawned in the Klamath River. Allen et al. (2006) indicated that eulachon usually spawn no further south than the Lower Klamath River and Humboldt Bay tributaries. The California Academy of Sciences (CAS) ichthyology collection database lists eulachon specimens collected from the Klamath River in February 1916, March of 1947, and 1963, and in Redwood Creek in February 1955 (see CAS online collections database at http://research.calacademy.org/research/Ichthyology/collection/index.asp). During spawning, fish were regularly caught from the mouth of the river upstream to Brooks Riffle, near the confluence with Omogar Creek (Larson and Belchik 1998), indicating that this area contains the spawning and incubation, and migration corridor essential features.

Historically, the Klamath River was described as the southern limit of the range of eulachon (Hubbs 1925, Schultz and DeLacy 1935; both as cited in NMFS 2010d). Other accounts have described large spawning aggregations of eulachon occurring regularly in the Klamath River (Fry 1979, Moyle et al. 1995, Larson and Belchik 1998, Moyle 2002, Hamilton et al. 2005), and occasionally in the Mad River (Moyle et al. 1995, Moyle 2002) and Redwood Creek (Ridenhour and Hofstra 1994, Moyle et al. 1995). In addition, small numbers of eulachon have been reported from the Smith River (Moyle 2002). The only reported commercial catch of eulachon in northern California occurred in 1963 when a combined total of 25 metric tons (56,000 lbs) was landed from the Klamath River, the Mad River, and Redwood Creek (Odemar 1964). Since 1963, the run size has declined to the point that only a few individual fish have been caught in recent years. Moyle (2002) indicates that eulachon have been scarce in the Klamath River since the 1970s, with the exception of three years: they were plentiful in 1988 and moderately abundant again in 1989 and 1998. After 1998, they were thought to be extinct in the Klamath Basin, until a small run was observed in the estuary in 2004. According to accounts of Yurok Tribal elders, the last noticeable runs of eulachon were observed in the Klamath River in 1988 and 1989 by Tribal fishers (Larson and Belchik 1998). Larson and Belchik (1998) reported that eulachon have not been of commercial importance in the Klamath in recent years and that their current run strength is completely unstudied. However, in January 2007, six eulachon were reportedly caught by tribal fishers on the Klamath River. Another seven eulachon were captured between January and April of 2011 at the mouth of the Klamath River (McCovey 2011).

4.2.2.6 Marbled Murrelet (*Brachyramphus marmoratus*)

Species status
The marbled murrelet was listed as threatened in 1992 (57 FR 45328) under the ESA in Washington, Oregon, and California due to substantial loss and modification of nesting habitat (older forest), and mortality from net fisheries and oil spills.

Critical habitat
Critical habitat was previously designated in 1996 (61 FR 26256) to include 3,887,800 acres in 32 units on Federal and non-Federal lands within Washington, Oregon, and California. In 2011, the USFWS revised the final ruling to remove approximately 189,671 acres in northern California and southern Oregon based on new information indicating that these areas do not meet the definition of critical habitat (76 FR 61599).

The nearest designated critical habitat to the Action Area is located 44 mi west of IGD.

Life history
Murrelets are long-lived seabirds that spend most of their life in the marine environment, but use old-growth forests for nesting. Courtship, foraging, loafing, molting, and preening occur in nearshore marine waters. Throughout their range, marbled murrelets are opportunistic feders and utilize prey of diverse sizes and species. They feed primarily on fish and invertebrates in nearshore marine waters, although they have been detected on rivers and inland lakes.

Marbled murrelets produce one egg per nest and usually only nest once a year; however, re-nesting has been documented. Nests are not built, but rather the egg is placed in a small depression or cup made in moss or other debris on the limb. Incubation lasts about 30 days, and chicks fledge after about 28 days after hatching. Both sexes incubate the egg in alternating 24-hour shifts. The chick is fed up to eight times daily, and is usually fed only one fish at a time. The young are semiprecocial, capable of walking but not leaving the nest. Fledglings fly directly from the nest to the ocean (USFWS 2012).

Geographic distribution
The range of the murrelet, defined by breeding and wintering areas, extends from the northern terminus of Bristol Bay, Alaska, to the southern terminus of Monterey Bay in central California. The listed portion of the species’ range extends from the Canadian border south to central California. Murrelet abundance and distribution has been significantly reduced in portions of the listed range, and the species has been extirpated from some locations. The areas of greatest concern due to small numbers and fragmented distribution include portions of central California, northwestern Oregon, and southwestern Washington (USFWS 1997).

Nesting murrelets in California are mostly concentrated near the coastal waters of Del Norte and Humboldt counties and in lesser numbers near San Mateo and Santa Cruz counties. This species winters throughout its nesting range and in small numbers in southern California. It spends most of its time on the ocean, but nests inland in old-growth conifers with suitable platforms, especially redwoods near coastal areas.

Threats
Threats include loss of habitat, predation, gill-net fishing operations, oil spills, marine pollution, and disease.

Conservation needs/existing strategies
Stabilizing and increasing habitat quality and quantity on land and at sea are the primary means for stopping the current population decline and encouraging future population growth. The following short-term and long-term conservation actions are identified (USFWS 2012):

Short-term conservation actions:

1. maintain all occupied nesting habitat on Federal lands administered under the Northwest Forest Plan;
2. on non-Federal lands, maintain as much occupied habitat as possible and use the Habitat Conservation Plan process to avoid or reduce the loss of habitat;
3. maintain potential and suitable habitat in large contiguous blocks;
4. maintain and enhance buffer habitat surrounding occupied habitat;
5. decrease adult and juvenile mortality; and
6. minimize nest disturbances to increase reproductive success.

Long-term conservation actions:

1. increase the amount and quality of suitable nesting habitat;
2. decrease fragmentation of nesting habitat by increasing the size of suitable stands;
3. protect “recruitment” nesting habitat to buffer and enlarge existing stands, reduce fragmentation, and provide replacement habitat for current suitable nesting habitat lost to disturbance events;
4. speed up development of new habitat; and
5. improve the distribution of nesting habitat across the landscape

4.2.2.7 Northern Spotted Owl (*Strix occidentalis caurina*)

Species status
The NSO was federally listed as threatened in 1990 due to widespread loss and adverse modification of suitable habitat across the owl’s entire range and the inadequacy of existing regulatory mechanisms to conserve the owl (USFWS 1990).

Critical habitat
NSO critical habitat is designated within a 5-km (3-mi) buffer of the Klamath River from IGD upstream to the Pacific Ocean (Figure 4-7) (USFWS 2008f). Within this 5-km (3-mi) buffer, 5,394 acres (4%) of critical habitat is designated. Critical habitat is present (1) north of Iron Gate Reservoir and (2) south of the Klamath River east of Copco 1 Reservoir.

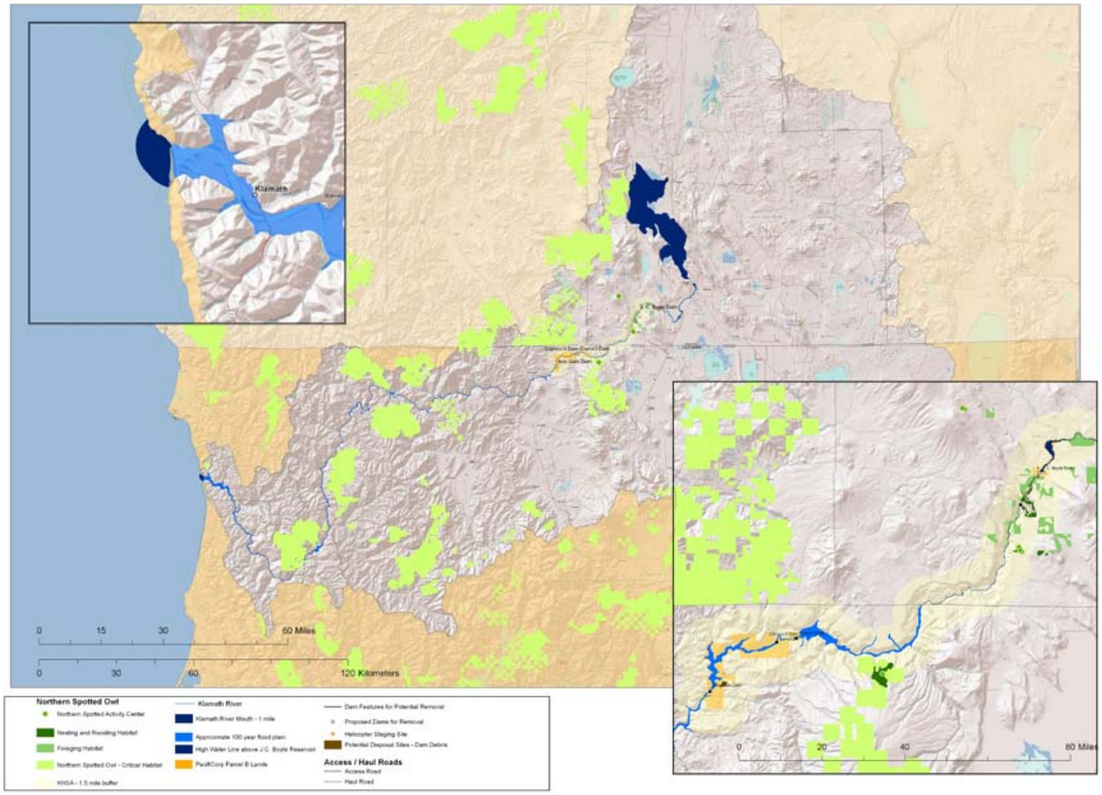


Figure 4-7. Designated Northern Spotted Owl Critical Habitat within the Klamath River Basin

In June 1990, the USFWS issued a final rule listing all NSO populations as threatened under the authority of the ESA. Critical habitat was originally designated in 1992 (USFWS 1992), and expanded in 2008 based on the Recovery Plan for the Spotted Owl and includes 1.2 million acres in California, 2.3 million acres in Oregon, and 1.8 million acres in Washington (USFWS 2008f, USFWS 2010). Critical habitat is designated under the ESA as an area in which biological or physical features essential to the conservation of the species are present within their occupied geographical range and may require special management consideration or protection (USFWS 1992).

In addition, USFWS critical habitat designation (USFWS 2008f) includes the following PCEs, physical and biological attributes that are essential to a species' conservation:

(i) **Forest types that support the species across its geographic range** which primarily include early- mid- or late- seral stages of Sitka spruce, western hemlock, mixed conifer and mixed evergreen, grand fir, Pacific silver fir, Douglas-fir, white fir, Shasta red fir, redwood/Douglas-fir, and the moist end of the ponderosa pine coniferous forest zones at elevations up to approximately 3,000 ft (914 m) near the northern edge of the range and up to approximately 6,000 ft (1,828 m) at the southern edge. This PCE is essential to the conservation of the species as it provides biotic communities that are known to be necessary for the spotted owl. This PCE must occur with at least one of the PCEs described below.

(ii) **Nesting, roosting, and foraging habitat**. Home ranges require forest types (described in (i) above) that contain one or more habitat types (nesting, roosting, foraging) which provides habitat components essential for survival and successful reproduction of a resident breeding pair. The core area of the home range is used most intensively and usually includes the nesting area. The remainder of the home range is used for foraging and roosting.

a. Nesting habitat includes moderate to high (60–80%) canopy closure, multi-layered and multi-species canopy with >30in dbh overstory trees; high incidence of large trees with various deformities (e.g., large cavities, broken tops, mistletoe platforms); large snags; large accumulation of fallen trees and woody debris on the ground; sufficient open space below the canopy for flying.
b. Roosting habitat provides thermoregulation, shelter, and cover to reduce predation risk while resting or foraging. Habitat characteristics are similar to nesting habitat; however, excludes features required for nesting (e.g., large cavities, broken tops, mistletoe platforms, snags).
c. Foraging habitat provides a food supply for survival and reproduction and contains some roosting habitat attributes but can consist of more open and fragmented forests.

(iii) **Dispersal habitat** includes forest described in (i) above and could be (a) younger less diverse stands than foraging habitat, but include some roosting structures and foraging habitat or (b) habitat that is generally equivalent to roosting and foraging habitat. Dispersal habitat can occur in between or within larger blocks of nesting, foraging, and roosting habitat. Dispersal habitat is essential to maintaining stable populations by filling territorial vacancies when resident NSO die or leave their territories, and to provide adequate gene flow across the range of the species.

As noted in Section 3.2.6, the USFWS has proposed to revise up to 13,962,449 acres of NSO critical habitat in Washington, Oregon, and California. However, since no component of critical habitat will be removed or modified, no further analysis was conducted regarding the proposed revision.

Life history

Spotted owl pairs occupy the same territories each year as long as suitable habitat is present. However, nesting may not occur every year, and survival of offspring varies annually and geographically. Nest trees are often used more than one year, but occasionally a pair will move to a new nest tree within its home range. Spotted owls begin their annual breeding cycle in late winter (late February to early March) when pairs begin to roost together (Thomas 1990). One to three eggs (usually two) are laid in March or April. Incubation lasts for approximately 30 days, and juvenile owls leave the nest 3–5 weeks after hatching. Many leave the nest site well before they are able to fly. Both parents feed the young until August or September. The young become independent in September or October, at which time they disperse from the parental nest areas.

Spotted owls are mainly found in old-growth forests characterized by high canopy closure (>70%), multi-layered canopy structure, large-diameter trees, downed logs, and snags (Thomas 1990, Buchanan 1991). The multi-layered canopy provides various microclimates, which helps spotted owls regulate their body temperature and provides foraging, roosting, and nesting habitat. While nests are found mainly in mature stands, they have also been observed in younger stands where the forest has been managed for uneven-aged stand composition, or in areas managed for rapid tree growth, facilitating habitat development in a relatively short period of time. Nests are found in tree or snag cavities, on platforms (abandoned raptor or raven nests, squirrel nests, mistletoe brooms, debris accumulations), or on top of broken-off snags. In more mature forests, spotted owls tend to use broken-top trees and cavities more frequently than platforms (LaHaye 1988, Buchanan 1991, Gutièrrez et al. 1995). Dispersal habitat includes stands that have at least an 11-in-average tree diameter and at least 40% canopy closure (Thomas 1990).

Geographic distribution

The current range of the spotted owl extends from San Francisco Bay in Marin County north through the coast range of California, western Oregon, western Washington, to southwestern British Columbia (USFWS 1990).

Threats

Past habitat loss, current habitat loss, and competition by barred owls (*Strix varia*) are the most pressing current threats to the northern spotted owl (USFWS et al. 2008). Management practices on federal lands between 1994 and 2003 resulted in a decrease of habitat by 2.5% in the Western Oregon Cascades, 1.2% in Klamath California, and 6.8% in Klamath Oregon (Bigley and Franklin 2004, as cited in USFWS 2008f), whereas timber harvest on non-federal land resulted in a loss of 10.7% of habitat in Oregon and 2.2% in California since 1994 (Raphael 2006, as cited in USFWS 2008f). Habitat in both federal and non-federal lands has decreased over time; however, the author indicated that it is important to note that the timber harvest may not have removed habitat actually occupied by northern spotted owls. Competition by barred owls for foraging, roosting, and nesting resources results in reduced site occupancy, reproduction, and survival (USFWS 2008f). The result of climate change on vegetation and disease (e.g., sudden oak death, West Nile virus) may also threaten northern spotted owl survival; however, at this time, these threats are uncertain (USFWS 2008f).

Barred owls, which have expanded their distribution into the western United States, are now found in the Klamath Basin. Barred owls occupy a similar ecological niche to that of spotted owls. They forage in similar habitats and have overlapping diets, although barred owls appear to be more tolerant of disturbance and habitat fragmentation (Dark et al. 1998). Barred owls exhibit a behavioral dominance, which can lead to either displacement of spotted owls (Hamer 1988) or hybridization with spotted owls (Hamer et al. 1994). There is also some indication that barred owls may actually prey on spotted owls (Leskiw and Gutièrrez 1998). As part of the Northwest Forest Plan, long-term annual monitoring of northern spotted owls is conducted about 104 km (65 mi) northwest of the Proposed Action in two BLM Districts in Western Oregon (Medford and Roseburg) (Davis et al. 2010). In 2009, surveys monitored 156 spotted owl sites (75 pairs, 9 singles, 14 unknown status of a single or pair of individuals) with in a survey area of approximately 1,422 km^2 (351,334 ac) in size. During the 2009 surveys, 58 non-juvenile barred owls were observed, one of which was a spotted-barred owl hybrid.

Conservation needs/existing strategies

In order to remove the northern spotted owl from protection under the ESA, the population must be sufficiently large and well-distributed, an adequate amount of suitable habitat is present, threats have been eliminated or reduced resulting in stable or increasing population, and the species is not expected to become threatened in the foreseeable future (USFWS 2010). The USFWS Draft Revised Spotted Owl Recover Plan (2010) identifies four steps to conserve the species: (1) habitat modeling application; (2) active forest management and habitat conservation; (3) barred owl management; and (4) research and monitoring.

A spatially explicit demographic modeling application has been updated in the USFWS 2010 draft recovery plan and is currently under public review. The modeling tool will evaluate the effectiveness of land use management plans by combining information from over 4,000 spotted owl sites and nesting and roosting geographic data.

Management strategies to provide suitable habitat and connectivity between populations have been implemented on state and federal lands. In Oregon and California, Habitat Conservation Plans and Safe Harbor Agreements cover more than 970,000 acres of non-federal land (USFWS 2010). Management of federal land under land-use allocations, identified in the Northwest Forest Plan (i.e., Late-Successional Reserves, Managed Late-Successional Areas, and Congressionally Reserved Areas) are intended to directly support northern spotted owl habitat and connectivity of habitat between populations. Management of other land-use allocations (i.e., Adaptive Management Areas, Administratively Withdrawn Areas, and Riparian Reserves) can provide support for habitat and connectivity between populations; however, that is not the management goal.

Status within the Action Area

NSO activity centers have been documented in the vicinity of Copco 1 and J.C. Boyle and suitable northern spotted owl habitat, although limited, is most abundant near the J.C. Boyle dam and reservoir and Copco 1 Reservoir (Table 4-6, Figures 4-8 through 4-10).

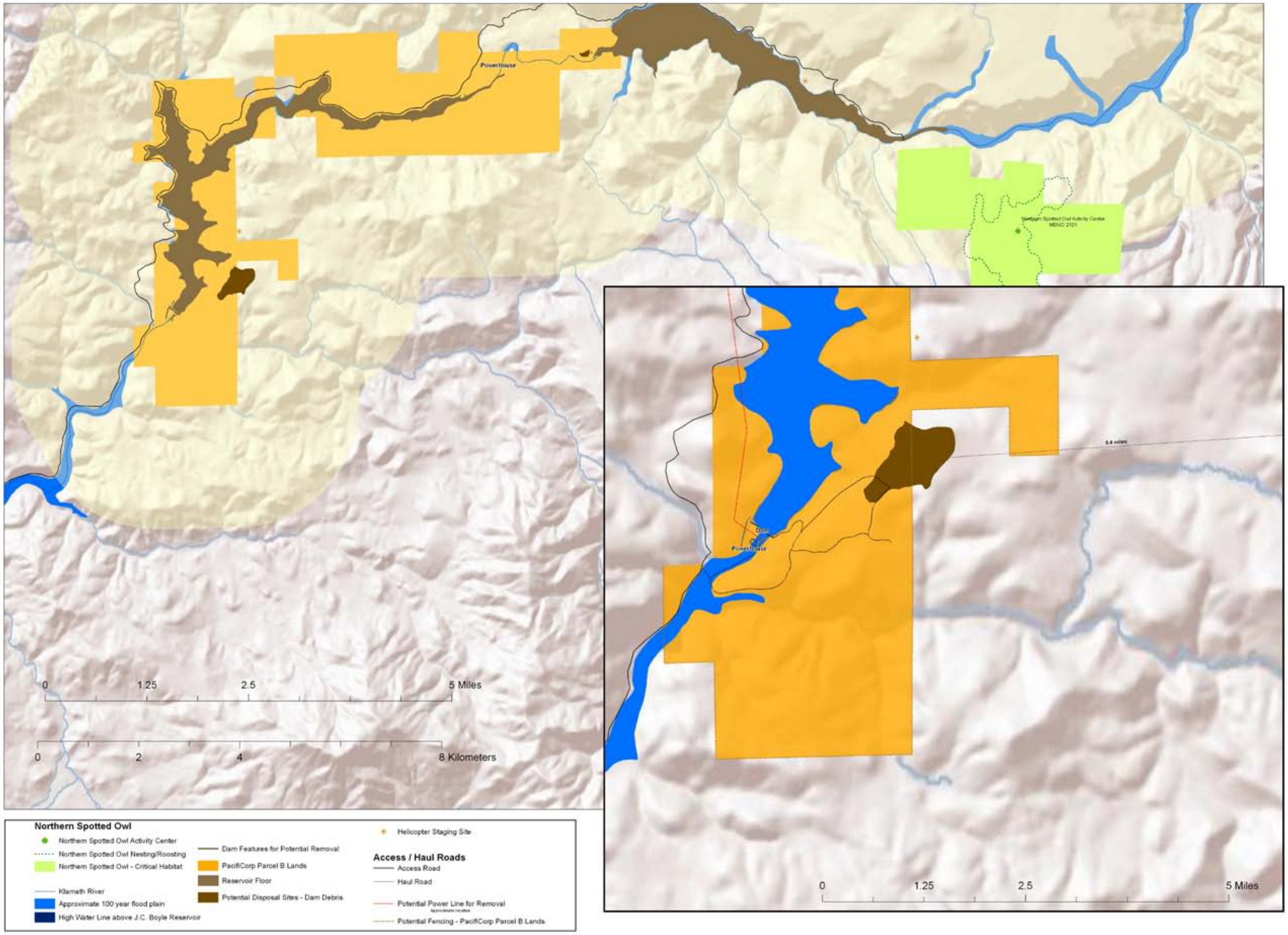


Figure 4-8. Northern Spotted Owl Activity Centers and Suitable Habitat near Iron Gate

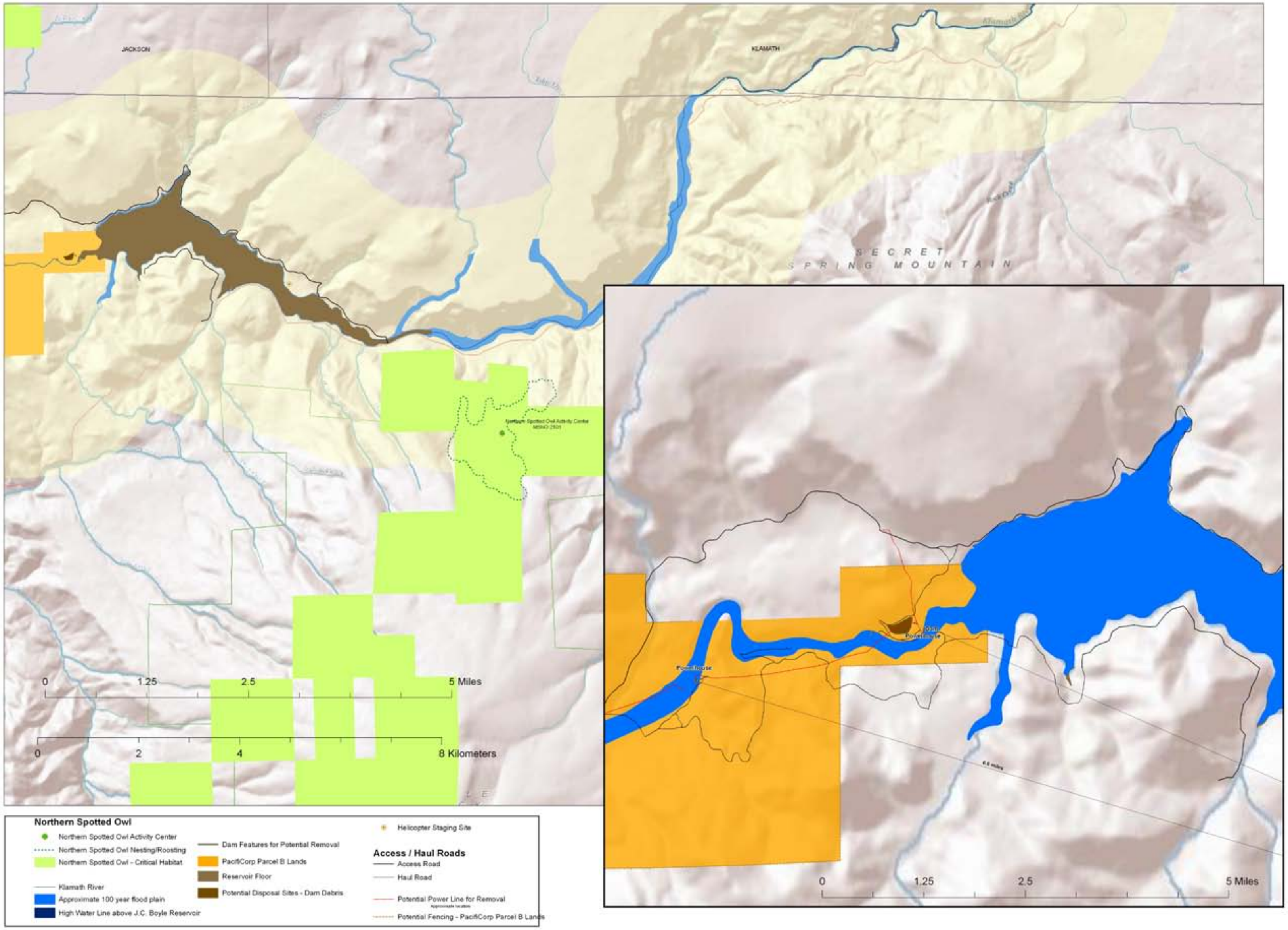


Figure 4-9. Northern Spotted Owl Activity Centers and Suitable Habitat near Copco

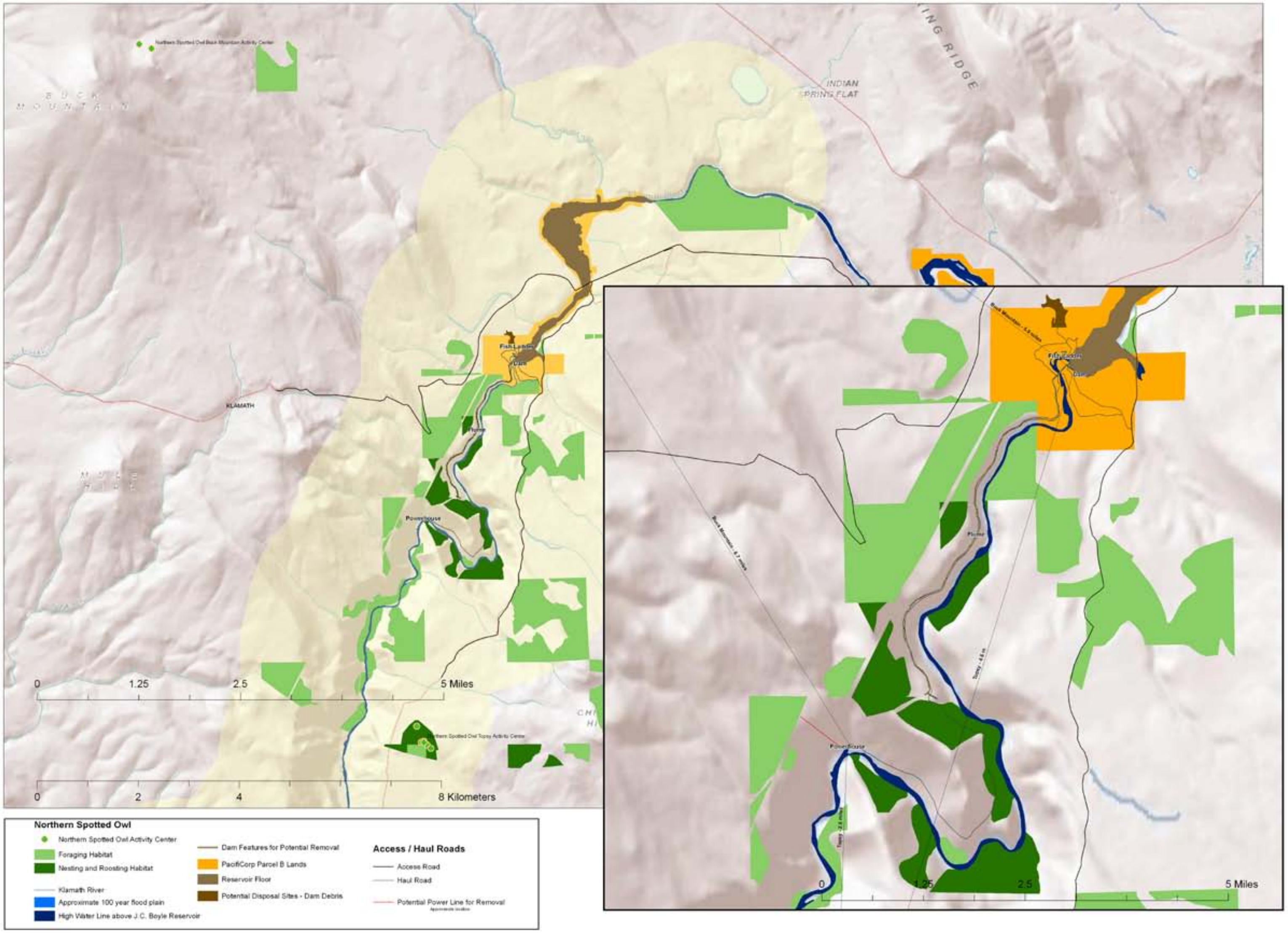


Figure 4-10. Northern Spotted Owl Suitable Habitat near J.C. Boyle

Table 4-7. Summary of Current Northern Spotted Owl Habitat and Activity Centers between IGD and J.C. Boyle Reservoir

Construction area	Northern spotted owl habitat and activity centers
IGD and associated construction areas	• No suitable nesting, roosting, or foraging habitat is present (Oakley Consulting 2011). • No activity centers (pers. comm. Lynn Roberts, USFWS Fish and Wildlife Biologist, Arcata office, July 26 2011).
Copco 1 Dam and associated construction areas	• The only suitable nesting and roosting habitat identified by Oakley Consulting (2011) is located about 8 km (5 mi) east of Copco 1 Dam and about 4.0 km (2.5 mi) southeast of the Copco Reservoir and is mostly included within the designated critical habitat (Figure 4-9). This suitable habitat is identified as Montane Hardwood Oak and includes mixed conifer in the steep north facing canyon area that grades into ponderosa pine and oak woodland habitat to the west and the north (Oakley Consulting 2011). The critical habitat between the Copco 1 Reservoir and mapped suitable nesting and roosting habitat is not identified as suitable nesting and roosting habitat (L. Finley, USFWS Yreka Fish and Wildlife Office, pers comm. September 8, 2011). Suitable habitat is present north of Copco dam sites in Oregon (greater than 3.2 km (2 mi) away, which is located primarily on BLM land and is in small 16–24 ha (40–60 ac) patchs. • One activity center is located in the suitable habitat east of Copco 1 Dam described above. The status of this northern spotted owl activity center (termed Lucky Owl) Master Site Number 2191 is active with a pair and 2 fledgelings in 2010 (Figure 4-9). PacifiCorp 2002 and 2003 surveys resulted in four detections south of the Klamath River, upstream of Copco Reservoir (Klamath Facilities Removal EIS/EIR), which appear to be consistant with Master Site Number 2191 (L. Finley, USFWS Yreka Fish and Wildlife Office, pers comm., July 5, 2011).
Copco 2 Dam and associated areas	• Suitable habitat is described above for Copco 1 Dam. • Closest activity center is described above for Copco 1 Dam.
J.C. Boyle Dam and associated construction areas	• Suitable nesting/roosting and foraging habitat is present around the J.C. Boyle area (E. Willy, Biologist, USFWS Klamath Office, pers. comm., August 3, 2011). Foraging habitat is located about 0.4 km (0.2 mi) from J.C. Boyle Dam and within Parcel B lands and suitable nesting and roosting habitat is present adjacent to J.C. Boyle haul route (Figure 4-10). There is no critical habitat within 16 km (10 mi) of the J.C. Boyle area • There are two activity centers located within 6.4 km (4.0 mi) of J.C. Boyle Dam. Master Site Number 1306 (known as Buck Mountain) is located about 9.5 km (5.9 mi) north west of J.C. Boyle Dam. The owl pair was last detected reproducing in 2007, but has not been observed in recent surveys. Master Site Number 2388; known as Topsy) is located about 7.5 km (4.6 mi) southwest of J.C. Boyle Dam. Recent surveys indicated this site was occupied by a single male in 2005 and 2006, was not occupied in 2007, 2008, and 2009, and 2011 surveys are currently in progress (Elizabeth Willy, USFWS Fish and Wildlife Biologist, Klamath Office, pers. comm., 3 August 2011). PacifiCorp surveys resulted in two detections near the J.C. Boyle Powerhouse and one just north of the Klamath River downstream of the J.C. Boyle Powerhouse in 2003 (Klamath Facilities Removal EIS/EIR); however, specific information on the observations (e.g., behavior status and the status of reproduction) was not able to be verified.

Status of suitable habitat in the Action Area

The status of suitable habitat within the Action Area upstream of J.C. Boyle Reservoir and downstream of IGD is considered unsuitable within the 100-yr floodplain (L. Roberts, USFWS Arcata Field Office, pers comm., September 8, 2011). The majority of habitat surrounding Project features between IGD and J.C. Boyle Reservoir are considered unsuitable with only two areas containing suitable nesting and roosting habitat (1) south east of Copco 1 Reservoir and intersperced areas surrounding J.C. Boyle Dam (Figures 4-8 through 4-10) (Oakley Consulting 2011;and E. Willy, Biologist, USFWS Fish and Wildlife, pers. comm.). The majority of land within this area is owned by private or other entities (which include easements and tribal lands) and the BLM (Table 4-7).

Table 4-8. Land Ownership[1] within a 2.4-km (1.5-mi) Buffer along the Klamath River from IGD Upstream to the East Side of J.C. Boyle Reservoir

Land ownership[1]	Acres (%)
Private or other[2]	64,281 (75%)
BLM	17,293 (20%)
USDA Forest Service	2,543 (3%)
State agency	1,593 (2%)
Total	**85,710**

[1] Land ownership layer is BLM surface management data for Oregon and California

[2] Other lands include those not managed by state or federal agencies. Private lands include easements and tribal lands.

NSO populations are divided in to physiographic provinces, four of which are included within the Action Area: Eastern Oregon Cascades, California Cascades, California Klamath, and California Coast. In general, these provinces include poor distribution and quality of existing habitat and a high level of natural and manmade fragementation (USFWS 1998). Loss of NSO habitat within these provinces is most noticeable on federal lands as a result of harvest in the California Cascades and natural fire disturbance in the California Klamath physiographic province (Table 4-8) (USFWS 2011a)

Table 4-9. Northern Spotted Owl Habitat Loss on Federal Lands Resulting from Harvest and Natural Disturbances from 1994/96[1] to 2006/7[1] (acres) (adapted from Davis and Dugger in press, as cited in USFWS 2011a)

Physiographic provinces	1994/96 acres	Harvest acres (%)[2]	Natural disturbance			Total habitat loss (%)
			Wildfire	Insect and disease	Total (%)[2]	
Eastern Oregon Cascades	402,900	5,800 (1.4%)	17,800	2,300	20,100 (5.0%)	25,900 (6.4%)
California Coast	145,400	300 (0.2%)	2,100	100	2,200 (1.5%)	2,500 (1.7%)
California Cascades	213,200	6,500 (3.0%)	1,800	300	2,100 (1.0%)	8,600 (4.0%)
California Klamath	1,489,800	4,400 (0.3%)	71,6000	1,600	76,200 (4.9%)	77,600 (5.2%)

[1] 1996 and 2006 for Oregon and Washington, 1994 and 2007 for California.

[2] Percent of 1994/96 habitat.

Summary of the current viability

In July 1994, a total of 5,431 occupied spotted owl locations were known; however, because not all areas can or have been surveyed on an annual basis, the current range-wide status is unknown (USFWS 1995, USFWS 1992, Thomas et al. 1993, all as cited in USFWS 2010). Forsman et al. (2010) evaluated population trends using range-wide estimates of population size and demographic data for 11 study areas within Oregon, Washington, and California. The weighted mean estimate of λ for all 11 study areas was 0.971 (Standard Error = 0.007, 95% Confidence Interval = 0.960–0.983) indicating that between 1986 and 2006, the population declined 2.9% per year. Five of the 11 demographic study areas are located in northern California and southern Oregon. The populations in these areas are either stationary or declining (Table 4-9).

Table 4-10. Northern Spotted Owl Parameters from the Demographic Study Areas in Northern California and Southern Oregon (modified from USFWS 2010 and Forsman et al. 2010)

Demographic study area	Fecundity	Apparent survival[1]	λ_{RJS}[2] (SE; 95% CI)	Population change[3]
Klamath	Declining	Stable	0.990 (0.014; 0.962–1.017)	Stationary
Southern Cascades	Declining	Declining since 2000	0.982 (0.030; 0.923–1.040)	Stationary
NW California	Declining	Declining	0.983 (0.008; 0.968–0.998)	Declining
Hoopa	Stable	Declining since 2004	0.989 (0.013; 0.963–1.014)	Stationary
Green Diamond	Declining	Declining	0.972 (0.007; 0.960–0.983)	Declining

[1] Based on modeled average.
[2] Re-parameterized Jolly-Seber method.
[3] Based on estimates of realized population change.

4.2.2.8 Steller (=northern) Sea Lion (*Eumetopias jubatus)*

Species status

The Steller sea lion, also known as the northern sea lion, eastern DPS was federally listed as threatened in 1990 due to significant population declines (55 FR 49204). After further population declines in Alaska, NMFS evaluated new genetic information that revealed two distinct population structures. NMFS classified the western DPS as endangered while keeping the eastern DPS as threatened (NMFS 2008c). The species that may be affected by the Proposed Action and is further evaluated is the eastern DPS.

Critical habitat

Critical habitat includes an air zone that extends 3,000 feet (0.9 km) above areas historically occupied by sea lions at each major rookery in California and Oregon, measured vertically from sea level. Critical habitat includes an aquatic zone that extends 3,000 feet (0.9 km) seaward in State and Federally managed waters from the baseline or basepoint of each major rookery in California and Oregon.The closest designated critical habitat is at Pyramid Rock, located 105 km (65 mi) north of Klamath River Estuary, and Sugarloaf Island and Cape Mendocino, located about 125 km (80 mi) south of the Klamath River Estuary (Figure 4-11).

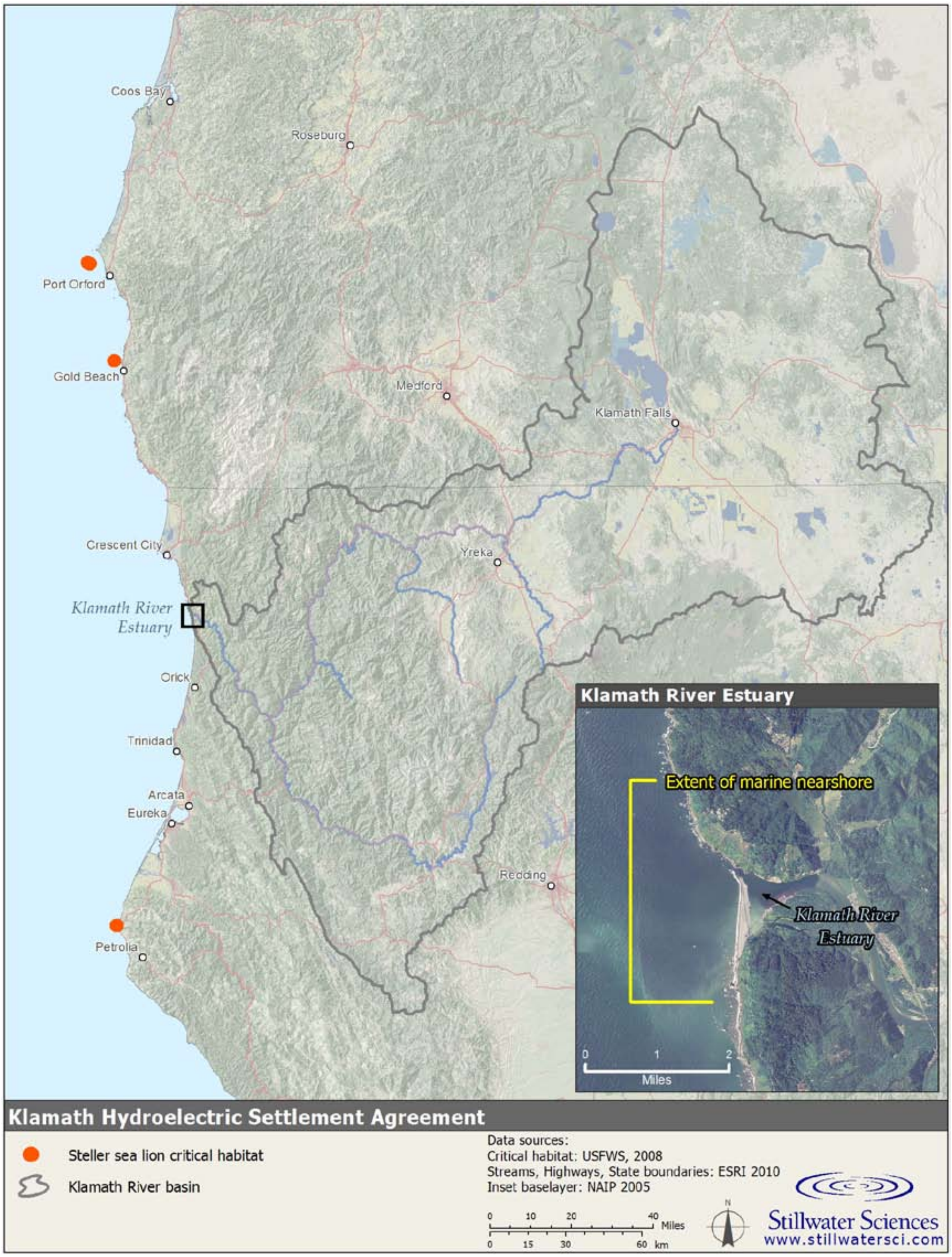


Figure 4-11. Steller Sea Lion Critical Habitat in the Vicinity of the Klamath River

Life history

Steller sea lions exhibit sexual dimorphism, in which adult males are noticeably larger than females and are further distinguished by a thick mane of coarse hair. Steller sea lions forage in near-shore and pelagic waters and are capable of traveling long distances in a season they can dive to approximately 1,300 ft in depth. They also use terrestrial habitat as haul-out sites for periods of rest, molting, and as rookeries for mating and pupping during the breeding season. At sea, they are seen alone or in small groups, but may gather in large "rafts" at the surface near rookeries and haul outs. This species is capable of powerful vocalizations that are accompanied by a vertical head bobbing motion by males. Steller sea lions are opportunistic predators, foraging and feeding primarily at night on a wide variety of fishes (e.g., capelin, cod, herring, mackerel, pollock, rockfish, salmon, sand lance, etc.), bivalves, cephalopods (e.g., squid and octopus) and gastropods. Their diet may vary seasonally depending on the abundance and distribution of prey. They may disperse and range far distances to find prey, but are not known to migrate (NMFS 2011).

Steller sea lions are colonial breeders. Adult males, also known as bulls, establish and defend territories on rookeries to mate with females. Bulls become sexually mature between 3 and 8 years of age, but typically are not large enough to hold territory successfully until 9 or 10 years old. Mature males may go without eating for 1–2 months while they are aggressively defending their territory. Females typically reproduce for the first time at 4 to 6 years of age, usually giving birth to a single pup each year. At birth, pups are about 3.3 ft in length and weigh 35–50 lbs. Adult females, also known as cows, stay with their pups for a few days after birth before beginning a regular routine of alternating foraging trips at sea with nursing their pups on land. Female Steller sea lions use smell and distinct vocalizations to recognize and create strong social bonds with their newborn pups. Males can live up to 20 years, while females can live up to 30 (NMFS 2011).

Geographic distribution

The current range of the eastern DPS extends from southeast Alaska, British Columbia, California, and Oregon within suitable habitat of haul-outs and rookeries, which usually consist of beaches (gravel, rocky or sand), ledges, and rocky reefs (NMFS 2011).

Threats

The most likely threats to the eastern DPS of Steller sea lion are development, increased disturbance and habitat destruction, increases in magnitude or distribution of commercial or recreation fisheries, entanglement in fishing gear and other marine debris, and environmental change (NMFS 2008c).

Steller sea lions’ direct and indirect interactions with fisheries are currently receiving significant attention and may possibly be an important factor in their decline. Direct impacts from fishing are largely due to fishing gear (drift and set gillnets, longlines, trawls, etc.) that has the potential to entangle, hook, injure, or kill sea lions. These pinnipeds have been seen entangled in fishing equipment with what are considered "serious injuries." Steller sea lions are also indirectly threatened by fisheries because they have to compete for food resources, and critical habitat may be modified by fishing activities (NMFS 2011).

NMFS has prepared a Steller seal lion recovery plan (NMFS 2008c). Protective zones, catch/harvest limits, various procedures, and other measures have been implemented around major haul-outs and rookeries in order to safeguard critical habitat (NMFS 2011). Many rookeries are located at remote sites and protected in parks, refuges, wilderness areas, and ecological reserves where further developments are unlikely or unsuitable (NMFS 2008c).

Status within the Action Area

There are no known rookeries, haul-outs, or designated critical habitat within the nearshore environment that may be affected by sediment releases. The status of rookeries within northern California and southern Oregon are provided in further detail under Summary of Current Viability.

Summary of the current viability

In California, Steller sea lions have been counted sporadically at the Sugarloaf/Cape Mendocino rookery and haulout during breeding seasons since 1927. Non-pup numbers appear to have been relatively stable, although highly variable, since 1996. The two highest counts were 900 in 1930 and 740 in 2001, suggesting that the current population is comparable to historical levels. Pups have been counted in recent years and numbers have increased (62 in 1996 to 131 in 2004) (NMFS 2008c).

The Saint George Reef rookery, located near the California/Oregon border, appears to be at a fairly high level relative to historical measures and counts of non-pups have been stable, although variable, since 1990. During 2004, 444 pups and 738 non-pups were counted at this site. Bonnot (1928) reported 1,500 Steller sea lions at Saint George Reef in 1927 and Bonnot and Ripley (1948) counted 700 animals in 1930. Pups have been counted since 1996 (except for 1997) and have increased (243 in 1996 to 444 in 2004) (NMFS 2008c).

In Oregon, Steller sea lions occupy two rookeries, located at Rogue Reef and Orford Reef, and eight haul-out sites. The total number of non-pup sea lions counted during the breeding season surveys at all of these sites has increased from 1,461 in 1977 to 4,169 in 2002 (Brown et al. 2002), an annual rate of increase of about 3.7%. Although not nearly as well documented, pup numbers also appear to have increased. In 1996, 685 and 335 pups were counted at Rouge Reef and Orford Reef respectively, whereas in 2002, 746 and 382 pups were counted at the two sites. Steller sea lion abundance (all age classes) in Oregon, based on 2002 pup counts at rookeries, was estimated at 5,076–5,753 animals. A total of 5,297 animals were actually counted during the 2002 surveys (NMFS 2008c).

4.2.2.9 Southern Resident DPS Killer Whale (*Orcinus orca*)

Species status

The Southern Resident DPS killer whale was listed as an endangered species on November 18, 2005 (70 FR 69903). Prior to the ESA listing, NMFS determined that the Southern Resident stock was below its optimum sustainable population and designated it as depleted under the Marine Mammal Protection Act (MMPA) in May 2003 (68 FR 31980) and a Proposed Conservation Plan was announced in 2005 (70 FR 57565).

Critical habitat

In November 2006, NMFS designated critical habitat for Southern Resident DPS killer whales. Based on the natural history of the Southern Residents and their habitat needs, the following physical or biological features were identified as essential to conservation: (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging. From observed sightings and other data, three “specific areas” were identified within the geographical area occupied by the species, containing important physical or biological features. The designated areas are: (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, which comprise approximately 2,560 square miles of marine habitat within the area occupied by Southern Resident DPS killer whales in Washington. Critical habitat includes all waters relative to a contiguous shoreline delimited by the line at a depth of 20 ft relative to extreme high water. Some of these areas overlap with military sites, which are not designated as critical habitat because they were determined to have national security impacts that outweigh the benefit of designation and are therefore excluded under ESA section 4(b)(2).

Critical habitat for Southern Resident DPS killer whales is not designated in California or the Action Area.

Life history

Killer whales are the world’s largest dolphin. The sexes show considerable size dimorphism, with males attaining maximum lengths and weights of 9.0 m and 5,568 kg, respectively, compared with 7.7 m and

3,810 kg for females (Dahlheim and Heyning 1999). Adult males develop larger pectoral flippers, dorsal fins, tail flukes, and girths than females (Clark and Odell 1999). Maximum life span is estimated to be 80–90 years for females and 50–60 years for males (Olesiuk et al. 1990). Animals are black dorsally and have a white ventral region extending from the chin and lower face to the belly and anal region. Each whale has a uniquely shaped and scarred dorsal fin and saddle patch, which permits animals to be recognized on an individual basis, as depicted in photo identification catalogs, such as those compiled for the northeastern Pacific region (e.g., Black et al. 1997, Dahlheim 1997, Dahlheim et al. 1997, van Ginneken et al. 1998, 2000, Matkin et al. 1999, Ford and Ellis 1999, Ford et al. 2000).

Most mating in the North Pacific is believed to occur from May to October (Nishiwaki 1972, Olesiuk et al. 1990, Matkin et al. 1997). However, small numbers of conceptions apparently happen year-round, as evidenced by births of calves in all months. Gestation periods in captive killer whales average about 17 months (Asper et al. 1988, Walker et al. 1988, Duffield et al. 1995). Mean interval between viable calves is four years (Bain 1990). Newborns measure 2.2–2.7 m long and weigh about 200 kg (Nishiwaki and Handa 1958, Olesiuk et al. 1990, Clark et al. 2000, Ford 2002). Calves remain close to their mothers during their first year of life, often swimming slightly behind and to the side of the mother's dorsal fin. Weaning age remains unknown, but nursing probably ends at 1–2 years of age (Haenel 1986, Kastelein et al. 2003). Mothers and offspring maintain highly stable social bonds throughout their lives and this natal relationship is the basis for the matrilineal social structure (Bigg et al. 1990, Baird 2000, Ford et al. 2000).

As top-level predators, killer whales feed on a variety of marine organisms ranging from fish to squid to other marine mammal species. Resident stocks primarily prey on fish, primarily salmon (96% of prey) and more specifically Chinook salmon (70% of salmon) (Ford et al. 1998, Ford and Ellis 2006). Other salmonids eaten in smaller amounts included chum (*O. keta*, 22% of the diet), pink (*O. gorbuscha*, 3%), coho (*O. kisutch*, 2%), and sockeye (*O. nerka*, <1%) salmon, and steelhead (*O. mykiss*, <1%) (Ford and Ellis 2006). Prey consumption rate of Chinook and chum salmon were calculated by Noren (2011) for the adult Southern Resident DPS killer whale population. Chinook and chum salmon were used because they are the most prevalent salmon species in the diet of Southern Resident DPS killer whales. When only subsiding on Chinook, the daily consumption rate is from 9–12 fish/day. Fish consumption increased significantly to 41–49 fish/day when the population consumed only chum. These rates are consistent with Osborne's (1999) estimated 28–34 salmon/day based on the average size of all five salmon species. Extrapolation of these estimates indicates that a Southern Resident population of 82 whales would eat 289,131–347,000 Chinook/yr or 1,222,003–1,466,581 chum/yr (Noren 2011). This does not, however, account for any other prey species and is therefore likely an overestimate of potential salmon consumption.

Geographic distribution

Killer whales occur in all oceans, but are generally most common in coastal waters and at higher latitudes, with fewer sightings from tropical regions (Dahlheim and Heyning 1999, Forney and Wade 2007). In the North Pacific, killer whales occur in waters off Alaska, including the Aleutian Islands and Bering Sea (Murie 1959, Braham and Dahlheim 1982, Dahlheim 1994, Matkin and Saulitis 1994, Miyashita et al. 1995, Dahlheim 1997, Waite et al. 2002), and range southward along the North American coast and continental slope (Norris and Prescott 1961, Fiscus and Niggol 1965, Gilmore 1976, Dahlheim et al. 1982, Black et al. 1997, Guerrero-Ruiz et al. 1998). Populations are also present along the northeastern coast of Asia from eastern Russia to southern China (Zenkovich 1938, Tomilin 1957, Nishiwaki and Handa 1958, Kasuya 1971, Wang 1985, Miyashita et al. 1995). Northward occurrence in this region extends into the Chukchi and Beaufort seas (Ivashin and Votrogov 1981, Lowry et al. 1987, Matkin and Saulitis 1994, Melnikov and Zagrebin 2005). Sightings are generally infrequent to rare across the tropical Pacific, extending from Central and South America (Dahlheim et al. 1982, Wade and Gerrodette 1993, García-Godos 2004) westward to much of the Indo-Pacific region (Tomich 1986, Eldredge 1991, Miyashita et al. 1995, Reeves et al. 1999, Visser and Bonoccorso 2003, Baird et al. 2006, Forney and

Wade 2007). Killer whales occur broadly in the world's other oceans, with the exception of the Arctic Ocean (Miyashita et al. 1995, Dahlheim and Heyning 1999, Forney and Wade 2007).

Three distinct forms of killer whales, termed as residents, transients, and offshores, are recognized in the northeastern Pacific Ocean. Although there is considerable overlap in their ranges, these forms display significant genetic differences due to a lack of interchange between member animals (Stevens et al. 1989, Hoelzel and Dover 1991, Hoelzel et al. 1998, Barrett-Lennard 2000, Barrett-Lennard and Ellis 2001, Krahn et al. 2004). Important differences in ecology, behavior, morphology, and acoustics also exist (Baird 2000, Ford et al. 2000).

Resident killer whales in the U.S. are distributed from California to Alaska, with four distinct communities recognized: Southern, Northern, Southern Alaska, and Western Alaska. In addition, the presence of resident killer whales has been documented off the coast of Russia (Krahn et al. 2002, 2004). The Southern Resident DPS killer whales consists of three pods, identified as J, K, and L pods. 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 (Heimlich-Boran 1988, Felleman et al. 1991, Olson 1998, Osborne 1999, Ford et al. 2000, Krahn et al. 2002). Pods visit coastal sites off Washington and Vancouver Island (Ford et al. 2000), but travel as far south as central California and as far north as the Queen Charlotte Islands. Offshore movements and distribution are largely unknown for the Southern Resident DPS killer whale.

Threats

The NMFS 2008 Recovery Plan for Southern Resident DPS killer whales cites three primary factors that threaten this species: toxic pollution, vessel activity and sound, and the quantity and quality of prey (NMFS 2008d).

Southern resident DPS killer whale survival and fecundity are correlated with Chinook salmon abundance (Ward et al. 2009, Ford et al. 2009). Many salmon populations are themselves at risk, with 9 ESUs of Chinook salmon listed as threatened or endangered under the ESA. Hanson et al. (2010) found that Southern Resident DPS killer whale stomach contents included several different ESUs of salmon, including Central Valley fall-run Chinook salmon. The population of Southern Resident DPS killer whales experienced a dramatic decline in the mid-1990s, and as a consequence was listed as Endangered under the ESA in 2005.

Status in the Action Area

Southern resident killer whales are not expected to occur in the action area. As previously described, they primarily occur in the inland waters of Washington state and southern Vancouver Island, although individuals from this population have been observed off coastal California in Monterey Bay, near the Farallon Islands, and off Point Reyes (NMFS 2008d). Southern resident killer whale survival and fecundity are correlated with Chinook salmon abundance (Ward et al. 2009, Ford et al. 2009). Many salmon populations are themselves at risk, with 9 ESUs of Chinook salmon listed as threatened or endangered under the ESA.

5 EFFECTS OF THE PROPOSED ACTION ON LISTED SPECIES AND CRITICAL HABITAT

5.1 Proposed Action

As stated in Section 1, the Proposed Action is limited to the full facilitiy removal of the four lower dams (J.C. Boyle, Copco 1 and 2, and Iron Gate) and related appurtenances on the Klamath River. In general, removal of these dams will require reservoir drawdown, demolition of the dams and associated facilities, waste disposal, reservoir revegetation, and implementation of conservation measures (refer to Section 2). Each of these actions has the potential to affect one or more of the listed species discussed in this BA. However, not all of the proposed activities will affect all species. Therefore, the following “Effects” section will assess each species individually for only those project actions that have the potential to affect one or more individuals of that species. In addition, an analysis of effects on the PCE of each species critical habitat will be assessed.

Full facility removal would result in the release of 1.2–2.9 million metric tons of fine sediment stored in the reservoirs into the Klamath River downstream of IGD (Reclamation 2011b), resulting in higher SSCs than would normally occur under existing conditions (Figure 5-1) and local, short-term sediment deposition. SSC would begin to increase during reservoir drawdown, prior to the deconstruction of the dams and continue to rise through the spring runoff period as material behind the dams is mobilized downstream. Reservoir drawdown is expected to commence in January 2020. Based on the suspended sediment modeling conducted to analyze each alternative (including facility removal), SSCs are expected to exceed 1,000 mg/L for weeks, with the potential for peak concentrations exceeding 5,000 mg/L for hours or days, depending on hydrologic conditions during facility removal (Reclamation 2011b). The transport of this suspended sediment load is expected to affect coho salmon and other native fish species in various ways.

The effects of the Proposed Action on terrestrial wildlife species are expected to be primarily due to noise disturbance that will occur during the actual dam demolition. Noise disturbance would result from heavy equipment operations or blasting. The NSO is the only federally-listed terrestrial wildlife species that could be affected by noise disturbance in the vicinity of the four dams.

5.1.1 Bull Trout

Bull trout inhabit the cold headwaters of UKL tributaries and as such are upstream of the hydroelectric reach. However, bull trout may be affected by anadromous salmonids that would have the opportunity to recolonize UKL tributaries once the Four Facilities are removed. These effects would center on predation, the potentialfor introduction of disease and pathogens transmission, potential for interspecific competition for food and space, and the restoration of marine-derived nutrients to the system.

5.1.1.1 Short-Term Effects

Bull trout do not inhabit mainstem river reaches or tributary streams within or downstream of the IGD. **Therefore, reservoir drawdown or dam removal activities will have no effect on bull trout in the short-term.**

5.1.1.2 Long-Term Effects

Predation effects

The Proposed Action would result in the reintroduction of anadromous salmon into the tributaries to UKL, specifically Long Creek and a short section of Boulder Creek, where they could interact with bull trout. Because of this, bull trout could be affected by increased predation from reintroduced salmonids. However, this effect would not occur due to introduced Chinook or coho salmon because these species do not feed during their spawning migrations. The effect may be limited to steelhead, which may occupy bull trout habitat and are known to prey on a variety of food resources including eggs and fry of other fish.

Age 0 bull trout rear in shallow, low velocity stream margin habitats during the summer. An advantage to rearing in edgewaters is avoidance of larger piscivorous bull trout and other aquatic predators.

In general, juvenile and sub-adult fluvial and adfluvial bull trout start to migrate to larger river or lake habitats after age 2 or 3 and begin feeding on larger prey with fish becoming an increasing part of their diets (Pratt 1992, Ratliff and Howell 1992). Fraley and Shepard (1989) found that bull trout greater than 110 mm in the upper Flathead River consumed small trout and sculpin. Underwood et al. (1995) found bull trout (less than 200 mm) from three southeast Washington streams feeding on a wide range of food sources including mayfly nymphs, midge larva, rainbow trout, and frogs.

Ratliff et al. (1996) found that some of the age 2 and older bull trout in the Metolius River system did not continue to disperse downstream from early juvenile rearing habitats, but instead moved into adjacent warmer tributaries not utilized by bull trout for spawning. Ratliff et al. (1996) suggested that bull trout movement into these warmer tributaries was apparently for feeding opportunities on abundant sculpin. Goetz et al. (2004) considered large adult, migratory bull trout to be “apex predators” that feed opportunistically, based on what food items are most available at any one time or location. This may include cannibalism of other bull trout by larger adults (Beauchamp and Van Tassel 2001, Spangler and Scarnecchia 2001). Bull trout would be expected to benefit from the increase in food resources provided by anadromous salmonid eggs, fry, and juveniles.

Steelhead spawn in the spring, emerge from the substrate later that same year and spawn in slightly different stream gradients than bull trout. Upon emergence, they would be too small (i.e. gape limited) to feed upon small bull trout that emerged earlier and that would be larger in size than larval steelhead. Juvenile steelhead have a flexible life history pattern and can spend 1 to 3 years in freshwater prior to outmigrating to the ocean; juveniles distribute themselves widely and many move into main stem riverine systems as they rear (NRC 2004), limiting the spatial overlap between species and potential for predation on small bull trout. **Therefore, increases in predatory pressures by anadromous salmonids as a result of the the Proposed Action may affect, but is not likely to adversely affect bull trout populations.**

Potential for introduction of disease and pathogens

In the Klamath River, *P. minibicornis* and *C. shasta* share the same invertebrate host: an annelid polychaete worm, *Manayunkia speciosa* (Bartholomew et al. 2006, Bartholomew et al. 1997). The invertebrate host for the parasite is present in a variety of habitat types, including runs, pools, riffles, edge-water, and reservoir inflow zones, as well as sand, gravel, boulders, bedrock, aquatic vegetation, and is frequently present with a periphyton species: *Cladophora* (a type of algae) (Bartholomew and Foott 2010). Slow-flowing habitats may have higher densities of polychaetes, and areas that are more resistant to disturbance, such as eddies and pools with sand and *Cladophora*, may support increased densities of polychaete populations (Bartholomew and Foott 2010), especially if flow disturbance events are reduced or attenuated.

Observations below IGD indicate *C. shasta* has the potential to infect large portions of salmonid populations and cause significant mortality. If salmon spawning migrations were to occur above IGD, an upriver infectious nidus for *C. shasta* may be created similar to the one that currently occurs below IGD where spawning congregations occur. The likelihood of this happening is unknown. While *C. shasta* has been detected above IGD in the lower Williamson River (a tributary of UKL) and in areas below IGD in nearly equal levels, the effects on fish have differed between these two areas. Results from the pathogen exposure portion of a study (Maule et al. 2009) demonstrate that *C. shasta* was present in the Williamson River and abundant. Historically, *C. shasta* occurred and continues to be present in the upper basin and resident fish above the dams evolved with these parasites. Historically, anadromous fish and their associated pathogens migrated to the upper Klamath Basin and available information suggests that the likelihood of introducing new pathogens that would affect existing populations is minimal (Bartholomew 1998, Bartholomew and Courter 2007, Stocking and Bartholomew 2007).

Columnaris and Ich are ubiquitous in freshwater systems, and both are present throughout the Klamath River system above and below IGD. Removal of dams would reduce or eliminate populations of warmwater fish associated with existing reservoirs that are potential hosts to *columnaris* and Ich. Generally, with the exception of *columnaris* and Ich, pathogens associated with anadromous fish do not impact non-salmonids, including federally listed suckers (Administrative Law Judge 2006). Whirling disease, another myxozoan parasite spreading in the West in recent decades, is absent from the Klamath River (S. Foott, Service, pers. comm.) and sampling has found no evidence of the disease in the upper Klamath watershed streams (C. Banner, ODFW, pers. comm.).

IHN is uncommon in the Klamath River and the type of IHN present in coastal California is not virulent to trout species, only Chinook salmon (direct testimony of J. Scott Foott, Project Leader of the California-Nevada Fish Health Center in [Administrative Law Judge 2006]). FERC concluded there is a slight risk of transmission of disease IHN to upper watershed (FERC 2007). Because of its low levels, *R. salmoniranrum*, the causative agent of bacterial kidney disease in salmon, does not appear to pose a significant risk of disease in the salmonid population in the Klamath River system, and consequently the bacteria will not pose a significant threat to fish in the upper basin (Administrative Law Judge 2006). Similarly, parasitic *trematode metacercaria* of *Nanophyetus salminicola*, the host to the Rickettsia bacterium that causes salmon poisoning in canines, is present in many juvenile and adult salmon. However, they do not appear to present a significant health threat to resident fish in the upper Klamath Basin. Because a majority of the pathogens currently found in the lower basin also exist in the upper basin of the Klamath River system, a logical conclusion is that migration of anadromous fish above IGD would not be a significant factor contributing to disease for resident fish (Administrative Law Judge 2006).

Bull trout may be at risk if pathogens present downstream of IGD were not present in the Upper Klamath basin. **However, based on the presence of the same pathogens upstream and downstream of IGD and the evolution of bull trout in the presence of these pathogens, the reintroduction of anadromous salmonids upstream of IGD may affect, but is not likely to adversely affect bull trout.**

Interspecific competition for food and space

Dam removal will eventually provide access for anadromous salmonids to Long and Boulder creeks where bull trout currently exist. Sub-adult and adult bull trout and anadromous salmonids have the potential to spatially overlap during bull trout feeding, migration, and overwintering habitat, rather than spawning and rearing habitat. In these areas and during these periods, there may some potential for interspecific competition for food resources and space.

There would be no competition for food resources between bull trout and Chinook salmon because adult salmon do not feed during spawning migrations. In addition, bull trout spawn in headwater locations with stream gradients greater than 4 percent, whereas Chinook salmon spawn in gradients less than 4 percent (Davies et. al. 2007). Furthermore, Chinook salmon spawn in larger and deeper streams than that preferred by bull trout, as a result, competition for food resources and space would be limited due to minimal spatial overlap. Steelhead and bull trout do not spawn during the same time so there would be insignificant competition for available spawning habitat. **As a result, competition for food resources**

and space due tothe reintroduction of anadromous salmonids may affect but is not likely to adversely affect bull trout.

Marine-derived nutrients (MDNs)
Dam removal would reintroduce anadromous salmonids to the Long and Boulder creeks where bull trout currently exist, and would likely provide a beneficial effect in prey base for bull trout by increasing the amount of eggs, fry, juveniles, and carcasses that bull trout may feed. Increased bull trout productivity could result from the addition of these MDNs. **As a result, the addition of MDNs due to the reintroduction of anadromous salmonids into Long and Boulder creeks may affect but is not likely to adversely affect bull trout.**

5.1.1.3 Critical Habitat

Bull trout critical habitat is not designated in the Hydroelectric Reach. However, food resources are a PCE of bull trout critical habitat, which is located in the UKL and its tributaries. The reintroduction of Chinook salmon into bull trout habitat will result in increased food resources (Chinook salmon eggs, fry, smolts) for bull trout. This would result in a beneficial effect on bull trout’s food resources. **Therefore, the reintroduction of anadromous salmonids upstream of UKL may result in a beneficial effect on bull trout critical habitat. As a result, reintroduction of anadromous salmonids upstream of UKL may affect, but is unlikely to adversely affect bull trout critical habitat.**

5.1.2 Lost River and Shortnose Suckers

The Lost River and shortnose suckers are native to UKL and its tributaries. Historically, these species were not known to, and likely did not, occupy riverine habitat below Keno Reservoir (Hamilton et al. 2011). Shortnose sucker is the only lake sucker that occurs in abundance in the Klamath drainage below Keno, and adults have consistently been collected in all three reservoirs. Lost River suckers are present in all three reservoirs, but only in low abundance (USFWS 2002c). These species would be affected by the elimination of lake habitat that would occur from the drawdown and removal of dams. In addition, the capture and relocation of individuals from the reservoirs to UKL may result in the injury or mortality of some individuals.

5.1.2.1 Short-Term Effects

FERC concluded that removal of the mainstem dams would eliminate existing habitat for adult shortnose and Lost River suckers in the project reservoirs (FERC 2007). In addition, drawdown of the reservoirs and conversion to a free-flowing river is expected to result in the near total mortality of individuals of these species in the reservoirs. However, given existing information, the USFWS does not consider reservoir populations and habitat below Keno Dam as contributing significantly to sucker recovery (Hamilton et al. 2011). Analysis by FERC suggests that the population of Lost River and shortnose suckers in Copco Reservoir is supported primarily by the downstream movement of juvenile and adult suckers from UKL and J.C. Boyle Reservoir (FERC 2007).

Those Lost River and shortnose suckers not relocated to the Upper Basin prior to reservoir drawdown would likely be lost, but with little or no successful reproduction (Buettner et al. 2006), and no connection to upstream populations, the individuals downstream of Keno Dam contribute minimally to conservation goals or significantly to recovery (Hamilton et al. 2011). Even though they may not contribute to upstream populations, individuals of these species will be lost due to reservoir drawdown and dam removal. **Therefore, the Proposed Action may affect and is likely to adversely affect Lost River and shortnose suckers in the short-term.**

5.1.2.2 Long-Term Effects

The removal of the Four Facilities will eliminate all Lost River and shortnose sucker habitat downstream of Keno Dam. This will result in a long-term reduction in usable habitat for these species. In addition, those Lost River and shortnose suckers not relocated to the Upper Basin prior to reservoir drawdown will likely suffer 100% mortality. Even though suckers in the Four Facilities' reservoirs experience little or no successful reproduction (Buettner et al. 2006), have no connection to upstream populations, and the individuals downstream of Keno Dam contribute minimally to conservation goals or significantly to recovery (Hamilton et al. 2011), there would still be a long-term loss to their populations. **Therefore, the removal of the Four Facilities may affect and is likely to adversely affect Lost River and shortnose suckers in the long-term**.

5.1.2.3 Conservation Measures

To help mitigate impacts on Lost River and shortnose suckers, a rescue and relocation program will be implemented prior to reservoir drawdown. This conservation measure would target adult suckers, which would preserve breeding stock to augment the populations in UKL. Juveniles would not be targeted due to the difficulty of identifying Lost River and shortnose suckers from the Klamath smallscale sucker. The Klamath smallscale sucker does not inhabit UKL and it is inadvisable to introduce them into unoccupied habitat.

The Proposed Action also includes development and implementation of a 2- to 3-year radio tagging and telemetry study that focuses on Lost River and shortnose suckers in the Hydroelectric Reach. This study would be implemented prior to reservoir drawdown. The purpose of the study is to identify preferred habitat and congregations of suckers in the reservoirs. This information will be used to better target heavy fish use areas and maximize salvage of suckers prior to reservoir drawdown.

Congregations of Lost River and shortnose suckers would be captured using electrofishing and trammel nets. Capture, handling, holding, and transport of captured suckers would be conducted according to the *"Fish Handling Guidelines for Salvaged and Transported Klamath Basin Suckers"* (Reclamation 2008). Captured Lost River and shortnose suckers could then be placed in aerated tank trucks and transported to suitable release sites in UKL. A detailed plan describing sucker rescue and relocation would be developed by the DRE prior to 2019.

It is expected that implementation of this conservation measure would reduce the deleterious short-term effects from the Proposed Action. However, the capture and relocation effort itself may result in a low level of injury or mortality of captured stock. Courter et al. (2010) observed a delayed mortality rate of 3.4% (14 fish) in adult suckers that were relocated into UKL following capture in Tule Lake. In addition, it is not known how many suckers inhabit the Hydroelectric Reach reservoirs; therefore it is unknown what proportion of the population would be captured and successfully relocated.

Even though there may be injury or mortality to individual suckers associated with this conservation measure, it would save fish that would otherwise be lost during the reservoir drawdown and dam removal. **Therefore, implementation of this measure may affect and is likely to adversely affect Lost River and shortnose suckers in the short-term. However, relocation of captured suckers into UKL and tributary streams would increase spawning populations in this area and would be a beneficial effect in the long-term.**

5.1.2.4 Critical Habitat

The PCEs identified in the critical habitat proposal for SNS and LRS are: 1) *Water.* Water of sufficient quantity, depth, and suitable quality; 2) *Spawning and rearing habitat.* Adequate substrate and stream velocity for spawning, emergent vegetation adjacent to open water for rearing habitat, and protection from predation, currents, and turbulence; and 3) *Food.* Abundant forage base (76 FR 76342).

Only the Upper Klamath Lake Units for SNS and LRS proposed critical habitat occurs within the Proposed Action area. Proposed critical habitat for SNS and LRS does not include areas downstream of Keno Dam, including the Hydroelectric Reach. The Proposed Action will have no effect on PCE 1 and PCE 2 listed above. Reintroduction of anadromous salmonids in UKL could have an indirect beneficial effect on PCE 3 by restoring MDNs into the watershed and could increase primary productivity (USFWS 2007a). **Therefore, implementation of the Proposed Action may affect, but is not likely to adversely affect SNS and LRS Upper Klamath Lake Unit proposed critical habitat, respectively**.

5.1.3 Southern DPS Green Sturgeon

Potential effects of the Proposed Action on this species would be limited to the Klamath River estuary and nearshore environment, because the southern DPS green sturgeon are only known to occupy this area during summer and fall for feeding. The only exposure this species would have to the Proposed Action is a short-term degradation of water quality due to increased SSC in the estuary during reservoir drawdown and dam removal and potential effects of sediment-borne contaminents on critical habitat.

5.1.3.1 Short-Term Effects

Under existing conditions, SSC within the Klamath River estuary is relatively high (Figure 5-1). The lower Klamath River downstream of the Trinity River confluence (RM 40.0) to the estuary mouth (RM 0.0) is currently listed as sediment impaired under Section 303(d) of the CWA, as related to protection of the cold freshwater habitat beneficial use associated with salmonids (SWRCB 2006, NCRWQCB 2010). Under the Proposed Action, sediment would be released from IGD, and would decline in concentration in the downstream direction as a result of flow accretion from tributaries. As a result, the magnitude of SSC from the Proposed Action relative to existing conditions is at its lowest level in the Klamath River estuary. Modeling (Reclamation 2011b) indicates that under the most likely to occur and worst-case scenarios (50% and 10% exceedance concentrations, respectively), the Proposed Action would result in July to September of 2020 SSC at Klamath Station exceeding what would be expected to occur naturally under extreme conditions (once every ten years on average). Under the worst case proposed action scenario, SSC would be approximately 5–30 mg/L higher during the summer months than under existing conditions (Figure 5-1) and return to background levels in Ocotber of 2020.

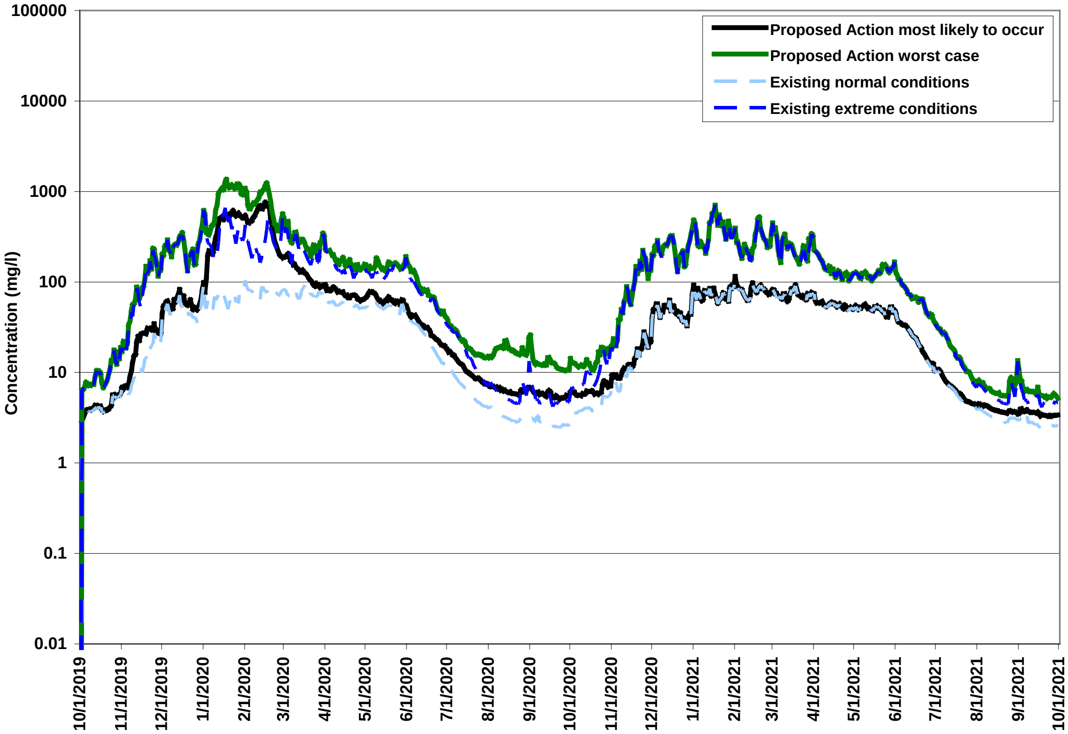


Figure 5-1. Comparison of SSC at Klamath Station (RM 5) Under Current Operations and the Proposed Action, as Predicted using SRH-1D Model

Garakouei et al. (2009) conducted a laboratory analysis of fingerling sturgeons' response to SSC. The species used in the study were *Acipenser persicus* and *A. stellatus*, both native to the Caspian Sea and found in Iran. The authors found that these sturgeon fingerlings were more sensitive than fingerling salmonids to elevated suspended sediment levels. Cherr and Clark (2005), as reported in Garakouei et al. (2009), stated that sturgeons require muddy water during spawning to prevent adhesion and deformation of eggs, which indicates that adult sturgeon may be more tolerant of suspended sediment than fingerlings. Adult southern DPS green sturgeon, not fingerlings, would be the life stage that would enter the Klamath River estuary during the summer and fall period. Fingerlings would be found in the Sacramento River where they would stay for one to three years.

Adult Southern DPS green sturgeon would not be in the estuary until the summer and fall. Therefore, Southern DPS green sturgeon would not be exposed to elevated SSC resulting from the initial winter/spring period drawdown. The summer time worst case SSC would be higher than existing conditions, however, green sturgeon are not sight feeders and generally feed on benthic organisms detected in fine sediments by their sensitive barbells. This trait would likely reduce the impacts of suspended sedimentation on the species in terms of feeding ability (Environmental Protection Information Center [EPIC] et al. 2001, as cited in California Department of Water Resources [CDWR] 2003). Adult sturgeon may also be more tolerant of turbid water since they require it for egg laying. In addition, only a small proportion, if any, of the total Southern DPS green sturgeon population would be expected to use the Klamath River estuary in 2020, further minimizing the potential for any short-term impacts related to the project. **Therefore, the Proposed Action may affect, but is not likely to adversely affect the southern DPS green sturgeon in the short-term**.

5.1.3.2 Long-Term Effects

In the long-term, conditions in the estuary are not expected to be significantly different than the current condition. The benefits of a more natural water temperature, flow, and sediment transport regime are not expected to extend to the estuary, or at least be greatly diminished due to accretion flow from the many tributaries upstream. **Therefore, the Proposed Action may affect, but is not likely to adversely affect the Southern DPS green sturgeon in the long-term.**

5.1.3.3 Southern DPS Green Sturgeon Critical Habitat

The Klamath River estuary is not designated as critical habitat for the Southern DPS green sturgeon. However, the nearshore area beyond about one mile area north, south, and offshore of the mouth of the river is considered critical habitat.

As stated in 74 FR 52300, the specific PCEs essential for the conservation of the Southern DPS green sturgeon in coastal marine areas include:

- *Migratory corridor.* A migratory pathway necessary for the safe and PCE of sediment timely passage of Southern DPS fish within marine and between estuarine and marine habitats.
- *Food resources.* Abundant prey items for subadults and adults, which may include benthic invertebrates (crabs, clams, shrimp) and fish.
- *Water quality.* Coastal marine waters with adequate dissolved oxygen levels and acceptably low levels of contaminants (e.g., pesticides, poly-aromatic hydrocarbons, heavy metals that may disrupt the normal behavior, growth, and viability of subadult and adult green sturgeon).

The migratory pathway for green sturgeon is in the nearshore and deep offshore ocean environment. The Proposed Action will not hinder migration for this species within this species’ critical habitat.

A considerable amount of fine sediment in the plume is anticipated to initially deposit on the seafloor shoreward of the 60-m isobath along the coast, with greater quantities depositing in close proximity to the mouth of the Klamath River (Klamath Facilities Removal EIS/EIR). After this initial deposition, as described by Farnsworth and Warrick (2007), resuspension during the typical winter storms would likely occur before final deposition and burial. Much of this sediment will eventually be transported further offshore to the mid-shelf and into deeper water depths off-shelf through progressive resuspension and fluid-mud gravity flows. This sediment deposition and resuspension may affect benthic food resources of the southern DPS green sturgeon. Food resources in the nearshore environment include crabs, shrimp, clams, annelid worms, and other invertebrates as well as small fish like anchovies and sand lances (74 FR 52300). Many of these food resources are mobile and would not be affected by sediment deposition. Some, like clams and annelid worms may be affected by sediment deposition and resuspension. However, the area of impact would be relatively small when compared to the expanse of the critical habitat zone and green sturgeon would be able to access other food resources if benthic food organisms become affected by the Proposed Action sediment deposition.

Sediment release associated with the Proposed Action could possibly cause short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) decreases in the water quality PCE of the southern DPS green sturgeon’s coastal marine critical habitat. This is due to the organic and inorganic contaminants that have been identified in the sediment deposits currently trapped behind the dams (Reclamation 2011d) being mobilized during reservoir drawdown and transported to the nearshore marine environment. However, core samples of reservoir sediment deposits were collected and analyzed for organic and inorganic contaminants in 2004-2005 and again in 2009-2010 with the results indicating no positive exceedences of applicable screening levels (Klamath Facilities Removal EIS/EIR). In addition, there were no positive exceedances of the applicable and available maximum marine screening levels (CDM 2011), with the exception of a small number of sediment samples from J.C. Boyle Reservoir, which exceeded the applicable marine screening level for dieldrin and 2,3,4,7,8,-PECDF (CDM 2011). The marine screening levels are designed to be protective of direct toxicity to benthic and epibenthic organisms, which corresponds to a “no adverse effects level.” The vast majority of 2009–2010 samples indicate a low risk of toxicity to sediment-dwelling organisms.

With respect to bioaccumulation potential, there were no exceedances of applicable marine bioaccumulation screening levels (CDM 2011). Further, with the exception of four samples in J.C. Boyle Reservoir (CDM 2011), levels of other known bioaccumulative compounds did not exceed Oregon DEQ bioaccumulation screening levels for marine fish. Note that Oregon DEQ bioaccumulatory screening levels are not strictly applicable in the California marine offshore environment; however, they are indicative of potentially bioaccumulative compounds.

The Proposed Action will not inhibit marine migration of Southern DPS green sturgeon in any way. Green sturgeon would be able to substitute other food resources if nearshore sediment deposition affects benthic-dependent prey species. The effect of the Proposed Action on the water quality PCE of critical habitat is expected to be insignificant due to the very low levels of contaminants in the reservoir sediments, low bioaccumulation potential, and the dilutive effects of the river water and ocean. **Therefore, the Proposed Action may affect, but is not likely to adversely affect Southern DPS green sturgeon critical habitat.**

5.1.4 Coho Salmon

Coho salmon could be affected in the short-term by erosion and sediment release during reservoir drawdown, dam deconstruction, road reconstruction, cofferdam installation and removal, spoils storage and hauling, and other activities that would disturb soils. In addition, impacts from blasting, weed control, fish rescue and relocation, and inadvertent accidental materials deposition into the river may also occur.

In the following sections, the predicted effects for the most likely and worst-case scenarios of SSC on each coho salmon life history stage and cohort (referenced by the year of emergence) are analyzed to evaluate the likely effects of the Proposed Action on anadromous fish populations in the Klamath River.

5.1.4.1 Short-Term Effects

Reservoir drawdown

In order to evaluate the effects of suspended sediment on coho salmon in the Klamath River, the historical population structure of SONCC coho salmon presented in Williams et al. (2006) was used, as described in Section 3.2.2.4. Williams et al. (2006) identifies nine populations within the Klamath River, including the Upper Klamath River, Shasta River, Scott River, Salmon River, Mid-Klamath River, Lower Klamath River, and three population units within the Trinity River watershed (Upper Trinity River, Lower Trinity River, and South Fork Trinity River population units). Effects of SSC on distinct population units are differentiated where appropriate.

Upstream migration of adult coho salmon in the Klamath River spans the period from September to January, with peak movement occurring between late-October and mid-November. As this is the only period when adults are present in the mainstem Klamath River, it is also the only period when adults would be exposed to elevated suspended sediment in the mainstem. Although coho salmon within the Upper Klamath River Population Unit do migrate as far upstream as IGD, in general coho salmon are primarily distributed within tributaries downstream of the Shasta River. Therefore, the analysis focuses on exposure to suspended sediment within, and downstream of, Seiad Valley (Figure 5-2). Fish within the Upper Klamath River Population Unit upstream of Seiad Valley could be expected to be exposed to slightly higher SSC concentrations, and fish within all other population units further downstream to lower concentrations.

Adult coho salmon enter the Klamath River between late September and through January, with peak upstream migration occurring between late October and mid-November. Based on adult migration observations in Scott River (2007–2009), Shasta River (2007–2009, and Bogus Creek (2003–2009, on average only around 4% of adult remain in the mainstem after January 1st (CDFG unpubl. data). In most years all adults are observed in tributaries prior to December 15th, although in some years (e.g., Scott River in 2009) most fish are observed between December 15th and January 1st.

The drawdown of Copco 1 is scheduled to begin on November 1, 2019, while J.C. Boyle and Iron Gate dams will begin on January 1, 2020. Sediment released from Copco 1 will be transported downstream and a portion will become trapped in the IGD reservoir, but some of the suspended load will continue downstream and result in elevated SSC. Under the modeled existing condition, SSC from November 1 through January 1 would be expected to be between 33 and 245 mg/L for five days at Seiad Valley (Appendix E of the Klamath Facilities Removal EIS/EIR). The existing condition SSC relates to a Newcombe and Jensen (1996) severity (SEV) of 6 or 7, which results in moderate stress and/or impaired homing to migrating adult coho. Under most likely or worst case scenario, the Proposed Action's estimated SSC between the period of November 1 and January 1 are expected to range from 33 to 665 mg/L for up to 26 days (Appendix E of the Klamath Facilities Removal EIS/EIR). The Proposed Action worst case SSC relates to a Newcombe and Jensen (1996) SEV of 7 or 8, which results in major stress and/or impaired homing for adults.

It is anticipated that nearly all adult coho should already be in tributaries when J.C Boyle and Iron Gate reservoirs begin drawing down in January 2020. Even though the November 1 Copco 1 reservoir drawdown would elevate SSC downstream of IGD, it will not be nearly to the degree that will occur after January 1st 2020. Under the most likely and worst-case scenarios, effects of the Proposed Action on migrating adults from all population units are anticipated to be higher than those experienced under existing conditions (Table 5-1), but will remain sublethal (Table 5-1). The worst-case scenario under the Proposed Action would differ from extreme existing conditions only in extending the duration of exposure to elevated suspended sediment by a week (Appendix E in the Klamath Facilities Removal EIS/EIR).

It is expected that SSC in the fall immediately following removal (2020) of the Four Facilities would be high enough to cause major physiological stress and impaired homing. This is because fall rainfall would be expected to erode a portion of the exposed sediment deposits within the reservoir areas.

Because coho salmon spawning in the mainstem is uncommon (Magneson and Gough 2006), it is unlikely that dam removal will directly affect egg or alevin development, with the exception of any redds constructed in the mainstem in the fall of 2019 or 2020. Coho salmon redds from the Upper Klamath River Population Unit that are built in the mainstem in the fall of 2019, as well as their progeny, would suffer up to 100% mortality under either scenario of the Proposed Action (Table 5-1); however, even under existing conditions, very high mortality (>80%) is expected (Table 5-1) due to the effects of suspended sediment on these life stages (in addition to other sources of mortality); therefore, the effects of suspended sediment resulting from the Proposed Action are within the range of those predicted for existing conditions. Based on spawning surveys conducted from 2001 to 2005 (Magneson and Gough 2006), 6 to 13 redds within the study area from IGD to the Indian Creek confluence could be affected, many of which are thought to be hatchery returning fish (NMFS 2010). Based on the range of escapement estimates of Ackerman et al. (2006), 13 redds could represent anywhere from 0.7 to 26% of the naturally returning spawning in the Upper Klamath River Population Unit, and much less than 1% of the natural and hatchery returns combined. The implementation of the adult salmonid capture and relocation program

(Section 2.3.6.1) in the reach between IGD and the Shasta River will likely capture adult coho salmon prior to them spawning in the mainstem Klamath River. This conservation measure will reduce the reservoir drawdown-related impact on redds to some degree.

It is predicted that SCC in the fall immediately following removal (2020) of the four facilities could be high enough to result in fine sediment infiltration into redds that were constructed in the mainstem by the Upper Klamath River Population Unit adults during fall 2020 (Figure 5-5). Although no detailed analysis of the amount of infiltration has been conducted, it would likely be as severe (up to 100% mortality) downstream of IGD as would occur in January 2020 during initial releases of sediment. It is likely the effect would be greater than the existing condition and result in elevated mortality of redds. However, in contrast to potential impacts during fall 2019, the removal of the four facilities will allow adult coho salmon, which might have constructed redds in the mainstem downstream of IGD, access to Jenny Creek, Spencer Creek, or the reach upstream of Copco 1. Therefore it is likely that fewer reddes would be constructed in the mainstem during fall 2020 than predicted for 2019, and thus the impact to coho redds associated with the Upper Klamath River Population redds would likely be less than described above for fall 2019 progeny.

Although most (assumed >50%) Age 0+ rearing is believed to occur in tributaries, age 0 juveniles are observed outmigrating from tributaries in spring and early summer. Under existing conditions, 0+ coho in the mainstem during spring and summer are exposed to SSCs that result in major stress (Table 5-1). Under the Proposed Action and the most likely SSC scenario age 0+ coho would be exposed to SSC that will result in major physiological stress and reduced growth (possibly no growth at all) (Table 5-1), similar to predictions for extreme existing conditions (Table 5-1). These effects, in addition to possible exposure to diseases and the elevated temperatures often recorded in the mainstem Klamath River during summer, could result in high mortality of this cohort for all populations that have some rearing in the mainstem. There could also be indirect effects on marine survival for those fish that survive the summer, but smolt at a smaller size (Bilton et al. 1982, Hemmingsen et al. 1986). Implementation of the juvenile outmigrant trapping program (Section 2.2.7.2) will reduce the impact to the Upper Klamath, Mid-Klamath, Shasta River, and Scott River populations during spring 2020. Concentrations of suspended sediment are predicted to remain elevated at IGD, but be within the range or existing conditions at Seiad Valley by the following winter (2021). Moderate stress is predicted for age 0+ coho rearing in the mainstem river between March 15 and November 14, 2021 (Table 5-1).

Table 5-1. Proposed Action, Most-Likely Scenario SSCs Compared with Normal Existing Conditions (50% exceedance probabilities) and Proposed Action, Worst-Case Scenario SSCs Compared with Extreme Existing Conditions (10% exceedance probabilities) for Coho Salmon

Scenario	**Life history stage: coho salmon**				
	Adult migration (Sept 1, 2019–Jan 1, 2020) and Sept 1, 2019 to Jan 1, 2021	**Spawning through fry emergence (Nov 1, 2019–Mar 14, 2020) and (Nov 1, 2020–Mar 14, 2021)**	**Age 0+ rearing during summer (Mar 15–Nov 14, 2020) and (Mar 15–Nov 14, 2021)**	**Age 1+ rearing during winter (Nov 15, 2019–Feb 14, 2020)**	**Outmigration** **Early spring outmigration: (Feb 15–March 31, 2020)** **Late spring outmigration: (April 1–June 30, 2020)**
Most likely	***Existing Conditions (normal)***				
	Stressful SSCs for about 5 days; deleterious affects on adults unlikely	Low survival (<20%)	Age 0+ summer: Major stress for age 0+ from 2020 cohort in mainstem (affecting <50% of total fry produced in the Klamath tributaries upstream of Salmon River)	Age 1+ winter: Moderate stress for age 1+ juveniles from 2019 cohort in mainstem (assume <1% of juveniles)	Early spring outmigration: Major stress mortality for smolts coming from Upper Klamath, Mid-Klamath, Shasta River, and Scott River populations during early spring (approximately 44% of run outmigrate in early spring) Late spring outmigration: Major stress for smolts coming from Upper Klamath, Mid-Klamath, Shasta River, and Scott River populations during late spring (approximately 56% of run)
	Proposed Action				
	Major stress and impaired homing for fall of 2019 and 2020 adults	Up to 100% mortality of progeny of mainstem spawners (about 13 redds, or 0.7–26% of Upper Klamath River Population Unit natural escapement) for 2019-2020 cohort. Up to 100% mortality for 2020–2021 cohort	Age 0+ summer: Reduced growth (affecting <50% of total fry produced in the Klamath Tributaries upstream of Salmon River) for 2020 cohort Moderate stress for 2021 cohort	Age 1+ winter: Major stress, reduced growth, and up to 20% mortality	Early spring outmigration: Major stress, reduced growth, and up to 20% mortality for smolts coming from Upper Klamath, Mid-Klamath, Shasta River, and Scott River populations during early spring (~44% of run outmigrate in early spring). (2,668 smolts, 3% of total production in basin) Late spring outmigration: Major stress and reduced growth

Scenario	**Life history stage: coho salmon**				
	Adult migration (Sept 1, 2019–Jan 1, 2020) and Sept 1, 2019 to Jan 1, 2021	**Spawning through fry emergence (Nov 1, 2019–Mar 14, 2020) and (Nov 1, 2020–Mar 14, 2021)**	**Age 0+ rearing during summer (Mar 15–Nov 14, 2020) and (Mar 15–Nov 14, 2021)**	**Age 1+ rearing during winter (Nov 15, 2019–Feb 14, 2020)**	**Outmigration Early spring outmigration: (Feb 15–March 31, 2020) Late spring outmigration: (April 1–June 30, 2020)**
Worst case	***Existing Conditions (extreme)***				
	Major stress and impaired homing	Up to 100% mortality of progeny of mainstem spawners (about13 redds, or 0.7–26% of Upper Klamath River Population Unit natural escapement)	Age 0+ summer: Major stress and reduced growth for fish rearing in mainstem (affecting <50% of total fry produced in the Klamath Tributaries upstream of Salmon River)	Age 1+ winter: Major stress and reduced growth for fish rearing in mainstem (assume <1% of juveniles)	Early spring outmigration: Major stress and reduced growth for smolts coming from Upper Klamath, Mid-Klamath, Shasta River, and Scott River populations during early spring (approximately 44% of run outmigrate in early spring)
					Late spring outmigration: Major stress for smolts coming from Upper Klamath, Mid-Klamath, Shasta River, and Scott River populations during late spring (approximately 56% of run)
	Proposed Action				
	Major stress and impaired homing for fall of 2020 adults	Same as existing conditions	Age 0+ summer: No growth (affecting <50% of total fry produced in the Klamath Tributaries upstream of Salmon River)	Age 1+ winter: Major stress, reduced growth and up to 52% mortality	Early spring outmigration: Major stress, reduced growth, and up to 49% mortality for smolts coming from Upper Klamath, Mid-Klamath, Shasta River, and Scott River populations during early spring (approximately 44% of run outmigrate in early spring) (6,536 smolts, 8% of total production in basin)
					Late spring outmigration: Major stress and reduced growth

Under existing conditions, SSCs are typically high during the winter at Seiad Valley (Figure 5-3), and predicted to cause major stress for a month for juvenile coho under both normal and extreme conditions (Appendix E of the Klamath Facilities Removal EIS/EIR). Under the Proposed Action, age 1 juveniles (progeny of the 2019 cohort) that have either successfully over-summered or moved from tributaries into the mainstem in fall, could be exposed to much higher SSC in the mainstem during the winter of facility removal than under existing conditions (Figure 5-2), and may suffer mortality rates of up to 52% under a worst-case scenario (Table 5-2). However, it is not known how many juveniles rear in the mainstem during winter, but it is assumed to be a small (<1%) proportion of any of the coho salmon populations. Many juveniles in the mainstem Klamath River appear to migrate to the lower river to rear and may avoid adverse conditions in the mainstem by using tributary or off-channel habitats during winter, thus reducing their exposure and potential mortality (Soto et al. 2009, Hillemeier et al. 2009), consistent with the observation that juvenile salmonids avoid turbid conditions (Sigler et al. 1984, Servizi and Martens 1992). This strategy may be even more pronounced under the even higher SSC expected under the Proposed Action.

Coho salmon smolts from the 2018 broodyear are expected to outmigrate to the ocean beginning in late February 2020, although most natural origin smolts outmigrate to the mainstem Klamath during April and

May (Wallace 2004). Courter et al. (2008), using USFWS and CDFG migrant trapping data from 1997 to 2006 in tributaries upstream of and including Seiad Creek (Horse Creek, Seiad Creek, Shasta River, and Scott River), reported that 44% of coho smolts were trapped from February 15 to March 31, and 56% from April 1 through the end of June. Once in the mainstem, smolts move downstream fairly quickly (Stutzer et al. 2006). As discussed in detail in Section E.2 of Appendix E of the Klamath Facilities Removal EIS/EIR, this analysis assumes a maximum exposure of 20 days for downstream migration. Under the Proposed Action, concentrations would be higher during spring than under existing conditions, and smolts outmigrating in early spring (prior to April 1) are likely to suffer up to 49% mortality in a worst-case scenario (Table 5-2). It is also expected that 51% of early spring smolts will experience major stress and reduced growth. Smolts outmigrating in late spring (after April 1) will be exposed to lower concentrations, and may experience only slightly worse physiological stress and reduced growth rates compared with existing conditions, even under a worst-case scenario. Those individuals experiencing stress and reduced growth may suffer delayed mortality due to greater susceptibility to disease and predation effects.

Coho salmon outmigrants during the spring of 2021 in the Seiad Valley area would experience SSC similar to the existing condition (Figure 5-3). However, 2021coho smolts immediately downstream of IGD would be expected to suffer up to 20% mortality during the early migration period, which would decrease to moderate to major stress during the late migration period. These effects would diminish in a downstream direction with the accretion of tributary inflow reducing the SSC until background suspended sediment levels were achieved in the Seiad Valley area.

Table 5-2. Summary of Predicted Age 1 Coho Salmon Smolt Mortality During Early Spring Outmigration (44% of Total Smolt Abundance) Resulting from the Proposed Action within Coho Salmon Population Units of the Klamath River Watershed

Population unit	Estimated total smolt abundance	Estimated mortality					
		Most likely to occur scenario			Worst-case scenario		
		Mortality (%)	Number of smolts	Proportion of population (%)	Mortality (%)	Number of smolts	Proportion of population (%)
Upper Klamath River	7,675[a]	20	676	9	49	1,655	22
Shasta River	1,131[b]	20	100	9	49	244	22
Scott River	1,300[b]	20	114	9	49	280	22
Mid-Klamath River	20,211[a]	20	1,779	9	49	4,357	22
Salmon River	4,611[a]	0	0	0	0	0	0
Upper Trinity River	3,122[c]	0	0	0	0	0	0
Lower Trinity River							
South Fork Trinity River							
Lower Klamath River	45,861[a]	0	0	0	0	0	0
Total	**83,911**		**2,668**	**3**		**6,536**	**8**

[a] Based on Courter et al. (2008) for an average water year under existing conditions.

[b] California Department of Fish and Game 2011, unpubl. data. Predictions for 2018 brood year based on average of brood year 2003, and 2006 smolt production (spring 2005 and 2008).

[c] Based on Schief et al. (2001) abundance estimates for natural production.

Hydrologic conditions resulting in the SSC and durations under worst case scenario for the smolt outmigration period (Table 5-2) are predicted to occur under a wet year (such as 1984). Wet years are predicted to increase SSC during spring smolt outmigration because of an increased likelihood of Iron Gate Reservoir filling with water after the January drawdown, resulting in a second release of sediment when the reservoir drains in the late spring. Based on the historical record, there is a 10% probability that the hydrologic conditions leading to the worst case scenario will occur during the implementation of the Proposed Action, and a 90% probability that the SSC will be less severe than predicted for the worst case scenario.

Table 5-3. Predicted SSCs and Exposure Durations for Coho Salmon Age 1 Juvenile Outmigration for Proposed Action Worst-Case Scenario (10% Exceedance Probability), for Klamath River at Seiad Valley (RM 129)

Life-history timing	Suspended sediment concentration (mg/L)	Exposure duration (days)
Age 1 juvenile outmigration (Feb 15–March 31, 2020)[a]	4,915 to 13,360	3
	1,808 to 4,915	6
	665 to 1,808	11
	245 to 665	18
	90 to 245	20
	33 to 90	20
Age 1 juvenile outmigration (April 1– June 30, 2020)[a]	665 to 1,808	1
	245 to 665	12
	90 to 245	20
	33 to 90	20

[a] maximum migration duration = 20 days

Implementation of the juvenile outmigrant trapping program (Section 2.2.6.2) will reduce the impact to the Upper Klamath, Mid-Klamath, Shasta River, and Scott River coho salmon smolt populations. Additional trapping would occur within tributaries to the Seiad Valley to Orleans reach if SSC exceed the predicted worst case scenario. It is expected that capture rates exceeding 50% can be achieved using aggressive capture techniques. See section 5.1.4.3 for more information.

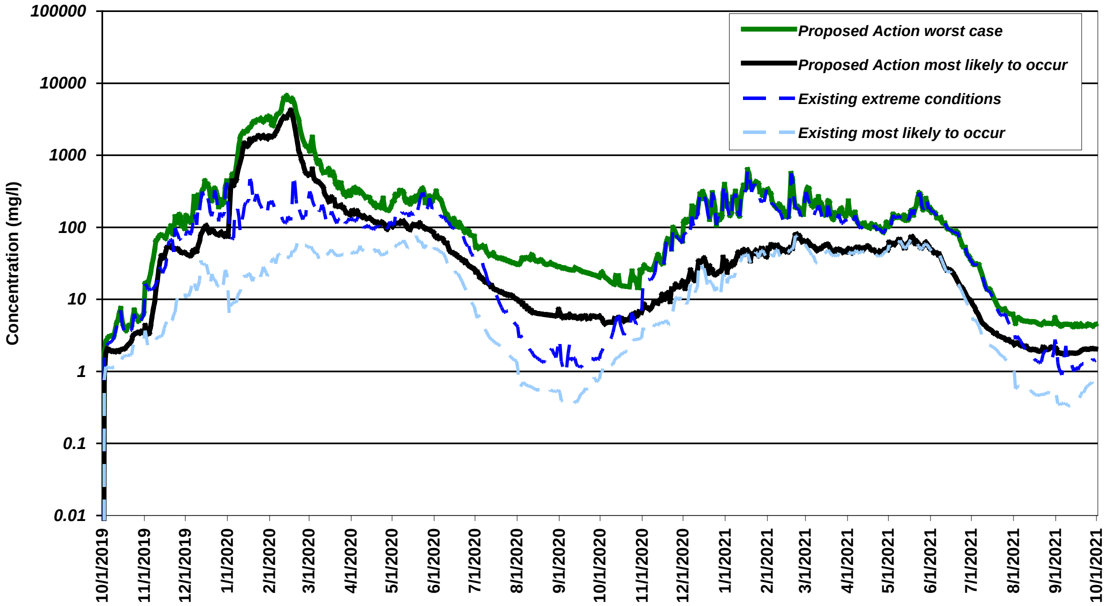


Figure 5-2. Comparison of SSC under the Proposed Action and Existing Conditions at Seiad Valley, as Predicted Using the SRH-1D Model

Based on the results of outmigrant trapping by the USFWS (2001) on the mainstem Klamath River compared with trapping in the Trinity River from 1997 to 2000 (Pinnix et al. 2010), most (>80%) coho smolts originate from the Trinity River and Lower Klamath River populations. The maximum SSC at Orleans is approximately 2,000 mg/L for the most likely scenario and about 4,000 mg/L for the worst-case condition under the Proposed Action (Figure 5-3). The background concentrations at Orleans will typically be around 200 mg/L, but will spike to around 500 mg/L during existing high flow events. For the majority of smolts produced from tributaries downstream of Orleans, the Proposed Action will result in sub-lethal effects, but no direct mortality. However, those individuals experiencing stress and/or reduced growth may suffer an unknown level of delayed mortality due to greater susceptibility to disease and predation effects. Most of the outmigrant juvenile coho salmon are expected to move downstream quickly into the estuary and ocean and will be less affected by SSCs than juveniles that migrate downstream slowly in the mainstem Klamath River.

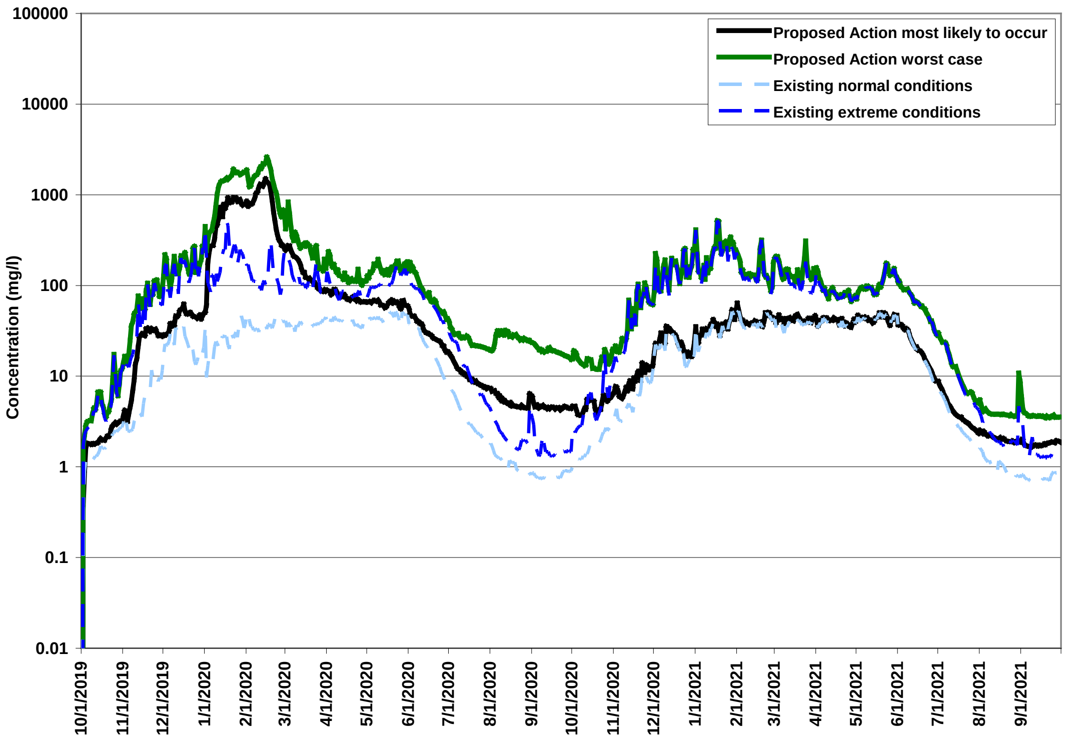


Figure 5-3. Proposed Action Compared with Existing Conditions at Orleans, as Predicted using the SRH-1D Model

The overall mortality rates predicted to occur as a result of the Proposed Action vary for each population, and are summarized in Table 5-2, based on the average smolt abundance predicted for the 2018 brood year (age 1 smolts in spring 2020). Smolt abundance data were available for the Shasta River, Scott River, and Trinity River populations. Smolt abundance data from all tributaries within the Upper Klamath, Mid-Klamath, Salmon and Lower Klamath River populations were not available, and so smolt production estimates as reported in Courter et al. (2008) were used. Courter et al. (2008) modeled all mainstem and tributary reaches within the Klamath Basin based on available smolt production data and habitat conditions within tributaries, and thus comprised the most complete assessment of potential smolt production available.

Under existing conditions, coho salmon smolts outmigrating from the Upper Klamath River, Scott River, and Shasta River populations currently have mortality rates (35–70%) presumably as a result of poor water quality and disease (Beeman et al. 2007, et al. 2008), which, in conjunction with physiological stress and reduced growth resulting from the Proposed Action, could result in even higher mortality in the spring of 2020.

In general, the wide distribution and use of tributaries by both juvenile and adult coho salmon will likely minimize the population's exposure to the worst effects of the Proposed Action. However, direct mortality is anticipated for around 13 redds, or 0.7–26% of Upper Klamath River Population's natural escapement for 2019. It is expected that impacts to redds constructed in the fall of 2020 will be less due to the ability of the Upper Klamath River adults ability to access the river reach and tributaries upstream of IGD.

Direct mortality is also anticipated for 2,668 smolts under the most-likely scenario, or 6,536 smolts under a worst-case scenario (Table 5-2). This equates to a 9% loss of the production from the Upper Klamath River, Mid-Klamath River, Shasta River, and Scott River population units under the most likely scenario, or 22% under a worst-case scenario. However, these losses were estimated without consideration of the adult and juvenile trapping and relocation conservation measures. Implementation of these conservation measures will further reduce the already low number of redds that would be impacted in the mainstem Klamath River. In addition, the implementation of the juvenile downstream migration trapping program is expected to reduce losses to juveniles by at least 50%, which would reduce the Upper Klamath River, Mid-Klamath River, Shasta River, and Scott River population units' mortality to 4.5% under the most likely scenario, or 11% under a worst-case scenario.

Sublethal effects are expected for the 51% of age 1+ smolts that outmigrate between April 1 and end of June from the Upper Klamath River, Mid-Klamath River, Shasta River, and Scott River population units. In addition, the Salmon River, Trinity River, and Lower Klamath River coho salmon populations will experience elevated stress levels and reduced growth, but no direct mortality from the reservoir drawdown. However, those individuals experiencing stress and reduced growth may suffer an unknown level of delayed mortality due to greater susceptibility to disease and predation effects. Implementation of the juvenile trapping conservation measure is expected to reduce the number of outmigrants exposed to these sublethal effects by at least 50%.

Based on the analyses above, the reservoir drawdown and sediment release activities of the Proposed Action may affect and is likely to adversely affect adult and juvenile coho salmon from the Upper Klamath, Scott River, Shasta River, Mid-Klamath, Salmon River, Trinity River, and Lower Klamath River population units in the short-term.

Dam and facilities removal

Demolition

The Proposed Action will require demolition of the dams and their associated structures, power generation facilities, installation of cofferdams, and other activities. These actions will include the use of heavy equipment and blasting as necessary and as such, have the potential to result in noise levels that could disturb or cause mortality of listed aquatic species (Reyff 2009).

As stated in the Detailed Plan, demolition activities at IGD will require the installation of a cofferdam in the tailrace area to facilitate removal of the power house facilities. Construction on the cofferdam is scheduled to begin on January 2, 2020. As described above, SSC effects are anticipated to begin in November in response to the Copco 1 reservoir drawdown. Copco 1-related SSC at IGD, under the worst-case scenario, is expected to range from 2 to 213 mg/L between November 1 and December 31, 2019 (Figure 5-4). Following initiation of IGD's drawdown on Janauary 2, 2020, SSC will increase very rapidly to nearly 1,400 mg/L by January 8 and continue to climb to over 14,000 mg/L by mid-February. Those few individuals that might still be migrating after January 1st will encounter these high levels of SSC associated with the reservoir drawdown (Figure 5-4). The cofferdam will be constructed in the tailrace area that is located immediately downstream of the diversion tunnel, which will be discharging extremely turbid water during the entire drawdown period. It is highly unlikely that any adult or juvenile coho salmon will be in this outfall area due to the adverse effects (gill abrasion, reduced dissolved oxygen uptake, high water velocities) that any fish in the vicinity would experience. **Therefore, the installation of a cofferdam in the tailrace area may affect, but is not likely to adversely affect adult coho salmon.**

The Detailed Plan may involve blasting, including removal of any mass concrete. This could include reinforced concrete in deck, wall, and floor slabs for any structures to be removed (including intake structures, control structures, fish handling facilities, and powerhouse). These activities are scheduled to occur between January 10 and June 26. The Detailed Plan currently indicates that all blasting will be conducted out of water. The cofferdam would be in place between the blasting sites and the mainstem river, which will be flowing in a highly turbid state (Figure 5-4). Adult coho salmon would be unlikely to be in the vicinity of the cofferdam and blasting area due to the high SSC. **Therefore, the noise and vibration associated with blasting the facilities on the terrace above the tailrace area may affect, but is not likely to adversely affect adult coho salmon.**

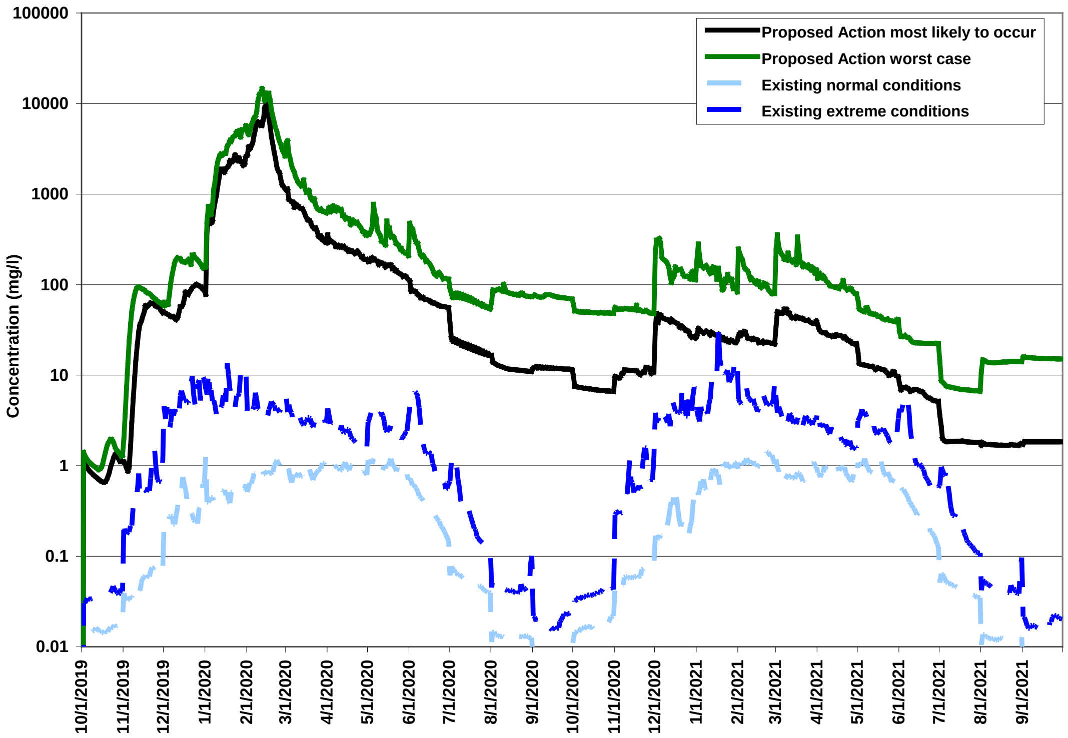


Figure 5-4. Proposed Action Compared with Existing Conditions at Iron Gate Dam, as Predicted using the SRH-1D Model

Any redds constructed in the mainstem in the vicinity of IGD are predicted to suffer 100% mortality as a result of the drawdown release of SSC. It is expected that SSC effects to redds will begin soon after the initiation of the Copco 1 reservoir drawdown, which will result in SSC exceeding 60 mg/L for at least 7 weeks in November and December 2019 (Figure 5-4). This would result in greater than 60 to 80% mortality of incubating eggs, alevin, and pre-emergent fry (Newcombe and Jensen 1996) prior to initiation of cofferdam construction or blasting. Following initiation of IGD's drawdown on Janauary 2, 2020, SSC will increase very rapidly to nearly 1,400 mg/L by January 8 and continue to climb to over 14,000 mg/L by mid-February. The IGD drawdown will very rapidly result in additional redd mortality. Although cofferdam construction would have the potential to crush any redds in its footprint, the reservoir drawdown would by itself result in 100% mortality. **Therefore, cofferdam construction and noise from blasting may affect, but is not likely to adversely affect coho salmon eggs, alevin, or pre-emergent fry**.

Coho salmon juveniles and pre-smolts likely inhabit the IGD demolition area that would be subject to cofferdam construction and out-of-water blasting effects. These fish would also be subject to SSC exceeding 60 mg/L for at least 7 weeks in November and December 2019 (Figure 5-5), which corresponds to a Newcombe and Jensen (1996) SEV of 9 (reduced growth rate and fish density). SSC during the Iron Gate reservoir drawdown is expected to increase very rapidly to nearly 1,400 mg/L by January 8, which is expected to result in up to 20% mortality of these individuals and major stress for the others. It is anticipated that the release of SSC will result either in the mortality or downstream displacement of any juveniles that are rearing in IGD demolition area prior to cofferdam installation. In addition, the cofferdam will exclude juvenile coho salmon from direct effects of facilities demolition. **Therefore, the cofferdam construction and noise from blasting may affect, but is not likely to affect coho salmon juveniles and pre-smolts that inhabit the tailrace area.**

During spring 2020 juveniles or fry could potentially migrate downstream from Bogus Creek. It can be assumed that most of the juvenile coho salmon migrating out of Bogus Creek will either be caught as part of the rescue and relocation program or move downstream away from the source of the suspended sediment. However, a few juvenile coho salmon may not get caught by the trapping program and could migrate upstream from Bogus Creek and enter the tailrace demolition area during the late-spring and early-summer while SSC is in the relatively low 30–80 mg/L range. Therefore, even though the number of juvenile coho salmon that may enter the tailrace area (while operations are occurring) is likely to be very low, it cannot be discounted. However, the cofferdam will exclude these individuals from the demolition site itself. **Therefore, however unlikely, noise from blasting may affect, but is not likely to adversely affect a small number juvenile coho salmon during the spring of 2020.**

Cofferdam dewatering effects

As determined above, placement of the cofferdam in the IGD tailrace area is not expected to adversely affect coho salmon. However, cofferdam operations also require dewatering of the work area. Once the cofferdam is complete, pumping water from the work area must occur to create a relatively dry work area. Dewatering has the potential to strand fish on the dry surface and/or impinge then on the pump head.

As described above, adult coho salmon that would normally be in the tailrace area during spawning migration are anticipated to be adversely affected by SSC released during the Copco 1 and Iron Gate reservoirs drawdown. As such adult coho salmon are not anticipated to be in the tailrace area during cofferdam installation. As such, it is highly unlikely that any adult coho salmon will be inside the cofferdam enclosure during dewatering activities. **Therefore, cofferdam dewatering may affect, but is not likely to adversely affect adult coho salmon**.

Coho salmon spawn downstream of IGD (Magneson and Gough 2006), spawning habitat has not been described within the footprint of the proposed cofferdam. In addition, it is predicted that any coho salmon redds that are constructed downstream of IGD in the mainstem will not survive the effects of SSC during the Copco 1 and Iron Gate reservoirs drawdown (Section 5.1.3.1). **Therefore, cofferdam dewatering may affect, but is not likely to adversely affect coho salmon eggs, alevin, or pre-emergent fry**.

Coho salmon juveniles and pre-smolts that may inhabit the IGD tailrace area are anticipated to be adversely affected by SSC released during the Copco 1 and Iron Gate reservoirs drawdown prior to installation and completion of the cofferdam. It is anticipated that the release of SSC will result in major stress and up to 20% mortality of any juveniles that are rearing in IGD tailrace area prior to cofferdam installation. It is expected that juvenile coho salmon would migrate downstream and into tributary streams to avoid the effects of the high SSC. However, it is possible that a few individuals could remain in the cofferdam area. Therefore, fish rescue and relocation activities will occur during cofferdam dewatering to capture any remaining juvenile coho salmon. A dewatering rescue and relocation plan will be developed by the DRE and approved by NMFS prior to initiation of reservoir drawdown. In addition, the pump(s) used to dewater the work area inside the cofferdam will be equipped with screens that have a mesh size of 3/32 of an inch or smaller and are in compliance with the NMFS screening criteria (NMFS 1997b) for approach velocities. **Cofferdam dewatering, when combined with implementation of a rescue and relocation program and screening criteria may affect and is likely to adversely affect juvenile coho salmon.**

Yreka water supply modifications

The City of Yreka relies on a 24-in diameter water supply pipeline that crosses the Klamath River near the upstream end of the reservoir impounded behind IGD. The steel pipe is minimally buried in the river bed. When the dam is removed, the pipe would become exposed to high velocity river flows and would likely sustain damage. The Proposed Action includes replacement of this pipeline prior to reservoir drawdown.

The current and proposed pipeline are located upstream of IGD and are therefore upstream of the current distribution of coho salmon. However, removal of the pipeline may result in increased turbidity in the river, the vast majority of which will resettle in the reservoir. The pipeline would be replaced and sediment would have resettled before IGD is removed; **therefore, replacement of the Yreka water supply pipeline would have no effect on coho salmon**.

Reservoir revegetation

Based on the reservoir area management planning currently underway, establishment of herbaceous vegetation in drained reservoir areas will be undertaken to stabilize the surface of the sediment and minimize erosion from exposed terrace surfaces following drawdown (O'Meara et al. 2010). Woody species would gradually establish on the river terraces as they propagated from the outer edges of the reservoir. Revegetation efforts would be initiated to support establishment of native wetland and riparian species on newly exposed reservoir sediment. Access for ground application equipment is expected to be limited immediately following drawdown due to terrain, slope, and sediment instability. The revegetation of the reservoir areas will reduce erosion, stabilize exposed surfaces, and eventually provide shade and food resources for fish in the new free-flowing river channel. **Revegetation of exposed reservoir substrates will be beneficial for coho salmon. Therefore, revegetation of exposed reservoir substrates may affect but is not likely to adversely affect coho salmon.**

Herbicides would be necessary during this period to control the growth of invasive plant species, with application occurring during the first year following dam removal and potentially during the second, if further treatments are necessary. Herbicide application would be required for 25%, 50%, and 75% of the total reservoir area for the low, most probable, and high cost restoration estimates, respectively (O'Meara et al. 2010).

The reservoir area management plan recognizes the potential water quality effects of herbicide application and calls for the use of herbicides with low soil mobility, and thus low potential to leach into groundwater or surface waters. It also calls for low use rates of herbicides and application of chemicals that pose a low toxicity risk to fish and aquatic organisms. Glyphosate is suggested in the management plan as one potential herbicide with such characteristics (O'Meara et al. 2010). To minimize use rates, spot treatments of a post-emergent herbicide such as glyphosate would be used rather than aerial application.

Glyphosate does not bioaccumulate, biomagnify, or persist in a biologically available form in the environment (Solomon and Thompson 2003). It acts specifically on plants and it is relatively nontoxic to animals (Solomon and Thompson 2003). Glyphosate is soluble in water, and tends to bind tightly to sediment, suspended particulates, organic matter and soil, becoming essentially unavailable to plants or other aquatic organisms (Monheit 2002). Glyphosate adsorbs strongly to soil and is not expected to move vertically below the six inch soil layer; residues are expected to be immobile in soil (EPA 1993). Glyphosate is readily degraded by soil microbes to aminomethyl phosphonic acid (AMPA), which is degraded to carbon dioxide. Glyphosate and AMPA are not likely to move to ground water due to their strong adsorptive characteristics. However, glyphosate does have the potential to contaminate surface waters either due to erosion, since it could be bound to soil particles suspended in runoff, or use to control aquatic vegetation (EPA 1993).

Glyphosate is considered to be practically non-toxic by the California Interagency Noxious Weed Coordinating Committee with an LC50 (lethal concentration at which 50% of test animals die in 96 hours) of 140–240 mg/L for rainbow trout and aquatic macroinvertebrates (Monheit 2002). Aquatic organisms would need to be exposed to concentrations of glyphosate 100 times greater than that which is present after ordinary (following label instructions) use around streams, and 60 times greater than is present after ordinary use around ponds to show toxic effects (Monheit 2002).

Batteglin et al. (2005) conducted a study in the Midwest that included the collection of 154 water samples from 51 watersheds in nine states. The agricultural lands within these watersheds were used to grow corn and soybeans and subject to three treatments of glyphosate during the course of 2002. Although not stated in the report, due to the thousands of acres requiring herbicide treatment, it can be assumed that aerial application was conducted. Batteglin et al. (2005) collected water samples following rainstorms that produced runoff from the farms. The highest concentrations of glyphosate ranged from 0.54 to 8.7µg/L (0.00054 to 0.0087 mg/L). The Proposed Action will utilize hand application treatments of glyphosate and as such would likely have lower runoff concentrations.

There is potential for glyphosate to affect the olfaction sense of coho salmon, which is critical for return adult migration. Tierney et al. (2006) investigated the acute effects of five agricultural pesticides, including glyphosate, on coho salmon olfaction. Tierney et al. (2006) reported that effects on olfaction occurred at glyphosate concentrations in water as low as 1 mg/L. No olfaction effect was detected at 0.1 mg/L (Tierney et al. 2006). Tierney et al. (2006) reported that the Canadian Water Quality Guidelines (CWQG) for the Protection of Aquatic Life (1999), as reported in Tierney et al. (2006), set an aquatic exposure limit for glyphosate at 65µg/L (0.065 mg/L). Tierney et al. (2006) concluded that "in view of the existing CWQG for glyphosate (65µg/L), the relatively high (1 mg/L) concentrations required to significantly decrease electro-olfactogram (EOG), and the physicochemical properties of glyphosate, acute exposures of glyphosate are unlikely to be a routine risk to olfactory systems of anadromous salmonids. Nevertheless, should a salmon-bearing location receive concentrated pulses of this pesticide, olfaction and consequently, ecological fitness may be impaired."

Based on implementation of applicable BMPs and the impact minimization measures listed in Section 2.2.6, the application of glyphosate to control weeds during the revegetation period within the Hydroelectric Reach may affect, but is not likely to adversely affect coho salmon.

5.1.4.2 Long-Term Effects

In general, the Proposed Action would establish a flow regime that more closely mimics natural conditions by increasing spring flow and by incorporating more variability in daily flows. Elimination of the reservoir would allow tributaries and springs such as Fall, Shovel, and Spencer creeks and Big Springs to flow directly into the mainstem Klamath River, creating patches of cooler water that could be used as temperature refugia by coho salmon (Hamilton et al. 2011). Dam removal would restore connectivity to habitat on the mainstem Klamath River up to and including Spencer Creek and would create additional habitat within the Hydroelectric Reach (see critical habitat effects section below). Coho salmon would be expected to rapidly re-colonize habitat upstream of IGD following dam removal, as observed after barrier removal at Landsburg Dam in Washington (Kiffney et al. 2008) and dam removal at Little Sandy Dam in Oregon (B. Strobel, Portland Water Bureau, pers. comm.). Assuming coho salmon distribution will extend up to Spencer Creek after dam removal, coho salmon from the Upper Klamath River population would re-claim 68 miles of habitat, including approximately 45 miles in the mainstem Klamath River and tributaries (DOI 2007, NMFS 2007b), as well as an additional 23 miles currently inundated by the reservoirs (Cunanan 2009).

Suspended sediment effects

As determined in Section 5.1.4.1, the reservoir drawdown-related sediment release is expected to adversely affect coho salmon redds, alevin, fry, juveniles, and smolts. Even though no single year-class is expected to be completely lost, mortality of a portion of these life history stages from the Upper Klamath River, Mid-Klamath River, Shasta River, and Scott River population units may affect the strength of the 2018 and 2019 year classes, requiring two or three generations to recover from losses. **Therefore, the reservoir drawdown and sediment release activities of the Proposed Action may affect and are likely to adversely affect coho salmon from the Upper Klamath, Scott River, Shasta River, and Mid-Klamath population units for two to three generations.**

5.1.4.3 Conservation Measures

Protection of mainstem spawning

Short-term effects of the Proposed Action (SSCs and bedload movement) are expected to result in up to 100% mortality of coho salmon embryos and pre-emergent alevin within redds that were constructed in the mainstem in the fall of 2019. It is estimated that between 6 and 13 redds from the Upper Klamath River Population Unit for coho salmon could be destroyed. Therefore, the Proposed Action includes a conservation measure that would be directed at capturing adult coho salmon as they migrate upstream to mainstem spawning areas. A detailed plan describing capture techniques, release locations, and monitoring methods would be developed in cooperation with NMFS by the DRE prior to 2019.

It is expected that this conservation measure would capture relatively few adult coho salmon because only 12 to 26 individuals are expected to spawn in the mainstem river. Overall effectiveness of the adult relocation operation would be measured by using radio-tags to track the tagged and released fish to determine spawning success and location. Depending on the condition of coho adults, some may be injured during capture, tagging, or transport, or may not spawn when released. However, the progeny of these adults is predicted to suffer 100% mortality if they spawn in the mainstem, so relocation is considered worth the risk of reduced spawning success. **Therefore, in the short-term, implementation of this conservation measure may affect and is likely to adversely affect the captured adult coho salmon. In the long-term, any progeny that are produced by released adult coho salmon would minimize the extent of mortality to redds on the mainstem and would contribute to the spatial structure, abundance, and productivity of the Upper Klamath population if these adults successfully spawn upstream of Iron Gate.**

Protection of outmigrating juvenile coho

It is anticipated that short-term effects of the Proposed Action (SSC) will result in mostly sublethal and in some cases lethal impacts on a portion of the juvenile coho salmon that are outmigrating from tributary streams to the Klamath River upstream of Orleans during late winter and early spring of 2020. The impacts predicted for coho salmon smolts are based on hydrologic conditions that have a 10% chance of occurring in 2020, and a 10% chance of being less severe. Deleterious short-term effects on outmigrating juveniles could be reduced by capturing juveniles outmigrating from tributaries prior to their entry into the mainstem. As described in Section 2.3.6.2, the goal of implementation of this measure will be to adjust the scale of trapping to ensure that actual impacts are within the ranges described in Section 5.1.4.1 for coho salmon.

Impacts for a worst case scenario described in Section 5.1.4.1 are based on a wet year with reservoir refilling, with the subsequent concentrations and durations of SCC summarized in Table 5-3. Monitoring of hydrologic conditions and suspended sediment during winter and spring 2020 will be conducted so that the implementation of this conservation measure can be adjusted based on monitoring results. If 2020 is a wet year and Iron Gate reservoir begins to refill, the implementation plans for this measure will be adjusted to be potentially more intensive. Monitoring results of SSCs during spring 2020 will be compared to the predicted values summarized in Table 5-1 (Section 5.1.4.1). If SCC are higher in concentration or duration than those predicted under a worst case scenario (Table 5-3), it will be assumed that there is an increased risk of impacts to coho salmon becoming higher than the predicted range described under Section 5.1.4.1, and implementation of this measure will be more intensive as described in section 2.2.6.8.

The effectiveness of this measure depends on the efficiency of trapping efforts. Trap efficiency varies with species and tributary. Current trapping efforts in the Shasta River and Scott River typically have trap efficiencies between around 5 and 30%, averaging around 15% (Underwood et al. 2010). These trapping efficiencies are low because only about 10% is ideal for estimating juvenile abundance as higher efficiencies unnecessary trap more juveniles and results in more stress and/or mortalities. It is anticipated that trapping efficiency could be increased over current efforts by more aggressive trapping efforts using multiple traps and increased weir panels. However, not all tributaries with outmigrating juveniles will be trapped, and within trapped tributaries some individuals will avoid traps and migrate to the mainstem (particularly during high flows). Overall, it is assumed 50% of juveniles outmigrating to the mainstem could be captured. Current predictions of mortality estimate a total of 2,668 to 6,536 smolts for an impact of 9 to 22% from the Upper Klamath River, Mid-Klamath River, Scott River, and Shasta River population units depending on a most-likely-to-occur or worst-case scenario. Assuming 50% capture efficiency this mitigation measure would reduce mortality a total of 1,334 to 3,268 smolts for an impact of 4–11% depending on a most-likely-to-occur or worst-case scenario. As discussed above, the intensity of implementation of this measure will be adjusted to ensure that mortality is within this predicted range. To evaluate the effectiveness of the mitigation measure, the trapping procedures would need to assess trap efficiency that would lead to the development of estimates of stream production and numbers of fish assumed missed by trapping effort.

The procedures of trapping, handling, trucking, and releasing outmigrating salmonids could result in injury or mortality to some individuals, and releasing fish at downstream locations could reduce natal cues and increase stray rates. For example, Chesney et al. (2007) reported coho salmon mortality rates associated with downstream migrant trapping on the Shasta and Scott rivers ranging from 3.6 to 7.9% for age 0+, 0.75 to 1% for age 1+, and 0% for age 2+ fish. Trucking mortality rates may be relatively low. Trucking mortality rates for rainbow trout that are hauled from the Mad River Hatchery to Shasta County are less than 0.5% (C. Layman, CDFG Mad River Hatchery, pers. comm., September 14, 2011).

Johnson et al. (1990) examined tag recovery rates in offshore fisheries for three groups of transported fish as well as the control group. The fish in their study were transported for approximately 30 minutes by truck. As indexed by the recovery of tagged fish in ocean catch, the relative survival to harvest of fish that were released immediately following transport was 76%, 83% and 84% relative to the un-transported control group. Quinn (1997) reported that displacement studies indicate that maturing salmon tend to reverse the sequence of their outward migration as juveniles. This will lead them to the river or hatchery where they began life. Displaced salmon return first to the odors of their release site and will continue to the rearing site if its odors can be detected. If not, they seem to seek the nearest river or hatchery.

Fish will be captured and transported only if conditions within the mainstem are as poor as predicted. Due to the uncertainties with suspended sediment modeling, water quality monitoring during spring 2020 would be used to trigger the initiation and cessation of the capture program and inform suitable release locations. Capture operations would only occur if SSC measured in the mainstem were at levels exceeding Newcombe and Jensen (1996) SEV levels of 8.

Even though this conservation measure is intended to minimize mortality of juvenile coho salmon resulting from reservoir drawdown, adverse effects to some individuals that survive through the high SSC is anticipated during the process. **Therefore, implementation of this conservation measure may affect**

and is likely to adversely affect coho salmon in the short-term. However, the survival of those fish that would have otherwise suffered mortality during the high SSC event may recruit to the adult population and eventually spawn, and would be beneficial in the long-term.

Fall flow pulses
Based on observations of coho salmon migration in Bogus Creek, Shasta and Scott rivers very few adult coho salmon migrate after January 1st. However, it is possible that a few adult coho salmon may be in the mainstem after this date and could possible be exposed to high SSC during reservoir drawdown. Deleterious short-term effects on any adults in the mainstem could be reduced by augmented flows during fall 2019 prior to dam removal.

Migration of coho salmon adults into tributaries appears to be affected by flow, with earlier tributary entrance times observed in Blue Creek, Shasta River, Bogus Creek and other tributaries during years with high flows during fall (Stillwater Sciences 2009a). A fall pulse-flow is anticipated to be effective at ensuring nearly all adult coho salmon migrate into tributaries prior to initiation of reservoir drawdown on January 1st.

The implementation of this conservation measure may affect, but is not likely to adversely affect coho salmon.

Hatchery management
It is anticipated that short-term SSC effects of the Proposed Action will result in mostly sublethal, and in some cases lethal impacts on juvenile coho salmon outmigrating from the IGH to the Klamath River upstream of Orleans during late winter and early spring of 2020.
Deleterious short-term effects on outmigrating hatchery coho salmon smolts could be reduced by adjustments to hatchery management.

Hatchery managers have to option to adjust the timing of hatchery releases during spring 2020. Although it would be out of synch with natural life history timing, if smolts are released later in the spring (e.g., mid-May), survival is anticipated to be higher based on current conditions (Beeman et al. 2008). In addition, extending the holding period for juveniles would also avoid the peak in spring release of sediment in the year following dam removal. **The increased holding period conservation measure option is expected to be beneficial for hatchery-reared coho salmon. Therefore, this conservation measure option may affect but is not likely to adversely affect hatchery-reared coho salmon.**

5.1.4.4 Critical Habitat

Essential features of critical habitat considered essential for the conservation of the SONCC coho salmon ESU (NMFS 1997a) include (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. PCEs for SONCC coho salmon are described in NMFS (1999) as follows: “In addition to these factors, NMFS also focuses on the known physical and biological features (primary constituent elements) within the designated area that are essential to the conservation of the species and that may require special management considerations or protection. These essential features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.”
The effects of the Proposed Action on critical habitat described below was based on evaluation of the physical, chemical and biological changes that were expected to occur to designated critical habitat within the area of analysis and how those changes would affect the PCEs for that critical habitat in the short- and long-term.

Substrate

Nearly all of the coarse sediment supplied from upstream of the hydroelectric reach is trapped in the reservoirs and as such has not contributed to the bedload supply downstream of IGD. The lack of clean and loose gravel diminishes the amount and quality of salmonid spawning habitat downstream of dams. It is expected that this reach is essentially fully armored because there has been no significant sediment supply to this reach for almost 50 years (Reclamation 2011b). Successive high flows released and spilled from IGD have winnowed out gravel and small cobbles from the river bed, leaving it in an artificially coarse condition and likely a lower bed elevation than prior to dam installation.

Short-term SRH-1D model simulations estimate between 2.5 to 5 ft of reach-averaged deposition of fine and coarse sediment between IGD (RM 195) and Bogus Creek (RM189.8), decreasing to 1.0 to 1.5 ft of deposition between Bogus Creek and Willow Creek (RM 185.2). Other reaches downstream showed no apparent increase in bed elevation due to sediment deposition (Reclamation 2011b) (Figure 5-5).

In the long-term (5 to 50 years), after downstream translation of dam-released sediment, bed elevations would adjust to a new equilibrium, which includes sediment supplied by upstream tributaries that was formerly trapped by dams within the Hydroelectric Reach. The average bed increase predicted over the next 50 years is 1.5 ft in the reach from Bogus Creek to Willow Creek and less than 1 ft downstream from there (Reclamation 2011b).

It must be noted that some of this deposition will occur over a bed that has, in all likelihood, been eroded over the past 50 years due to the elimination of bedload replenishment. Thus, the streambed will regain some of its lost elevation and substrate characteristics with the return of a more natural sediment transport regime.

Reclamation (2011b) concluded that downstream of IGD, there will be a substantial increase in sand content immediately following reservoir drawdown in the Bogus Creek to IGD reach. The percent of sand in the bed is expected to increase by up to 40% for the month immediately after reservoir drawdown. The pre-dam sand composition in the bed at Iron Gate was 20.4% (Klamath Facilities Removal EIS/EIR). Under a wet year scenario, the sand would decrease to below 20% within a year; however, under a median or dry scenario, a subsequent wet year would be required to flush the sand material from the bed. Downstream of Bogus Creek, it is expected that sand may take longer to be flushed downstream and under dry or median year scenarios it could take five to six years for sand in the bed to return to equilibrium levels between Bogus Creek and Willow Creek and up to 10 years between Willow Creek and Cottonwood Creek (Reclamation 2011b). Reclamation (2011b) expects that the Willow Creek to Bogus Creek reach will respond similiar to the Iron Gate reach upstream. However, because the reach is longer, it may take slightly longer to flush the excess sand from the bed during a wet year. However, under median or dry water year scenarios, it may take five or six years to return the sand to an equilibrium level. The Cottonwood Creek to Willow Creek reach may take even longer to reach equilibrium.

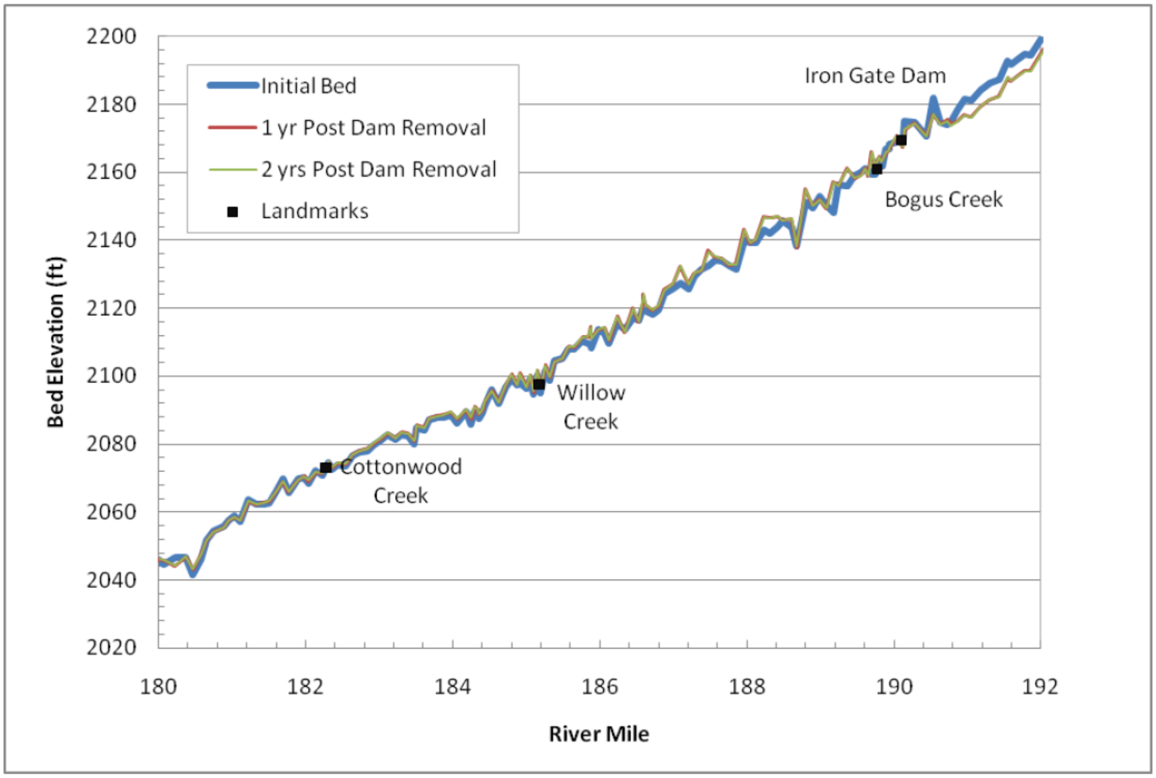


Figure 5-5. Bed Profile Downstream of Iron Gate Dam to Cottonwood Creek for Two Years Following Dam Removal (Reclamation 2011b)

SRH-1D model results indicate decreases in bed elevation and increases in median substrate size within the reservoirs during drawdown (January 2020 to May 2020) (Reclamation 2011c, Klamath Facilities Removal EIS/EIR). These changes would stabilize within 5 months as the bed within the historical river channel reaches pre-dam elevations (Reclamation 2011c; B. Greimann, pers. comm., December 23, 2010). These river sections are expected to revert to and maintain a pool-riffle morphology due to restoration of riverine processes along the Hydroelectric Reach (PacifiCorp 2004b).

Spawning sites

As stated above, successive high flows released and spilled from IGD have winnowed out gravel and small cobbles from the river bed, leaving it in an artificially coarse condition that is relatively unsuitable for spawning salmonids. The lack of spawning gravel is especially critical below IGD (FERC 2006). Spawning habitat quality improves in a downstream direction as tributary-supplied sediment from Bogus, Willow, and Cottonwood creeks enter the channel.

Based on spawning surveys conducted from 2001 to 2005 (Magneson and Gough 2006), from 6 to 13 redds would likely suffer 100% mortality as a result of the drawdown release of SSC. This would result in total mortality of incubating eggs, alevin, and pre-emergent fry prior to initiation of blasting. In addition, the proportion of sand in the bed is expected to increase to up to 40% for the month immediately after reservoir drawdown. The sand is not expected to reach equilibrium levels for at least a year during a wet water year and up to five or six years during dry or median water years. The high sand content reduces spawning habitat quality. **Therefore, the initial drawdown and release of sediment may affect and is likely to adversely affect the upper mainstem Klamath River coho salmon's spawning sites PCE in the short-term and extend for several years thereafter**.

Once the sand is flushed from the river bed downstream within 1 to 6 years following dam removal, it can be expected that there will be an increase of suitable spawning gravel in the reach between IGD and Bogus Creek. This would be due to the restoration of the transport of spawning gravels from areas upstream of IGD (FERC 2007). This effect would potentially improve critical habitat for coho salmon by reducing median substrate to a size more favorable for spawning (DOI 2011). The release of sediment from behind the dams would help create more natural substrate characteristics in the Hydroelectric Reach and result in a significant increase in the number of spawning sites available for coho salmon. **The Proposed Action would result in a long-term beneficial effect to the spawning site PCE downstream of IGD and for critical habitat that will be designated in the Hydroelectric Reach and its tributaries. Therefore, Proposed Action may affect but is not likely to adversely affect the spawing site PCE downstream of IGD and for critical habitat that will be designated in the Hydrologic Reach and its tributaries in the long-term.**

Food resources

As stated above, there will be a substantial increase in sand content immediately following reservoir drawdown in the Bogus Creek to IGD reach. The percent of sand in the bed is expected to increase to up to 40% for the month immediately after reservoir drawdown. If dam occurs during a wet year, it is expected that the percent sand in the substrate would then decrease to below 20% by the end of the spring runoff in 2020. Under a median or dry water year, a subsequent wet year would be required to flush the sand from the bed and return to an equilibrium level (Reclamation 2011b). Increased sand concentrations would reduce the interstices in the substrate and in turn affect benthic macroinvertebrates (BMI) production.

Under the Proposed Action, increased SSCs would be expected to affect filter-feeding BMI in the short-term. The high concentrations of suspended sediment released during winter are not predicted to have a severe effect on macroinvertebrates during their winter dormancy period. However, excessive levels of SSCs during spring 2020 are expected to cause physiological stress, reduced growth, and potential mortality to filter-feeding BMIs. The scraper-grazers feeding guild among the BMIs are also expected to be deleteriously affected, but due to their increased mobility, would be affected less than the filter-feeders. This could affect BMI as far downstream as the Orleans. During summer SSC will be lower, but would be expected to impact macroinvertebrates during the peak of their feeding and reproductive period. Recolonization of affected BMI populations would occur relatively quickly due to the shortened life cycle of BMIs and rapid dispersal through drift and/or the flying stages of many BMI adults. In addition, recolonization is expected to occur rapidly through drift or dispersal of adult life stages from established BMI populations within the many tributary rivers and streams of the Klamath River.

Juvenile coho salmon feed primarily on drifting terrestrial insects, much of which are produced in the riparian canopy, and on aquatic invertebrates growing in the interstices of the substrate and in the leaf litter in pools (NMFS 2003). This increase in sand composition of the substrate would partially fill in interstitial spaces between gravel, cobble, and boulders, which will adversely affect BMI production and availability as a food source for coho salmon. **Therefore, the initial drawdown and release of sediment may affect and is likely to adversely affect coho salmon’s food resources PCE between IGD and Orleans in the short-term**.

In the long-term, the reformation of river channels in the reservoir reaches upstream of IGD under the Proposed Action is expected to benefit BMIs by providing more suitable substrates than currently exist. As a result, suitable habitats formed upstream of IGD might be opened to additional colonization by BMIs through rapid dispersal by drift from upstream populations within current riverine reaches and/or dispersion of adult life stages. Recolonization would also be expected to occur rapidly from established BMI populations within the many tributary rivers and streams of the Klamath River. Increased habitat availability for BMI population is anticipated to increase food availability for juvenile coho salmon downstream of IGD as BMI freely drift or migrate downstream from the Hydroelectric Reach. This would result in a significant increase in the amount of food resources available for coho salmon. **The Proposed Action would result in a long-term beneficial effect to the upper mainstem Klamath River coho salmon's food resources PCE. Therefore, the Proposed Action may affect but is not likely to adversely affect the upper mainstem Klamath River coho salmon's food resources PCE in the long-term.**

Water quality

Suspended sediment

As described in Section 5.1.3.1, the Proposed Action would result in a short-term SSC in the mainstem during the winter of facility removal that is much higher than under existing conditions. These elevated SSC will result in effects on juvenile coho salmon and redds that range from extreme stress to mortality. **Therefore, the Proposed Action may affect and is likely to adversely affect the suspended sediment component of coho salmon's water quality PCE in the short-term.**

The sediment released from the drawdown and dam removal would be a short-term response to the Proposed Action, and not continue for more than one or two years. In the long-term, suspended sediment loads would be normal run of the river amounts. **Therefore, in the long-term, the drawdown and dam removal would have no effect on the suspended sediment component of coho salmon's water quality PCE.**

Water temperature

Reservoir drawdown under the Proposed Action would occur during winter months, when the reservoir water column is well-mixed and temperatures are driven by river inflows and prevailing meteorological conditions, so there are no anticipated short-term effects of the Proposed Action on water temperature during the drawdown period.

In agreement with the Klamath River Water Quality Model (KRWQM) results, Klamath TMDL model (see Appendix D of the Klamath Facilities Removal EIS/EIR) results indicate that under the Proposed Action, water temperature in the Klamath River downstream of IGD (RM 190.1) would be 2–10°C (3.6–18°F) lower during August through December and 2–5°C (3.6–9°F) higher during January through March than those under the existing condition (Figure 5-6), due to removal of the large thermal mass created by the reservoirs (NCRWQCB 2010). There is a brief period in late-April and early-May where the model indicated that water temperatures may exceed those preferred by juvenile coho salmon.

The Klamath TMDL model also predicts that daily fluctuations in water temperature downstream of IGD would be greater under the Proposed Action than the existing condition as water temperatures would be in equilibrium with (and would reflect) daily fluctuations in ambient air temperatures. These impacts would decrease in magnitude with distance downstream of IGD, should be similar to existing conditions near the mouth of the Salmon River (≈RM 66) (Figure 5-8), and will dissipate by the Scott River confluence (RM 143.9) (Figure 5-7).

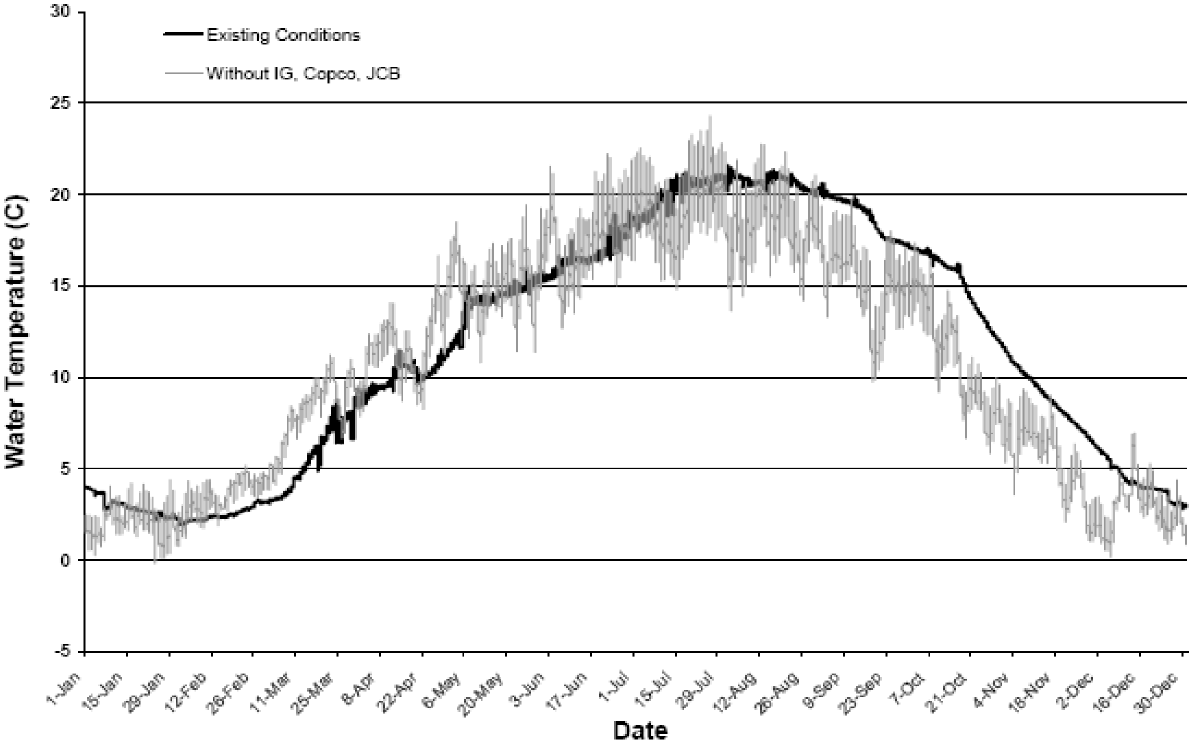


Figure 5-6. Simulated Hourly Water Temperature Downstream of IGD (RM 190.1) Based on Year 2004 for Existing Conditions Compared with Hypothetical Conditions without J.C. Boyle, Copco 1, Copco 2, and Iron Gate Dams (Source: PacifiCorp 2004b)

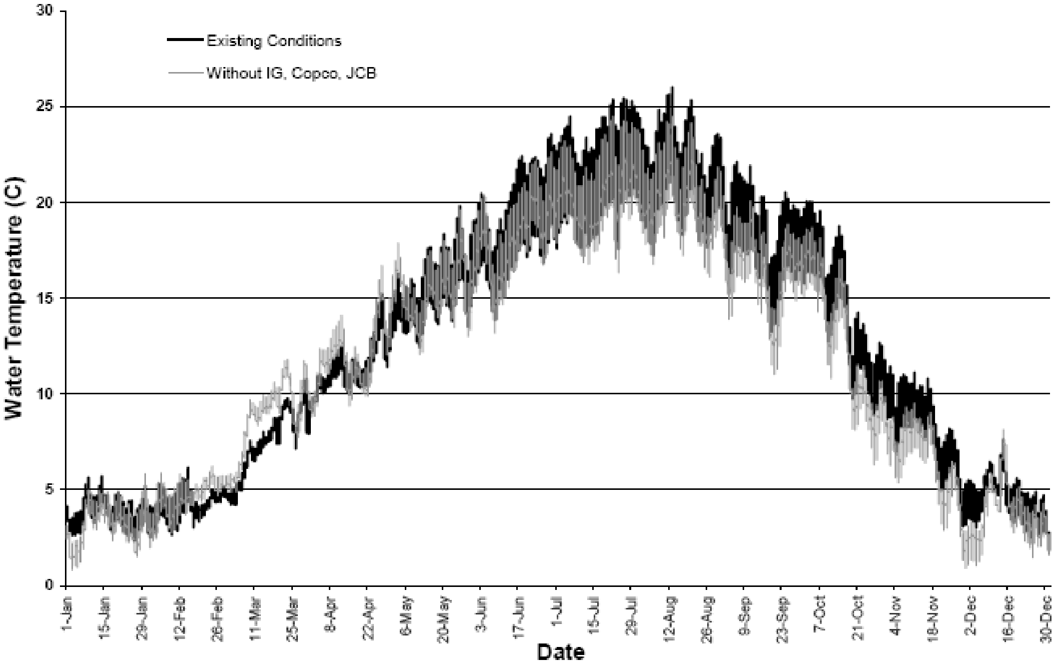


Figure 5-7. Simulated Hourly Water Temperature Immediately Upstream of the Scott River Confluence (RM 143.9) Based on Year 2004 for Existing Conditions Compared with Hypothetical Conditions without J.C. Boyle, Copco 1, Copco 2, and Iron Gate Dams (Source: PacifiCorp 2004b)

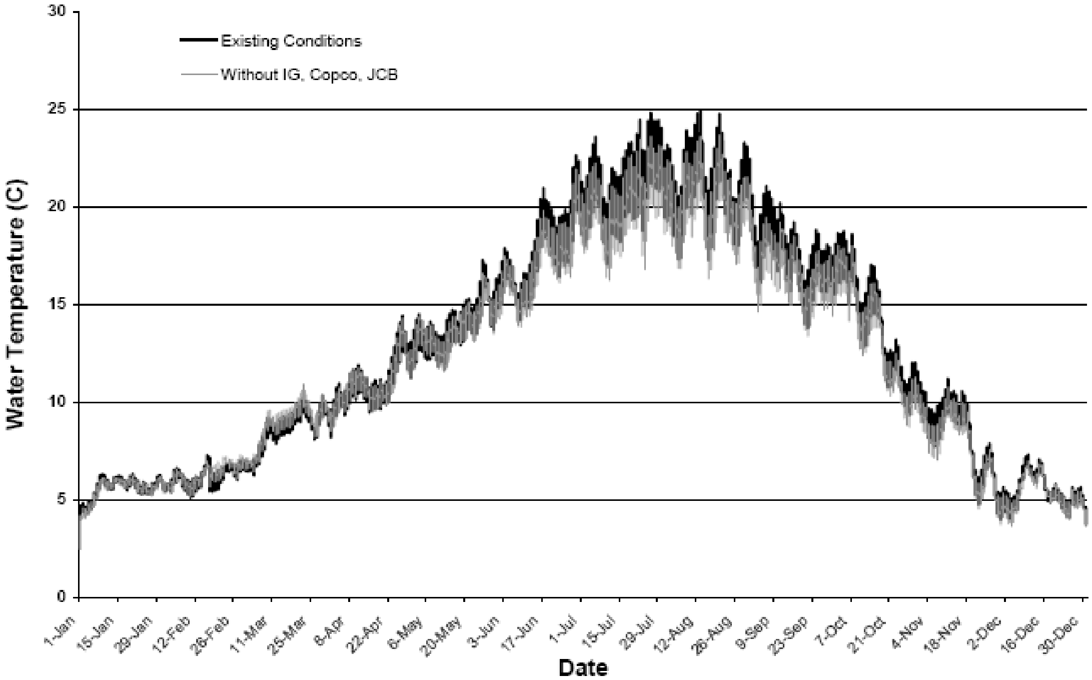


Figure 5-8. Simulated Hourly Water Temperature Downstream of the Salmon River Confluence (≈RM 66) Based on Year 2004 for Existing Conditions Compared with Hypothetical Conditions without J.C. Boyle, Copco 1, Copco 2, and Iron Gate Dams (Source: PacifiCorp 2004b)

Simulations of water temperatures without the reservoirs (as discussed in Hamilton et al. 2011) show that the temperature difference with and without dams would be greatest downstream of IGD, but could extend an additional 120 to130 mi downstream. Estimated decreases in stream temperature with dam removal relative to current conditions are likely to be smaller with continued climate change; however, temperature conditions would be much improved under the Proposed Action as compared with existing conditions. In summary, water temperature in the Klamath River downstream of IGD (RM 190.1) would be 2–10°C (3.6–18°F) lower during August through December, 2–5°C (3.6–9°F) higher during January through March, and 2–5°C (3.6–9°F) higher from late-April through July than those under the existing condition (Figure 5-6). Water temperatures in the reach above the Scott River and downstream of the Salmon River appear to be slightly cooler overall and would help buffer the projected increases in water temperature from climate change.

The thermal lag formerly caused by water storage in reservoirs and the associated increased thermal mass would be eliminated in the Lower Klamath River. This elimination would cause water temperatures to have natural diurnal variations and become more in sync with historical migration and spawning periods for coho salmon, warming earlier in the spring, and cooling earlier in the fall compared with existing conditions (Stillwater Sciences 2009b, Hamilton et al. 2011). Changes in water temperature would benefit upstream migrant adults and juveniles during fall upstream migration and juvenile redistribution to overwintering habitats by providing a broader window of suitable water quality during migration. Juvenile outmigrants may also move out earlier during spring with slightly warmer water temperatures, potentially reducing their susceptibility to parasites and disease and improving growth rates.

Under the Proposed Action, short-term impacts from reservoir drawdown would have no effect on water temperature during the drawdown period. In the long-term, water temperatures during late-April through July (downstream of IGD to the Scott River confluence) appear to be higher than existing conditions and may exceed those preferred by juvenile coho salmon; however, juvenile outmigrants may also move out earlier during the spring with slightly warmer water temperatures, potentially reducing their susceptibility to parasites and disease, and improving growth rates. The cooler fall temperatures would be beneficial for adult migration and juvenile rearing. The warmer winter temperatures are within the preferred range for coho salmon and may actually improve growth rates. The thermal lag formerly caused by water storage in reservoirs would be eliminated and would cause water temperatures to have natural diurnal variations and become more in sync with historical migration and spawning periods for coho salmon (Stillwater Sciences 2009b, Hamilton et al. 2011). **As a result of the overall long-term beneficial impacts, which are expected to occur in perpetuity after dam removal, the Proposed Action may affect but is not likely to adversely affect the water temperature component of coho salmon water quality PCE.**

Dissolved oxygen

Under the Proposed Action, high SSCs are expected in the middle and lower Klamath River immediately following dam removal. The high fraction of organic carbon present in the reservoir sediments allows for the possibility of oxygen demand generated by microbial oxidation of organic matter exposed to the water column from deep within the sediment profile and mobilized during dam removal.

Based on results from a dissolved oxygen spreadsheet model (see Section 3.2.4.1 of the Klamath Facilities Removal EIS/EIR), immediate oxygen demand (IOD) downstream of IGD would be 0–8.6 mg/L and biological oxygen demand (BOD) would be 0.3–43.8 mg/L for all water year types considered (i.e., wet, median, dry) and for all six months following drawdown (Table 5-4). The highest predicted oxygen demand levels (i.e., IOD and BOD) would occur during the first four to eight weeks following drawdown of Copco 1 and Iron Gate Reservoirs (i.e., in February 2020) corresponding to the peak SSCs in the river (see above section on suspended sediments). Despite the relatively high predicted IOD and BOD values, dissolved oxygen concentrations downstream of IGD would generally remain greater than 5 mg/L (Table 5-5), the minimum acceptable dissolved oxygen concentration for salmonids. Exceptions include predicted concentrations in February 2020 for median (WY1976) and typical dry year (WY2001) hydrologic conditions, which exhibit minimum values of 3.5 mg/L and 1.3 mg/L, respectively.

Table 5-4. Estimated Short-Term Immediate Oxygen Demand and Biochemical Oxygen Demand by Month for Modeled Flow and SSCs Immediately Downstream of IGD under the Proposed Action

Year	Avg. monthly temperature (deg C)[1]	80% dissolved oxygen[2]	Flow (cfs)[3]	Flow (cms)	SSC (mg/L)[4]	IOD (mg/L)	BOD (mg/L)
Typical Wet Hydrology (WY 1984 Conditions Assumed)							
11/30/2019	9.9	7.29	3,343	95	444	0.3	1.6
12/1/2019	5.0	9.40	7,139	202	430	0.3	1.5
1/21/2020	3.7	9.73	8,675	246	1,962	1.2	6.9
2/15/2020	4.4	9.55	3,949	112	7,116	4.5	25.1
3/1/2020	6.7	9.00	4,753	135	593	0.4	2.1
4/15/2020	8.4	8.63	4,374	124	939	0.6	3.3
Median Hydrology (WY 1976 Conditions Assumed)							
11/12/2019	9.9	7.29	2,074	59	96.2	0.1	0.3
12/12/2019	5.0	9.40	2,156	61	202.5	0.1	0.7
1/22/2020	3.7	9.73	6,533	185	2,593.5	1.6	9.1
2/14/2020	4.4	9.55	2,933	83	9,893.2	6.2	34.8
3/1/2020	6.7	9.00	3,016	85	1,461.2	0.9	5.1
4/7/2020	8.4	8.63	2,657	75	509.3	0.3	1.8
Typical Dry Hydrology (WY 2001 Conditions Assumed)							

Year	Avg. monthly temperature (deg C)[1]	80% dissolved oxygen[2]	Flow (cfs)[3]	Flow (cms)	SSC (mg/L)[4]	IOD (mg/L)	BOD (mg/L)
11/19/2019	9.9	7.29	1,141	32	79.1	0.0	0.3
12/23/2019	5.0	9.40	1,284	36	122.2	0.1	0.4
1/17/2020	3.7	9.73	4,245	120	3,513.7	2.2	12.4
2/16/2020	4.4	9.55	1,040	29	13,573.5	8.6	47.8
3/2/2020	6.7	9.00	1,344	38	2,420.7	1.5	8.5
4/5/2020	8.4	8.63	1,150	33	551.1	0.3	1.9

Source: Stillwater Sciences 2011

[1] Raw daily water temperature data for 2009 from http://www.pacificorp.com/es/hydro/hl/kr.html# (PacifiCorp 2009). Monthly summary data also presented in Table 3.2-12.

[2] Initial dissolved oxygen downstream of IGD calculated for 80% saturation using average monthly water temperature, salinity = 0 ppt, and elevation = 707 m (2,320 ft). An initial dissolved oxygen at 70% saturation was used for the November model runs based on 2009 conditions (Appendix C, Table C-7).

[3] Predicted daily flow values from Reclamation hydrologic model output (Greimann et al. 2011). Daily flow values correspond to the peak SSC for each month.

[4] Predicted peak SSC by month from Reclamation model output under the Proposed Action (Greimann et al. 2011).

Table 5-5. Estimated Location of Minimum Dissolved Oxygen and Location at which Dissolved Oxygen would Return to 5 mg/L Downstream of IGD due to High Short-Term SSC under the Proposed Action

Date	Boundary conditions at IGD			Spreadsheet model output		
	Initial dissolved oxygen (at 80% saturation)[1]	IOD	BOD	Minimum dissolved oxygen	Location of minimum dissolved oxygen	Location at which dissolved oxygen returns to 5 mg/L[2]
	(mg/L)	(mg/L)	(mg/L)	(mg/L)	RM	RM
Typical Wet Hydrology (WY 1984 Conditions Assumed)						
11/30/2019	7.29	0.3	1.6	7.10	189.5	190.1
12/1/2019	9.40	0.3	1.5	9.18	188.9	190.1
1/21/2020	9.73	1.2	6.9	8.56	188.2	190.1
2/15/2020	9.55	4.5	25.1	5.21	188.9	190.1
3/1/2020	9.00	0.4	2.1	8.70	188.9	190.1
4/15/2020	8.63	0.6	3.3	8.11	188.9	190.1
Median Hydrology (WY 1976 Conditions Assumed)						
11/12/2019	7.29	0.1	0.3	7.29	190.1	190.1
12/12/2019	9.40	0.1	0.7	9.34	189.5	190.1
1/22/2020	9.73	1.6	9.1	8.18	188.2	190.1
2/14/2020	9.55	6.2	34.8	3.49	188.9	175.2
3/1/2020	9.00	0.9	5.1	8.19	188.9	190.1
4/7/2020	8.63	0.3	1.8	8.38	189.5	190.1
Typical Dry Hydrology (WY 2001 Conditions Assumed)						
11/19/2019	7.29	0.0	0.3	7.29	190.1	190.1
12/23/2019	9.40	0.1	0.4	9.40	190.1	190.1
1/17/2020	9.73	2.2	12.4	7.62	188.9	190.1
2/16/2020	9.55	8.6	47.8	1.33	189.5	177.1
3/2/2020	9.00	1.5	8.5	7.62	189.5	190.1
4/5/2020	8.63	0.3	1.9	8.39	189.5	190.1

Source: Stillwater Sciences 2011.

[1] Initial dissolved oxygen downstream of IGD calculated for 80% saturation using average monthly water temperature, salinity = 0 ppt, and elevation = 707 m (2,320 ft). An initial dissolved oxygen at 70% saturation was used for the November model runs. See average monthly dissolved oxygen (percent saturation) for 2009 in Appendix C, Table C-7. Raw daily water temperature data from http://www.pacificorp.com/es/hydro/hl/kr.html# (PacifiCorp 2009).
[2] Minimum acceptable dissolved oxygen concentration for salmonids.
[3] Distance downstream of IGD.

While predicted short-term increases in oxygen demand under the Proposed Action generally result in dissolved oxygen concentrations above the minimum acceptable level (5 mg/L) for salmonids, exceptions to this would occur four to eight weeks following drawdown of J.C. Boyle and Iron Gate reservoirs (i.e., in February 2020), when dissolved oxygen would remain below 5 mg/L from IGD to near the confluence with the Shasta River (RM 176.7), or for a distance approximately 20–25 km downstream of the dam. **Therefore, the Proposed Action may affect and is likely to adversely affect the dissolved oxygen component of the water quality PCE in the short-term**.

Removal of the Four Facilities under the Proposed Action could cause long-term (2–50 years following dam removal) overall increases in dissolved oxygen, as well as increased daily variability in dissolved oxygen, in the lower Klamath River, particularly for the reach immediately downstream of IGD. KRWQM (see Klamath Facilities Removal EIS/EIR Section 3.2.1.1 for model background) results using 2001–2004 data indicate that substantial improvements in long-term dissolved oxygen may occur immediately downstream of IGD if the Four Facilities are removed, with increases of 3 to 4 mg/L possible during summer and late fall (PacifiCorp 2004c).

The Klamath TMDL model (see Appendix C of the Klamath Facilities Removal EIS/EIR) also indicates that under the Proposed Action (similar to the TMDL TCD2RN scenario), dissolved oxygen concentrations immediately downstream of IGD during July through November would be greater than those under the existing condition (similar to the TMDL T4BSRN scenario), due to the lack of stratification and oxygen depletion in bottom waters in the upstream reservoirs as compared with a free-flowing river condition (Appendix C of the Klamath Facilities Removal EIS/EIR; NCRWQCB 2010).

Overall, the removal of the Four Facilities under the Proposed Action would cause long-term increases in summer and fall dissolved oxygen in the lower Klamath River immediately downstream of IGD, along with potentially increasing daily variability. Effects would diminish with distance downstream of IGD, such that there would be no measurable effects on dissolved oxygen by the confluence with the Trinity River. **Under the Proposed Action, the long-term (2–50 years following dam removal) increases in summer and fall dissolved oxygen concentrations immediately downstream of IGD would be beneficial, and therefore may affect but is not likely to adversely affect the water quality PCE of coho salmon.**

Water velocity

The Four Facilities were developed as hydroelectric generation facilities and not as flood control dams. In addition, the dams impound relatively small pools ranging from 73 acre-feet at Copco 2 to 53,800 acre-feet at Iron Gate. These reservoirs typically fill and spill within the first few fall or winter runoff events and flood attenuation is relatively low, averaging about 5% (Klamath Facilities Removal EIS/EIR).

Removal of the Four Facilities is expected to result in relatively minor changes to river flows downstream of IGD (Figures 5-9 and 5-10). Assuming changes in water velocities are proportional to changes in flow exceedences, then there will be relatively little change between existing and Proposed Action conditions for the 90 and 50% exceedence flows downstream of IGD (Figure 5-9). Proposed Action water velocities downstream of IGD will be lower in the fall and slightly higher during the summer under the 10%

exceedence flow scenario. However, Proposed Action flows and water velocities would be similar to the existing condition at Orleans (Figure 5-10). Some increased flow variability downstream of Keno Dam would be expected due to the loss of the detention effect of the four reservoirs. **Therefore, the Proposed Action may affect, but is not likely to adversely affect the water velocity PCE of coho salmon.**

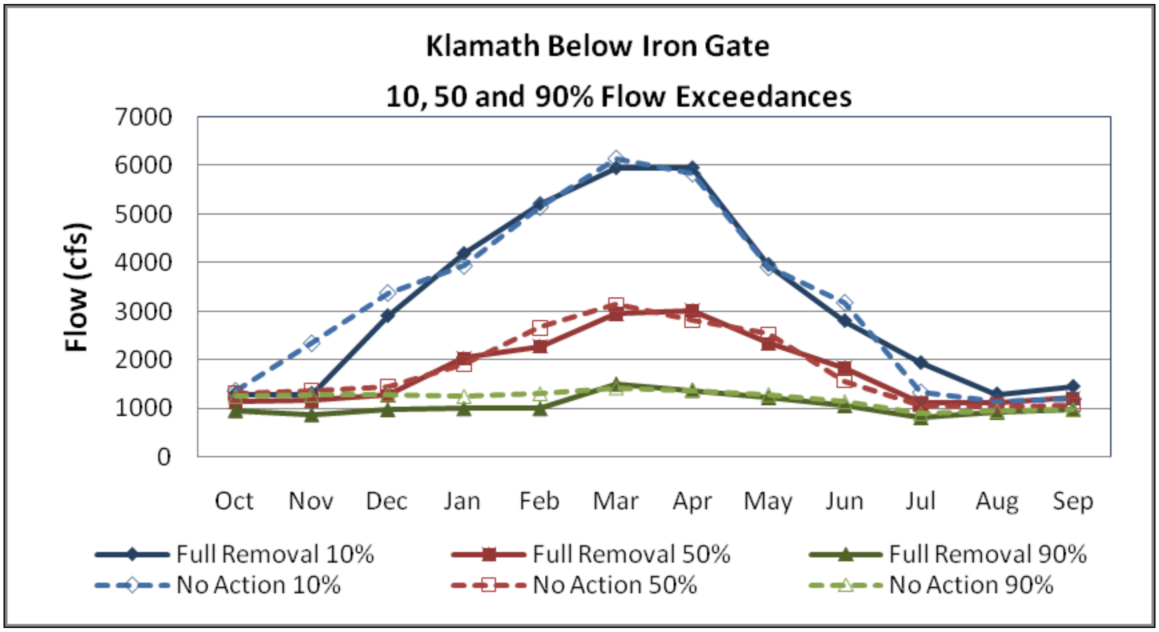


Figure 5-9. Flow Exceedences Downstream of IGD (Klamath Facilities Removal EIS/EIR)

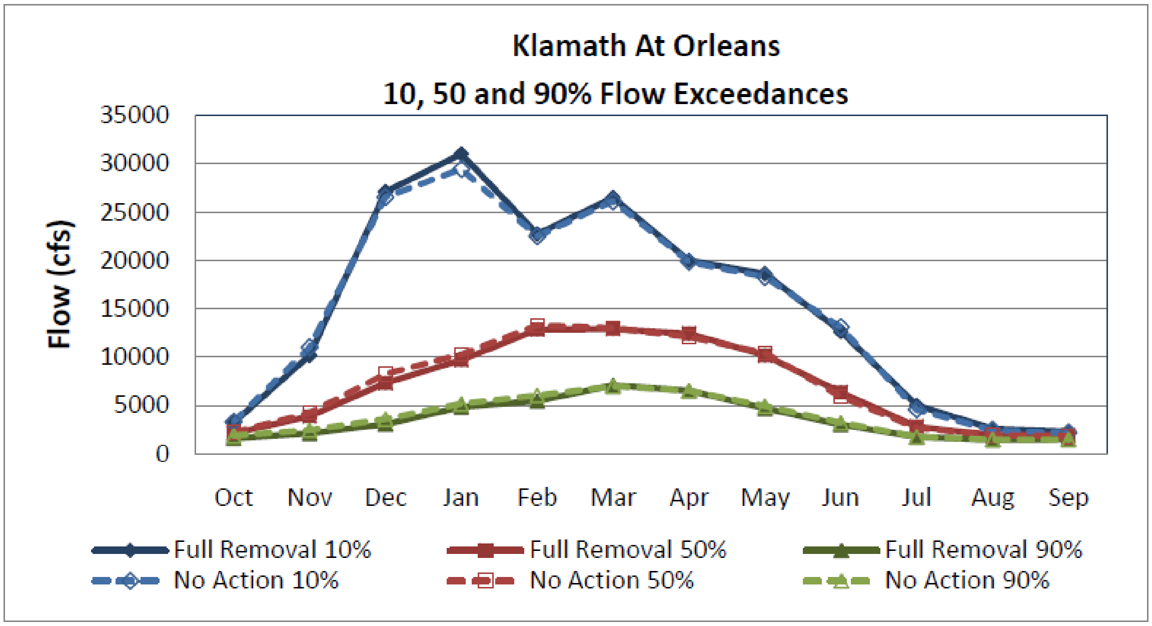


Figure 5-10. Flow Exceedences Downstream at Orleans (Klamath Facilities Removal EIS/EIR)

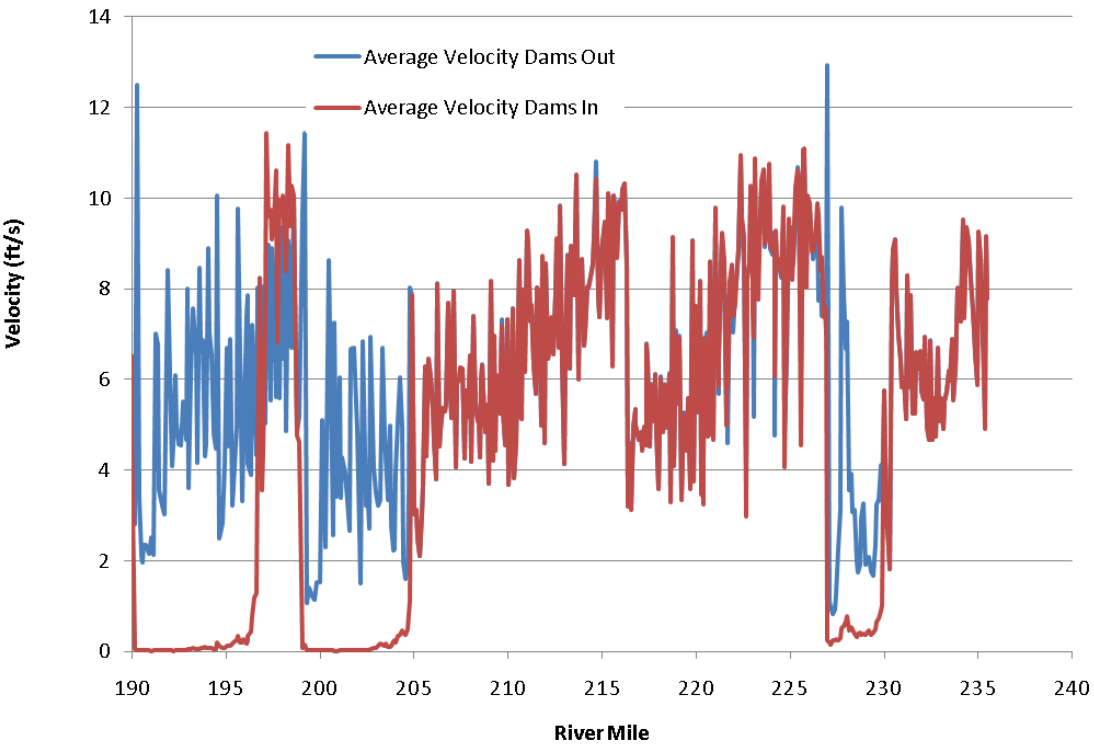


Figure 5-11. Average Water Velocity in J.C. Boyle to Iron Gate Reach for the Existing and the Proposed Action Conditions at 3,000 cfs (Reclamation 2011b)

Space

The PCE "space" refers to the space needed for individual and population growth and normal behavior (64 FR 24049). As stated above, the release of sediment associated with the reservoir drawdown and dam removal will result in sediment deposition in the reaches downstream of IGD. Sediment deposition will result in some channel and pool filling in the reach between IGD and Cottonwood Creek. This would result in a loss of space for coho salmon. However, this reach has also been subject to interrupted sediment supply due to the presence to the Four Facilities. This interruption of sediment transport has has likely resulted in some habitat simplification due to the river's reduced ability to establish and maintain the type of pool-riffle morphology tht would occur with a normal sediment supply. Therefore, although sediment deposition that results from the dam removal would reduce overall habitat space, the reintroduction of coarse sediment would allow for increased habitat complexity in the post-dam channel downstream of Iron Gate. **Therefore, the Proposed Action may affect, but is not likely to adversely affect the space PCE of coho salmon critical habitat in the short-term.**

Removal of the Four Facilities will increase coho salmon living space by an estimated 76 miles of potential habitat within the Hydroelectric Reach (Administrative Law Judge 2006). **The Proposed Action will result in a beneficial effect on coho salmon living space PCE once the future critical habitat revision occurs. Therefore, the Proposed Action may affect but is not likely to adversely coho salmon living space PCE in the long-term.**

Safe passage

Adult coho

SSC within the mainstem Klamath River would be high enough to cause major physiological stress and impaired homing in the falloff 2019 and immediately following removal of the dams in 2020 (Appendix

E in the Klamath Facilities Removal EIS/EIR), depending on the amount of reservoir sediment that remains to be eroded. This reduction in water quality may result in the few adult coho salmon that typically spawn in the mainstem Klamath River to stray into cleaner flowing tributary streams. However, the Proposed Action would also restore coho salmon migratory access to the Hydroelectric Reach, expanding their distribution to include historical habitat along the mainstem Klamath River and all tributaries upstream as far as Spencer Creek; including in Jenny, Shovel, and Fall creeks (Hamilton et al. 2005). Adults could first access this reach in fall of 2020 after dam removal. Once upstream of IGD, the migrating coho salmon would encounter progressively improving water quality. **Therefore, in the short-term the Proposed Action may affect and is likely to adversely affect safe passage PCE downstream of IGD during the fall of 2019 and 2020.**

In the long-term, the Proposed Action would allow for coho salmon access to an estimated 76 miles of potential habitat within the Hydroelectric Reach, (Administrative Law Judge 2006). **This increase in migratory access to habitat upstream of IGD will be beneficial for the species, and is expected to be included in future critical habitat revisions. Therefore, the Proposed Action may affect but is not likely to adversely affect coho salmon migratory acess to habitat upstream of IGD in the long-term.**

Coho salmon smolts

Coho salmon smolts from the 2019 cohort are expected to outmigrate to the ocean beginning in late February, although most natural origin smolts outmigrate to the mainstem Klamath during April and May (Wallace 2004). Under the Proposed Action, SSC would be higher during spring than under existing conditions, thereby reducing the quality of coho salmon smolt migration habitat. As a result, coho smolts outmigrating in early spring (prior to April 1) are likely to suffer up to 49% mortality in a worst-case scenario. Smolts outmigrating in late spring (after April 1) will be exposed to lower SSC, and may experience only slightly worse physiological stress and reduced growth rates compared with existing conditions, even under a worst-case scenario. **Therefore, the Proposed Action may affect and is likely to adversely affect coho salmon smolt safe passage PCE on the mainstem Klamath River in the short-term.**

In the long-term, the return to a more natural hydrologic regime is expected to result in river flows that are either the same or higher than the current condition for the months of March through July (Figure 5-9). The higher flows would assist smolt migration. **The Proposed Action will result in improved coho salmon smolt safe passage PCE in the long-term. Therefore, the Proposed Action may affect but is not likely to adversely affect coho salmon smolt safe passage PCE in the long-term.**

Riparian vegetation

Riparian habitat occurs along the river and reservoir shorelines in some areas and consists of deciduous, shrub, and grassland vegetation. Downstream of IGD, riparian vegetation coverage is limited to the edge of the river channel and the surfaces of existing gravel bars. The Proposed Action does not include removal of riparian vegetation and the proposed drawdown releases will not exceed flows currently experienced by the river channel. **Therefore, in the short-term, the Proposed Action would have no effect on the riparian vegetation PCE of critical habitat**.

Project dams prevent the downstream transport of sediment, which may result in a diminished supply of spawning gravel and other altered geomorphological processes (including sand and silt starvation) that may influence aquatic habitat and adversely influence the establishment of riparian vegetation (FERC 2007). In the long-term, with the dams out, a return to sediment transport and hydrologic process will likely improve riparian establishment and succession patterns. In addition, the Proposed Action includes the re-establishment of herbaceous vegetation in the drained reservoir areas, which could be a source for riparian vegetation recruitment downstream of IGD. **In the long-term, the Proposed Action will have a**

beneficial effect on the riparian vegetation PCE of critical habitat. Therefore, the Proposed Action may affect but is not likely to adversely affect the riparian vegetation PCE of critical habitat.

5.1.5 Southern DPS Eulachon

Potential effects of the proposed action on this species would be limited to the lower Klamath River, estuary, and nearshore environment. This is because the southern DPS eulachon are only known to occupy the action area during the winter and spring for spawning, incubation, and early rearing. The only potential adverse effects on this species that would occur as a result of the Proposed Action are short-term degradation of water quality due to increased SSC in the estuary during reservoir drawdown and dam removal.

5.1.5.1 Short-Term Effects

Under the Proposed Action, sediment would be released from IGD and would decline in concentration in the downstream direction as a result of flow accretion from downstream tributaries. Adults entering the Klamath River in the winter and spring of 2020 may be exposed to high SSC for a portion of their migration period. It is expected that under the worst-case scenario, SSC will range from 330 to 1,354 mg/L in winter and spring 2020. Although no analysis of the effects of SSC on eulachon is available, based on application of the Newcombe and Jensen (1996) approach using studies of the effects on other estuary species, it is predicted that under a most-likely or worst-case scenario, mortality would be higher under the Proposed Action than under existing conditions (Table 5-6). Mortality is also predicted to be higher for spawning, incubation, and larval life stages under the Proposed Action than under existing conditions, with no discernable difference in predicted effects between the most-likely and worst-case scenarios. Although eulachon have a relatively short duration of occurrence within the Klamath River (around one month), they can potentially migrate and spawn anytime during the winter and early spring. For this analysis it was assumed that adult migrate and spawn during the peak in SSC concentrations, although in reality it is likely that a proportion of the population will migrate before or after the largest pulses of SSC. **Overall, SSC in the Lower Klamath River resulting from the Proposed Action's reservoir drawdown may affect and is likely to adversely affect the Southern DPS eulachon.**

Table 5-6. Proposed Action, Most-Likely Scenario SSCs Compared with Normal Existing Conditions (50% Exceedance Probabilities) and Proposed Action, Worst-Case Scenario SSCs Compared with Extreme Existing Conditions (10% Exceedance Probabilities) for Eulachon

Scenario	Life history stage: Eulachon		
	Adult migration during the period of January 1, 2020-April 30, 2020, with a two-week duration of exposure	**Spawning and incubation during the period of January 1, 2020-April 30, 2020, with a three-week exposure**	**Larval drift during the period of January 1, 2020-April 30, 2020, with a three-day exposure**
Most likely	***Existing Conditions (normal)***		
	Major stress and impaired homing	Up to 52% mortality of incubation eggs	Up to 20% mortality of larvae
	Proposed Action		
	Up to 36% mortality migrating adults	Up to 84% mortality of incubating eggs	Up to 60% mortality of larvae
Worst case	***Existing Conditions (extreme)***		
	Up to 20% mortality of migrating adults	Up to 60% mortality of incubating eggs	Up to 40% mortality of larvae
	Proposed Action		
	Up to 36% mortality of migrating adults	Up to 84% mortality of incubating eggs	Up to 60% mortality of larvae

5.1.5.2 Long-Term Effects

In the long-term, conditions in the estuary are expected to be closer to those that occur under historical conditions. The return to water temperature, sediment transport, and flow regimes that more closely mimic historical patterns would likely benefit eulachon. **In the long-term, the Proposed Action will likely benefit the Southern DPS eulachon**. **Therefore, the Proposed Action may affect but is not likely to adversely affect Southern DPS eulacon in the long-term.**

5.1.5.3 Critical Habitat

The effects of the Proposed Action on critical habitat described below was based on evaluation of the physical, chemical, and biological changes that were expected to occur within the area of analysis and how those changes would affect the essential features necessary for the conservation of eulachon in the short and long-term.

NMFS (76 FR 65324) determined that the essential features of critical habitat considered essential for the conservation of the Southern DPS eulachon included:

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 obstructions 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.
3. Nearshore and offshore marine foraging habitat with water quality and available prey, supporting juveniles and adult survival.

Freshwater spawining and incubation
Water flow and quality

Flow Removal of the Four Facilities is expected to result in relatively minor changes to river flows downstream of IGD (Figures 5-9 and 5-10). Assuming changes in water velocities are proportional to changes in flow exceedance, there will be relatively little change between existing conditions and proposed action conditions for the 90 and 50% exceedence flows downstream of IGD (Figure 5-9). Under the Proposed Action, water velocities downstream of IGD will be lower in the fall and slightly higher during the summer under the 10% exceedence flow scenario. However, proposed action flows and water velocities would be similar to the existing condition downstream of Orleans, within critical habitat for eulachon (Figure 5-10). **Therefore, the Proposed Action may affect, but is not likely to adversely affect, the water flow essential for spawning and incubation habitat for Southern DPS eulachon.**

Suspended sediment The reach of the Klamath River utilized by eulachon extends upstream to Omogar Creek (RM 10.7). Under the proposed action, sediment would be released from IGD during facility removal and would decline in concentration in the downstream direction as a result of flow accretion from downstream tributaries. It is expected that under a worst-case scenario, SCC will range from 330 to 1,354 mg/L at Klamath from January 1 through February 19, 2020 (Figure 5-1). As discussed in Section 5.1.5.1, increased suspended sediment is predicted to temporarily degrade habitat suitability compared to existing conditions for spawning and incubation (Table 5-6). **Therefore, suspended sediment released during implementation of the Proposed Action may affect and is likely to adversely affect the spawning and egg incubation habitat of the Southern DPS eulachon in the short-term.**

Suspended sediment concentrations are predicted to return to background levels within the lower Klamath River by November 2020 (Figure 5-1) prior to the 2021 eulachon spawning migration and spawning season. **Therefore, the Proposed Action will have no effect on spawning and incubation habitat of the Southern DPS eulachon in the long-term.**

Water temperature Eulachon spawning and egg incubation occurs in the winter and early spring. Water temperatures within the lower Klamath River are expected to be similar to the existing conditions during this time of year (Figure 5-8). **Therefore, any changes in water temperature resulting from the Proposed Action will have no effect on spawning and incubation habitat of the Southern DPS eulachon in the short- and long-term.**

Dissolved oxygen Based on results from a dissolved oxygen model (see Section 3.2.4.1 of the Klamath Facilities Removal EIS/EIR), water quality objectives of 90% saturation (i.e. 10-11 mg/L) would occur within a distance of 62–93 miles downstream of IGD, or generally in the reach between Seiad Valley and Clear Creek. There would be no proposed action-related change in dissolved oxygen downstream of Clear Creek, and therefore no affect within eulachon critical habitat. **Therefore, the Proposed Action will have no effect on dissolved oxygen, which is essential for eulachon spawning and incubation habitat in either the short- and long-term.**

Substrate Short-term SRH-1D model simulations estimate between 2.5 to 5 ft of reach-averaged deposition of fine and coarse sediment between IGD (RM 195) and Bogus Creek (RM189.8), decreasing to 1.0 to 1.5 ft of deposition between Bogus Creek and Willow Creek (RM 185.2). Other reaches downstream showed no apparent increase in bed elevation due to sediment deposition (Reclamation 2011b) (Figure 5-5). The removal of the Four Facilities will result in a return to more natural sediment transport processes than what is currently occurring. **Therefore, the initial drawdown and release of fine and coarse sediment may affect but not likely to adversely affect the Southern DPS eulachon spawning and incubation habitat in the short- and long-term.**

There is no information on how the elevated SSC resulting from the removal of the Four Facilities would affect substrate characteristics necessary for successful spawning and egg incubation within the lower Klamath River. However, it could be assumed that a portion of the suspended sediment may settle out in the substrate and alter the quality of the sand and pea gravel that eulachon rely upon for spawning and egg adhesion. **Therefore, the Proposed Action's release of suspended sediment may affect and is likely to adversely affect spawning and incubation habitat of the Southern DPS eulachon in the short-term. Rapid transport of fine sediment is predicted to result in no effect on substrate in the long-term.**

Migration corridor

Safe and unobstructed migratory pathways are required for eulachon adults to pass from the ocean through estuarine areas to riverine habitats in order to spawn (76 FR 65324). Larval eulachon require access to rearing habitats within the estuaries and juvenile and adults to access habitats in the ocean (76 FR 65324). The Klamath River contains essential migration habitat for adult upstream movement to spawning areas and larval transport downstream to the estuary and ocean.

Water flow and quality

Flow Removal of the Four Facilities is expected to result in relatively minor changes to river flows downstream of IGD (Figures 5-9 and 5-10). Assuming changes in water velocities are proportional to changes in flow exceedences, there will be relatively little change between existing and proposed action conditions for the 90 and 50% exceedence flows downstream of IGD (Figure 5-9). Proposed Action water velocities downstream of IGD will be lower in the fall and slightly higher during the summer under the 10% exceedence flow scenario. However, Proposed Action flows and water velocities would be similar to the existing condition at Orleans (Figure 5-10) and downstream reaches. **Therefore, the Proposed Action may affect, but is not likely to adversely affect the water flow essential for adult and larval migration habitat for Southern DPS eulachon.**

Suspended Sediment The reach of the Klamath River utilized by eulachon extends upstream to Omogar Creek (RM 10.7). Under the Proposed Action, sediment would be released from IGD during facility removal, and would decline in concentration in the downstream direction as a result of flow accretion from downstream tributaries. It is expected that under a worst-case scenario, SSC will range from 330 to 1,354 mg/L at Klamath from January 1 through February 19, 2020 (Figure 5-1). As discussed in Section 5.1.5.1, increased suspended sediment is predicted to temporarily degrade habitat suitability compared to existing conditions for adult and larval migration (Table 5-6). **Therefore, it can be concluded that the Proposed Action may affect and is likely to adversely affect the migration habitat of the Southern DPS eulachon in the short-term.**

SCCs will return to background levels at Klamath by November of 2020 (Figure 5-1) prior to the 2021 eulachon adult and larval migration periods. **Therefore, the Proposed Action will have no effect on adult or larval migration habitat of the Southern DPS eulachon in the long-term.**

Water temperature Water temperatures are expected to be similar to existing conditions during the time of year when adult and larval migration occur (Figure 5-8). **Therefore, any changes in water temperatures resulting from the Proposed Action will have no effect on adult or larval migration habitat of the Southern DPS eulachon in the short- and long-term.**

Dissolved oxygen Based on results from a dissolved oxygen model (see Section 3.2.4.1 of the Klamath Facilities Removal EIS/EIR), water quality objectives of 90% saturation (i.e. 10-11 mg/L) would occur within a distance of 62–93 miles downstream of IGD, or generally in the reach between Seiad Valley and Clear Creek. There would be no proposed action-related change in dissolved oxygen downstream of Clear Creek, and therefore no affect within eulachon critical habitat. **Therefore, the Proposed Action will have no effect on dissolved oxygen, which is essential for eulachon migration habitat in the short- and long-term.**

Nearshore and offshore marine foraging habitat

NMFS identified nearshore and offshore foraging sites as essential habitat features for the conservation of eulachon (76 FR 65324). NMFS also determined that abundant forage species and suitable water quality were specific components of these habitat features (76 FR 65324). However, NMFS was unable to identify any specific areas in marine waters that met the definition of critical habitat under Section 3(5)(A)(i) of the ESA (76 FR 65324). Given the unknown, but potentially wide, distribution of eulachon prey items, NMFS could not identify "specific areas" where either component of the essential features were found with marine areas believed to be occupied by eulachon. Moreover, prey species move or drift great distances throughout the ocean and would be difficult to link to any specific area (76 FR 65324). Therefore, NMFS did not designate nearshore or offshore marine foraging habitat as critical habitat for this species. Thus, this critical habitat assessment does not include an assessment of the proposed action's potential effects to the Southern DPS eulachon's nearshore or offshore marine foraging habitat.

5.1.6 Marbled Murrelet

The Proposed Action would result in sediment discharge downstream of the Four Facilities and ultimately the nearshore marine environment. The marbled murrelet may be potentially affected through two primary exposure routes: direct exposure to contaminated sediments that will be carried downstream from the dams and delivered to the ocean, and indirect exposure via ingestion of contaminated forage material.

5.1.6.1 Analytical Background/Framework

A report completed by CDM (2011) was the primary source and framework for evaluating potential chemical and biological effects of sediment that would be released if the Four Facilities were removed.

CDM applied a Sediment Evaluation Framework (SEF), along with a tissue analysis of reservoir fish (bioassay) to assess the potential effect to the marbled murrelet from exposure to the reservoir sediments. The SEF is a decision making process that was developed by numerous regional state and federal agencies for the Pacific Northwest (RSET 2009) and is commonly used to determine when sediments from regional dredging projects are chemically and biologically suitable to be discharged into freshwater or marine environments without causing unacceptable adverse impacts (CDM 2011). The CDM report (2011) developed a listing of contaminants of potential concern including those that were detected in samples, and those that were not detected, but that displayed a method detection limit that exceeded a toxicity reference value. This approach is a standard assumption in risk assessments.

5.1.6.2 Direct Effects

Sediment release associated with the Proposed Action could cause short-term (<2 years following Facility removal) and long-term (2–50 years following dam removal) decreases in the water and sediment quality, including areas where marbled murrelets may forage in the marine environment. Most of the compounds noted in the CDM Report (2011) as compounds of potential concern were chemicals that are likely sediment associated versus compounds that would persist in the water column, thus direct exposure to marbled murrelets through dermal exposure and/or ingestion of chemicalss in the water column is unlikely. CDM (2011) also determined that additional dilution associated with tributary inputs and distance from the source were likely required in order to not exceed screening criteria. This additional dilution assumption would further decrease exposure because marbled murrelets occur in an area significantly downstream from the source. **Direct exposure through dermal exposure and/or ingestion of chemicals in the water column may affect, but is not likely to adversely affect the marbled murrelet.**

Direct effects to marbled murrelets could also manifest as a result of loss of forage. Aquatic organisms could be impacted through direct acute or chronic toxicity events that could occur from re-suspension of chemicals into the water column or through toxicity associated with exposure to sediments deposited downstream.

CDM (2011) gathered available water and sediment toxicity data to evaluate the risk to forage species. There will be dilution with the inclusion of waters from tributaries and additional dilution from tidal influence in the estuary. The marbled murrelet also has the ability to relocate should forage be diminished either by chronic or isolated toxicity events. Therefore, it is reasonable to assume that the residual toxicity to the forage base would be insignificant. **Forage base would not be diminished by acute or chronic toxicity based on the toxicity results (CDM 2011) and therefore, may affect but is not likely to adversely affect foraging marbled murrelets.**

5.1.6.3 Indirect Effects

A sediment release associated with the Proposed Action could cause a potential bioaccumulation of chemicals in forage species as a result of mobilization of sediment containing organic and inorganic compounds during reservoir drawdown. Several of the compounds identified as chemicals of potential concern have characteristics that make them bioaccumulative. Under the Proposed Action, exposures would be reduced due to mixing of released reservoir sediments with natural river sediments, and further reduced with dispersion of mobilized sediments over a large area and over time (CDM 2011). In addition, marbled murrelets are a highly mobile species and are not found in high densities within the nearshore marine action area. These factors are expected to decrease the chemical concentrations to levels that will no longer be of concern (CDM 2011).

CDM (2011) also assessed the potential effects of dioxin-like compounds, as converted to estimated concentrations of the most highly toxic form, 2,3,7,8-TCDD, and determined that they would not likely pose a risk to marbled murrelets through ingestion of exposed fish.

The effect of the Proposed Action on the bioaccumulation of contaminants to marbled murrelets from ingestion of prey that has been exposed to sediment near the mouth of the Klamath River is expected to be insignificant due to the very low levels of chemicals found to date in the reservoir sediments, the dilution effects of the river and ocean water, and the relatively low use of the action area by marbled murrelets. **Indirect effects from ingestion of prey that has been exposed to sediment near the mouth of the Klamath River may affect, but is not likely to adversely affect the marbled murrelet.**

5.1.7 Northern Spotted Owl

The Proposed Action includes the removal or modifications to the Four Facilities intended to benefit anadromous and resident fish and the ecosystem in the long-term. However, construction required for the removal or modification of structures will necessitate the use of chainsaws, helicopters, blasting, heavy equipment, and use of herbicides during the restoration of reservoirs. Anticipated effects of the Proposed Action were assessed based on the anticipated construction approach (Reclamation 2012b) and the current status of NSO and suitable habitat in the area (Section 4.2.2.7).

The effects of anticipated construction/de-construction actions on NSO activity centers were assessed for actions resulting in disturbance from noise and the effects of the herbicide glyphosate. The actions listed below will not affect the NSO because the species is not affected by changes in water flow, fish-rescue actions, or those that likely result in little to no noise disturbance:

- dam removal drawdown resulting in release of water or sediment;
- dam removal resulting in dewatering channels, destruction of aquatic habitat, fish rescue and relocation, and the end result of a free-flowing river;
- facilities removal resulting in dewatering channels, destruction of aquatic habitat, fish rescue and relocation, and leaving fish facilities in place;
- removal of dispersed recreation sites (because many are located along roads on or near the reservoir shoreline and do not have developed facilities, and therefore limited noise for removal is anticipated); and
- fish rescue and trapping and hauling activities at IGD and each Klamath Project reservoir.

5.1.7.1 Noise and Disturbance

The Proposed Action includes, but is not limited to, the removal or modification of project structures, upgrading roads, and restoration. These activities will result in noise that may disturb NSO. Effects of noise can either result in NSO being distracted to such an extent to disrupt its normal behavior or create the likelihood of harm or loss of reproduction. The disturbance distance is the the distance from the source of noise outward, which is likely to cause a NSO, if present, to be affected. Therefore, the noise effects analysis relied on established disturbance buffers from noise sources to known NSO nest sites during the breeding period (USFWS 2006, Table 5-7). The activities included in the Proposed Action and their associated noise disturbance distances and timing are summarized in (Table 5-8).

Table 5-7. Disturbance Distances[1] for the Northern Spotted Owl during the Breeding Period

Source of noise	Disturbance distance
Blasting	1,760 yards (1 mile)
Hauling on open roads	440 yards (0.25 mile)
Heavy equipment	440 yards (0.25 mile)
Rock crushing	440 yards (0.25 mile)
Helicopter—Type I[2]	880 yards (0.5 mile)
Aircraft—Fixed Wing	440 yards (0.25 mile)

[1] Noise distances were developed in coordination with the Arcata USFWS office using an estimation of auditory and visual disturbance effects (USFWS 2006) as a basis.

[2] Type I helicopters seat at least 16 people and have a minimum capacity of 2,300 kg (5,000 lbs). Both a CH 47 (Chinook) and UH 60 (Blackhawk) are Type I helicopters.

Table 5-8. Anticipated Construction Activities (Reclamation 2012b) that has the Potential to Disturb Owls

Element of de-construction	Construction activity	Disturbance buffer (radius around Proposed Action) (miles)	Anticipated timeline	Distance to nearest activity center (MSNO #)	Suitable nesting and roosting habitat present within the Disturbance buffer (Y/N)[1]	Minimization measures (See Section 2.2.6.6)	Effects[2]
J.C. Boyle							
Improve and use of haul routes	Noise from heavy equipment	0.25 mi	November 2019 through September 2020; **occurs during the Oregon breeding season**	1.1 km (0.7 mi) (MSNO 2388)	Y	Measure NSO 2	May affect but is not likely to adversely affect
Improve and use of disposal sites	Noise from heavy equipment	0.25 mi	November 2019 through September 2020; **occurs during the Oregon breeding season**	7.8 km (4.8 mi) (MSNO 2388)	N	None	No effect
Remove concrete stoplogs and spillway gates	Noise from blasting	1.0 mile	January–March 2020; **occurs during the Oregon breeding season**	7.5 km (4.7 mi) (MSNO 2388)	Y	Measure NSO 2	May affect but is not likely to adversely affect

Element of de-construction	**Construction activity**	**Disturbance buffer (radius around Proposed Action) (miles)**	**Anticipated timeline**	**Distance to nearest activity center (MSNO #)**	**Suitable nesting and roosting habitat present within the Disturbance buffer (Y/N)** [1]	**Minimization measures (See Section 2.2.6.6)**	**Effects**[2]
Mobilization; excavate dam embankment; remove spillway gates and crest structure, fish ladder, steel pipes, canal intake screen structure, left concrete gravity section, power canal (flume), shotcrete slope protection, forebay spillway control structure, tunnel inlet portal structure, surge tank, penstocks (including supports and anchors), tunnel portals, powerhouse gantry crane and substructure, tailrace flume walls, switchyard, warehouse, and support buildings; backfill tailrace channel area and canal spillway scour area; and demobilization.	Noise from heavy equipment	0.25 mi	January through September 2020; **occurs during the Oregon breeding season**	4.1 km (2.6 mi) (MSNO 2388)	Y	Measure NSO 2	May affect but is not likely to adversely affect
Modification or removal of 2.2-mile-long power canal (or flume)	Noise from heavy equipment	0.25 mi	January through September 2020; **occurs during the Oregon breeding season**	4.6 km (2.9 mi) (MSNO 2388)	Y	Measure NSO 2	May affect but is not likely to adversely affect
Remove 64-kV transmission lines	Noise from heavy equipment	0.25 mi	January through September 2020; **occurs during the Oregon breeding season**	4.1 km (2.5 mi) (MSNO 2388)	Y	Measure NSO 2	May affect but is not likely to adversely affect
Remove Sportsman Park recreation structures	Noise from heavy equipment	0.25 mi	Timeframe undetermined; however, could occur **during the Oregon breeding season**	9.8 km (6.1 mi) (MSNO 1306)	N	None	No effect
Remove Pioneer Park East unit	Noise from	0.25 mi	Timeframe	9.6 km (5.9 mi)	N	None	No effect

Element of de-construction	Construction activity	Disturbance buffer (radius around Proposed Action) (miles)	Anticipated timeline	Distance to nearest activity center (MSNO #)	Suitable nesting and roosting habitat present within the Disturbance buffer (Y/N)[1]	Minimization measures (See Section 2.2.6.6)	Effects[2]
recreation structures and remove and restore access roads	heavy equipment		undetermined; however, could occur **during the Oregon breeding season**	(MSNO 2388)			
Remove Pioneer Park West unit recreation structures and remove and restore access roads	Noise from heavy equipment	0.25 mi	Timeframe undetermined; however, could occur **during the Oregon breeding season**	9.2 km (5.7 mi) (MSNO 2388)	N	None	No effect
Remove Topsy Campground recreation structures (i.e., boat launch, floating dock, and fishing pier) and restore affected areas	Noise from heavy equipment	0.25 mi	Timeframe undetermined; however, could occur **during the Oregon breeding season**	7.8 km (4.9 mi) (MSNO 2388)	N	None	No effect
Copco No. 1							
Improve and use of haul route	Noise from heavy equipment	0.25 mi	July 2019 through June 2020; **occurs during the California breeding season**	2.9 km (1.8 mi) (MSNO 2191)	Y	Measure NSO 2	May affect but is not likely to adversely affect
Improve and use of disposal sites (same site as Copco 2)	Noise from heavy equipment	0.25 mi	July 2019 through June 2020; **occurs during the California breeding season**	9.2 km (5.7 mi) (MSNO 2191)	N	None	No effect
Dam removal	Noise from blasting	1.0 mile	November 2019 through April 2020; **occurs during the California breeding season**	9.0 km (5.6 mi) (MSNO 2191)	N	None	No effect
Mobilization; excavation of sediment at diversion tunnel intake; removal of penstocks	Noise from heavy equipment	0.25 mi	June 2019 through June 2020; **occurs during the**	9.0 km (5.6 mi) (MSNO 2191)	N	None	No effect

Element of de-construction	Construction activity	Disturbance buffer (radius around Proposed Action) (miles)	Anticipated timeline	Distance to nearest activity center (MSNO #)	Suitable nesting and roosting habitat present within the Disturbance buffer (Y/N)[1]	Minimization measures (See Section 2.2.6.6)	Effects[2]
(between powerhouse and dam), spillway gates, decks, piers, powerhouse intake structure, gate houses on right abutment, diversion control structure, powerhouse, switchyard, warehouse and residence, and plug tunnel portals; and demobilization			**California breeding season**				
Remove two-69-kV transmission lines (0.7 mi)	Noise from heavy equipment	0.25 mi	June 2019 through June 2020; **occurs during the California breeding season**	9.1 km (5.6 mi) (MSNO 2191)	N	None	No effect
Remove Mallard Cove recreation structures and remove and restore parking area	Noise from heavy equipment	0.25 mi	Timeframe undetermined; however, could occur **during the California breeding season**	6.1 km (3.8 mi) (MSNO 2191)	N	None	No effect
Remove Copco Cove recreation structures and remove and restore parking area	Noise from heavy equipment	0.25 mi	Timeframe undetermined; however, could occur **during the California breeding season**	9.0 km (5.6 mi) (MSNO 2191)	N	None	No effect
Copco No. 2							
Improve and use of haul route	Noise from heavy equipment	0.25 mi	February through October 2020; **occurs during the California breeding season**	7.7 km (4.8 mi) (MSNO 2191)	N	None	No effect
Improve and use of disposal sites (same site as Copco 1)	Noise from heavy equipment	0.25 mi	February through October 2020; **occurs**	9.2 km (5.7 mi) (MSNO 2191)	N	None	No effect

Element of de-construction	**Construction activity**	**Disturbance buffer (radius around Proposed Action) (miles)**	**Anticipated timeline**	**Distance to nearest activity center (MSNO #)**	**Suitable nesting and roosting habitat present within the Disturbance buffer (Y/N)** [1]	**Minimization measures (See Section 2.2.6.6)**	**Effects**[2]
			during the California breeding season				
Spillway removal	Noise from blasting	1.0 mile	May through June 2020; **occurs during the California breeding season**	9.5 km (5.9 mi) (MSNO 2191)	N	None	No effect
Mobilization; removal of power penstock intake structure, wood-stave penstock, concrete pipe cradles, steel penstock, supports, anchors, powerhouse; excavate embankment; backfill the tail race channel; plug the tunnel portal; and demobilization	Noise from heavy equipment	0.25 mi	February through October 2020; **occurs during the California breeding season**	10.7 km (6.6 mi) (MSNO 2191)	N	None	No effect
Remove -69-kV transmission line (1.23 mi)	Noise from heavy equipment	0.25 mi	February through October 2020; **occurs during the California breeding season**	9.2 km (5.7 mi) (MSNO 2191)	N	None	No effect
Iron Gate Dam							
Improve and use of disposal sites	Noise from heavy equipment	0.25 mi	June 2019 through 2020; **occurs during the California breeding season**	15.1 km (9.4 mi) (MSNO 2191)	N	None	No effect
Improve and use of haul route	Noise from heavy equipment	0.25 mi	June 2019 through 2020; **occurs during the California breeding season**	2.9 km (1.8 mi) (MSNO 2191)	N	None	No effect
Replace City of Yreka pipeline crossing	Noise from heavy equipment	0.25	Timeframe undetermined; however, could occur **during the**	~11 km (7 mi) MSNO 2191 (based on approximate	N	None	No effect

Element of de-construction	**Construction activity**	**Disturbance buffer (radius around Proposed Action) (miles)**	**Anticipated timeline**	**Distance to nearest activity center (MSNO #)**	**Suitable nesting and roosting habitat present within the Disturbance buffer (Y/N)** [1]	**Minimization measures (See Section 2.2.6.6)**	**Effects**[2]
			California breeding season	site location)			
Remove fish spawning facilities	Noise from blasting	1.0 mile	January through March 2020; **occurs during the California breeding season**	>16 km (>10 mi) MSNO 2191 (based on approximate site location)	N	None	No effect
Remove power house and penstock (below yard level)	Noise from blasting	1.0 mile	March through April 2020; **occurs during the California breeding season**	>16 km (>10 mi) MSNO 2191)	N	None	No effect
Remove spillway concrete structure	Noise from blasting	1.0 mile	June 2020; **occurs during the California breeding season**	>16 km (>10 mi) MSNO 2191)	N	None	No effect
Remove penstock intake structure and backfill tailrace area	Noise from heavy equipment and blasting	1.0 mile	July 2020; **occurs during the California breeding season**	>16 km (>10 mi) MSNO 2191)	N	None	No effect
Remove diversion/outlet shaft/tower structure	Noise from blasting	1.0 mile	July through August 2020; **occurs during the California breeding season**	>16 km (>10 mi) MSNO 2191)	N	None	No effect
Mobilization, excavate embankment, remove water supply pipes, fish facilities on dam, switchyard, tunnel control gate, and plug diversion tunnel portals	Noise from heavy equipment	0.25 mile	May 2019 through January 2021; **occurs during the California breeding season**	>16 km (>10 mi) MSNO 2191)	N	None	No effect

Element of de-construction	Construction activity	Disturbance buffer (radius around Proposed Action) (miles)	Anticipated timeline	Distance to nearest activity center (MSNO #)	Suitable nesting and roosting habitat present within the Disturbance buffer (Y/N) [1]	Minimization measures (See Section 2.2.6.6)	Effects[2]
Remove 69-kV transmission line (6.55 mi)	Noise from heavy equipment	0.25 mi	February through October 2020; **occurs during the California breeding season**	10.8 km (6.7 mi) (MSNO 2191)	N	None	No effect
Fall Creek recreation site (demobilization plan uncertain)	Noise from heavy equipment	0.25 mi	Timeframe undetermined; however, could occur **during the California breeding season**	11.3 km (7.0 mi) (MSNO 2191)	N	None	No effect
Jenny Creek recreation site (demobilization plan uncertain)	Noise from heavy equipment	0.25 mi	Timeframe undetermined; however, could occur **during the California breeding season**	14.0 km (8.7 mi) (MSNO 2191)	N	None	No effect
Remove Wanaka Springs recreation structures and restore site	Noise from heavy equipment	0.25 mi	Timeframe undetermined; however, could occur **during the California breeding season**	15.5 km (9.6 mi) (MSNO 2191)	N	None	No effect
Remove Camp Creek recreation structures (including transmission lines) and restore site	Noise from heavy equipment	0.25 mi	Timeframe undetermined; however, could occur **during the California breeding season**	>16 km (>10 mi) MSNO 2191)	N	None	No effect

Element of de-construction	Construction activity	Disturbance buffer (radius around Proposed Action) (miles)	Anticipated timeline	Distance to nearest activity center (MSNO #)	Suitable nesting and roosting habitat present within the Disturbance buffer (Y/N) [1]	Minimization measures (See Section 2.2.6.6)	Effects[2]
Remove Juniper Point recreation structures and restore site	Noise from heavy equipment	0.25 mi	Timeframe undetermined; however, could occur **during the California breeding season**	>16 km (>10 mi) MSNO 2191)	N	None	No effect
Remove Mirror Cove recreation structures and restore site	Noise from heavy equipment	0.25 mi	Timeframe undetermined; however, could occur **during the California breeding season**	>16 km (>10 mi) MSNO 2191)	N	None	No effect
Remove Overlook Point recreation structures and restore site	Noise from heavy equipment	0.25 mi	Timeframe undetermined; however, could occur **during the California breeding season**	>16 km (>10 mi) MSNO 2191)	N	None	No effect
Remove Long Gulch recreation structures and restore site	Noise from heavy equipment	0.25 mi	Timeframe undetermined; however, could occur **during the California breeding season**	15.8 km (9.8 mi) (MSNO 2191)	N	None	No effect
IGH Public Use Area recreation site (demobilization plan uncertain)	Noise from heavy equipment	0.25 mi	Timeframe undetermined; however, could occur **during the California breeding season**	>16 km (>10 mi) MSNO 2191)	N	None	No effect
Revegetation of reservoirs							
Iron Gate helipad site	Noise from heavy	0.5 mi	Following drawdown and dam removal in	15.4 km (9.6 mi) (MSNO	N	None	No effect

Element of de-construction	**Construction activity**	**Disturbance buffer (radius around Proposed Action) (miles)**	**Anticipated timeline**	**Distance to nearest activity center (MSNO #)**	**Suitable nesting and roosting habitat present within the Disturbance buffer (Y/N)** [1]	**Minimization measures (See Section 2.2.6.6)**	**Effects**[2]
	equipment, fixed wing aircraft, rotary aircraft		2020; may occur **during the California breeding season**	2191)			
Iron Gate Reservoir revegetation	Noise from heavy equipment, fixed wing aircraft, rotary aircraft	0.5 mi	Following drawdown and dam removal in 2020; may occur **during the California breeding season**	10.7 km (6.7 mi) (MSNO 2191)	N	None	No effect
Iron Gate Reservoir revegetation monitoring and maintenance	Noise from heavy equipment (e.g., disking)	0.25 mi	Years 2 through 5 and could occur **during the California breeding season**	10.7 km (6.7 mi) (MSNO 2191)	N	None	No effect
Copco 1 helipad site	Noise from heavy equipment, fixed wing aircraft, rotary aircraft	0.5 mi	Following drawdown and dam removal in 2020; may occur **during the California breeding season**	3.2 km (5.1 mi) (MSNO 2191)	N	None	No effect

Element of de-construction	**Construction activity**	**Disturbance buffer (radius around Proposed Action) (miles)**	**Anticipated timeline**	**Distance to nearest activity center (MSNO #)**	**Suitable nesting and roosting habitat present within the Disturbance buffer (Y/N)** [1]	**Minimization measures (See Section 2.2.6.6)**	**Effects**[2]
Copco 1 Reservoir revegetation	Noise from heavy equipment, fixed wing aircraft, rotary aircraft	0.5 mi	Following drawdown and dam removal in 2020; may occur **during the California breeding season**	2.4 km (1.5 mi) (MSNO 2191)	N Critical habitat is located within 0.10 mile; however, this area is unlikely suitable nesting and roosting habitat (L. Finley, USFWS Yreka Fish and Wildlife Office, pers comm., September 8, 2011)	None	No effect
Copco 1 Reservoir revegetation monitoring and maintenance	Noise from heavy equipment (e.g., disking)	0.25 mi	Years 2 through 5 and could occur **during the California breeding season**	2.4 km (1.5 mi) (MSNO 2191)	N Critical habitat is located within 0.10 mile; however, this area is unlikely suitable nesting and roosting habitat (L. Finley, USFWS Yreka Fish and Wildlife Office, pers comm., September 8, 2011)	None	No effect
Copco 2 Reservoir revegetation	Noise from heavy equipment, fixed wing aircraft,	0.5 mi	Following drawdown and dam removal in 2020; may occur **during the**	5.6 km (9.0 mi) (MSNO 2191) (approximate site location)	N	None	No effect

Element of de-construction	Construction activity	Disturbance buffer (radius around Proposed Action) (miles)	Anticipated timeline	Distance to nearest activity center (MSNO #)	Suitable nesting and roosting habitat present within the Disturbance buffer (Y/N) [1]	Minimization measures (See Section 2.2.6.6)	Effects[2]
	rotary aircraft		**California breeding season**				
Reservoir revegetation monitoring and maintenance at Copco No. 2	Noise from heavy equipment (e.g., disking)	0.25 mi	Years 2 through 5 and could occur **during the California breeding season**	5.6 km (9.0 mi) (MSNO 2191) (approximate site location)	N	None	No effect
J.C. Boyle Reservoir and revegetation (includes access roads)	Noise from heavy equipment	0.25 mi	Following drawdown and dam removal in 2020; may occur **during the Oregon breeding season**	1.1 km (0.7 mi) (MSNO 2388)	Y	Measure NSO 2	May affect but is not likely to adversely affect
J.C. Boyle Reservoir revegetation monitoring and maintenance at J.C. Boyle (includes access roads)	Noise from heavy equipment (e.g., disking)	0.25 mi	Years 2 through 5 and could occur **during the Oregon breeding season**	1.1 km (0.7 mi) (MSNO 2388)	Y	Measure NSO 2	May affect but is not likely to adversely affect
Fencing Parcel B Lands							
Fencing Parcel B lands near Iron Gate, Copco 1, and Copco 2	Noise from heavy equipment	0.25 mi	Unknown, could occur **during the California breeding seasons**	8.5 km (5.3 mi) (MSNO 2191)	N	None	No effect
Fencing Parcel B lands near J.C. Boyle	Noise from heavy equipment	0.25 mi	Unknown, could occur **during the Oregon breeding seasons**	6.8 km (4.2 mi) (MSNO 2388)	N	None	No effect

[1] Habitat assessment based on information provided by Oakley Consulting (2011), E. Willy, USFWS Fish and Wildlife Biologist, and Lynn Roberts USFWS Fish and Wildlife Biologist.

[2] Possible categories of effects from harassment:

- May affect and is likely to adversely affect (when noise disturbance occurs during the critical-breeding season and an activity center is located within the disturbance distance)
- May affect but is not likely to adversely affect (when noise disturbance occurs during the critical or late-breeding season, suitable nesting and roosting habitat is present, and assumes protocol-level surveys, and consultation with the USFWS prior to implementation to assure that a May affect and is likely to adversely affect will not result)
- No effect – when noise disturbance occurs outside of the critical and late-breeding season and/or no suitable nesting and roosting habitat present within the disturbance distance

No current activity centers are located within the disturbance distance of the anticipated construction activities analyzed (Table 5-8). Suitable habitat which has the potential to support future nesting spotted owl pairs is present within the disturbance distance of the following Proposed Action activities:

- Copco No 1 Reservoir
    - Improving and use of haul routes at Copco No. 1 Reservoir (the Reclamation currently confirming road haul routs).
- J.C. Boyle
    - Improving and use of haul routs for dam demobilization and reservoir revegetation monitoring and maintenance (the Reclamation currently confirming road haul routs).
    - Removal of the concrete stoplogs and spillway gates.
    - Mobilization; excavation of dam embankment; removal of spillway gates and crest structure, fish ladder, steel pipes, canal intake screen structure, left concrete gravity section, power canal (flume), shotcrete slope protection, forbay spillway control structure, tunnel inlet portal structure, surge tank, penstocks (including supports and anchors), tunnel portals, powerhouse gantry crane and substructure, tailrace flume walls, switchyard, warehouse, and support buildings; backfill tailrace channel area and canal spillway scour area; and demobilization.
    - Modification or removal of 2.2-mile-long power canal (or flume).
    - Removal of the 64-kV transmission lines.

With the implementation of the minimization measures described in Section 2.2.6.6, disturbance generated by the Proposed Action may affect, but is not likely to adversely affect NSO.

5.1.7.2 Herbicide Treatment

As part of the Proposed Action, revegetation and management of noxious and invasive weeds will occur on newly exposed land (e.g., reservoir shoreline). Long-term effects of the revegetation plan are anticipated to benefit northern spotted owl by providing future nesting, roosting, foraging, or dispersal habitat. NSO primarily on small mammals (e.g., mice, voles) and it is plausible that the risk to these prey species may occur from direct or indirect spraying of herbicides. Herbicides will be used to control weeds through hand treatment; therefore the application is not intended to target plants or trees that currently support suitable habitat. Effects of glysophate and glyphosate-based herbicides with surfactant additives are analyzed below.

- Studies and assessments of glyphosate show ecological risks for focused, short-term eradication efforts are small (Monheit 2003).
- While highly toxic to plants, glyphosate is non-toxic to other animals (Williams et al. 2000, as cited in Monheit 2003).
- Glyphosate is poorly absorbed by the digestive track and is excreted essentially unmetabolized (EXTOXNET database, Cornell Univ, both as cited in Monheit 2003; Williams et al. 2000).
- There is no evidence to support glyphosate is an immunotoxicant, neurotoxicant, or endocrine disruptor (SERA 2002, as cited in Monheit 2003).
- At typical application rates, none of the acute scenarios studied presented unacceptable risks to wildlife including predatory birds consuming small mammals (Bautista 2007).
- The majority of prey are arboreal and/or nocturnal and are not likely to be directly exposed to herbicides (USDA Forest Service 2010) and if consumption did occur, a Biological Opinion, Concurrence, and Conference Report on the Effects to 23 Species and 4 Critical Habitats from the U.S. Forest Service Pacific Northwest Region Invasive Plant Program (USFWS Reference Number

> 1-7-05-7-0653, as cited in USDA Forest Service. 2010) states: "The U.S. Forest Service found that the results of exposure scenarios to spotted owls indicate that no herbicide included in the Invasive Plant Program (which includes glyphosate) is likely to adversely affect spotted owls… There was no risk to spotted owls from eating contaminated small mammals because expected doses to predatory birds eating mammals for all herbicides, even with very conservative assumptions, are well below any known no observable adverse effects."

Glyphosate may be formulated with surfactants that increased efficacy. In some cases, toxicity data have indicated that surfactants added to the glyphosate are more toxic than the glyphosate itself. Studies conducted by the USDA Forest Service found no evidence that nonylphenolethoxylate-based surfactants lead to any level of concern for terrestrial wildlife (Bakke 2003, as cited in CINWECC 2004). **The Proposed Action may affect, but is not likely to adversely affect the NSO resulting from the use of a glyphosate-like herbicide, a nonylphenol ethoxylate-based surfactants, and through following the minimization measures and BMPs listed in Appendix A and Sections 2.2.6.6 and 2.2.6.7.** If another herbicide or herbicide base is chosen, it should meet similar characteristics of low toxicity to small mammals and birds.

5.1.8 Steller (=northern) Sea Lion

5.1.8.1 Short-Term Effects

The reservoir drawdown will result in the release of sediment that would have adverse short-term effects on Chinook salmon production in the mainstem Klamath River. It is estimated that up to 2,115 redds (about 8% of Klamath Basin production) in the mainstem will suffer 100% mortality during the reservoir drawdown period (Appendix E of the Klamath Facilities Removal EIS/EIR). The reduction in Chinook salmon production may affect individual Steller sea lions by reducing food intake.

The greatest potential effect of reservoir drawdown-related reduced food supply to Steller sea lions may be greatest between Fort Bragg, California and Florence, Oregon. This is because this area of the northeastern Pacific Ocean is where the greatest concentration of Klamath River Chinook salmon occurs. Depending on the strength of the salmon run, the month and the location, the Klamath River stock can make up to 37% of the adult Chinook salmon off of Fort Bragg (Figure 5-12) and up to about 45% off of the southern Oregon coast (Figure 5-13) during the spring and summer months. It must be noted that these stock composition percentages are highly variable on an annual or even monthly basis. For example, in July 2010, the Klamath Chinook salmon composition off Florence was only 2.6%, compared to the 45% in July 2007. No information was found regarding ocean Chinook salmon stock composition during the winter months off of California or Oregon. The stock composition percentages used in this analysis were the highest reported and as such the following analysis should be considered conservative.

A diet study identified that Steller sea lions are opportunistic foragers and consume variety of prey; the majority including pollock, herring, hake, flounder, skate, cephlapods, cod, salmonids, and rockfish (Sigler et al. 2009). Sigler et al. (2009) reported that in an analysis of 11,379 samples (scat with remains and identified prey items) only 236 (2%) were salmonids. The percentage of the Steller sea lion's diet that is made up of Klamath River-origin Chinook salmon can be calculated by multiplying the stock composition off of Fort Bragg and Florence (37 and 45%, respectively) by the 2% prey contribution. Therefore, Klamath-origin Chinook salmon likely make up between 0.74 and 0.9% of the Steller sea lion diet between Fort Bragg and southern Oregon, respectively.

The Proposed Action would potentially reduce the Klamath-origin Chinook salmon stock offshore by 8% (assuming 8% loss of Klamath Basin redd production equates to an 8% loss of Klamath Basin Chinook salmon in the ocean). An 8% reduction in the 0.74 to 0.9% Klamath component of the Steller sea lion's prey base would reduce the Klamath-origin contribution by an additional 0.06 to 0.07%.

It can be assumed that the loss of other salmonids (spring Chinook salmon, coho salmon, and steelhead) due to direct or delayed mortality resulting from the Proposed Action SSC would further decrease the food availability for sea lions. However, given that only 2% of the sea lion's food resources are salmonids from a variety of species and stocks, it can be assumed that substitution of other species would occur.

Any reduction in the Klamath-origin salmonid component of the sea lion's diet could be substituted by other prey species. **Therefore, the reduction in Klamath-origin salmonid stocks resulting from sediment release during reservoir drawdown may affect, but is not likely to adversely affect Steller sea lions.**

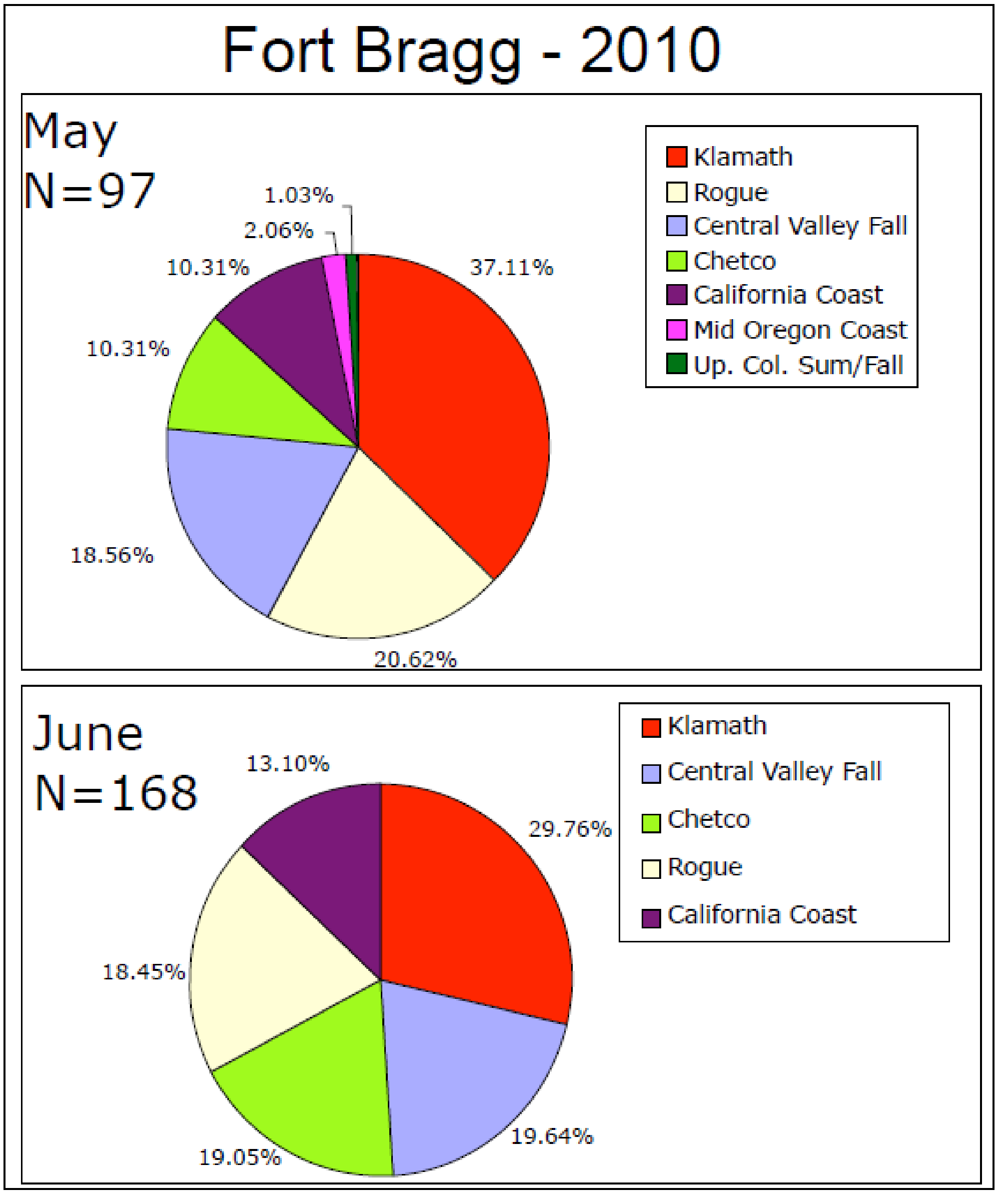


Figure 5-12. Proportion of Chinook Salmon Stocks in the Ocean off of Fort Bragg, California (California Salmon Council 2011)

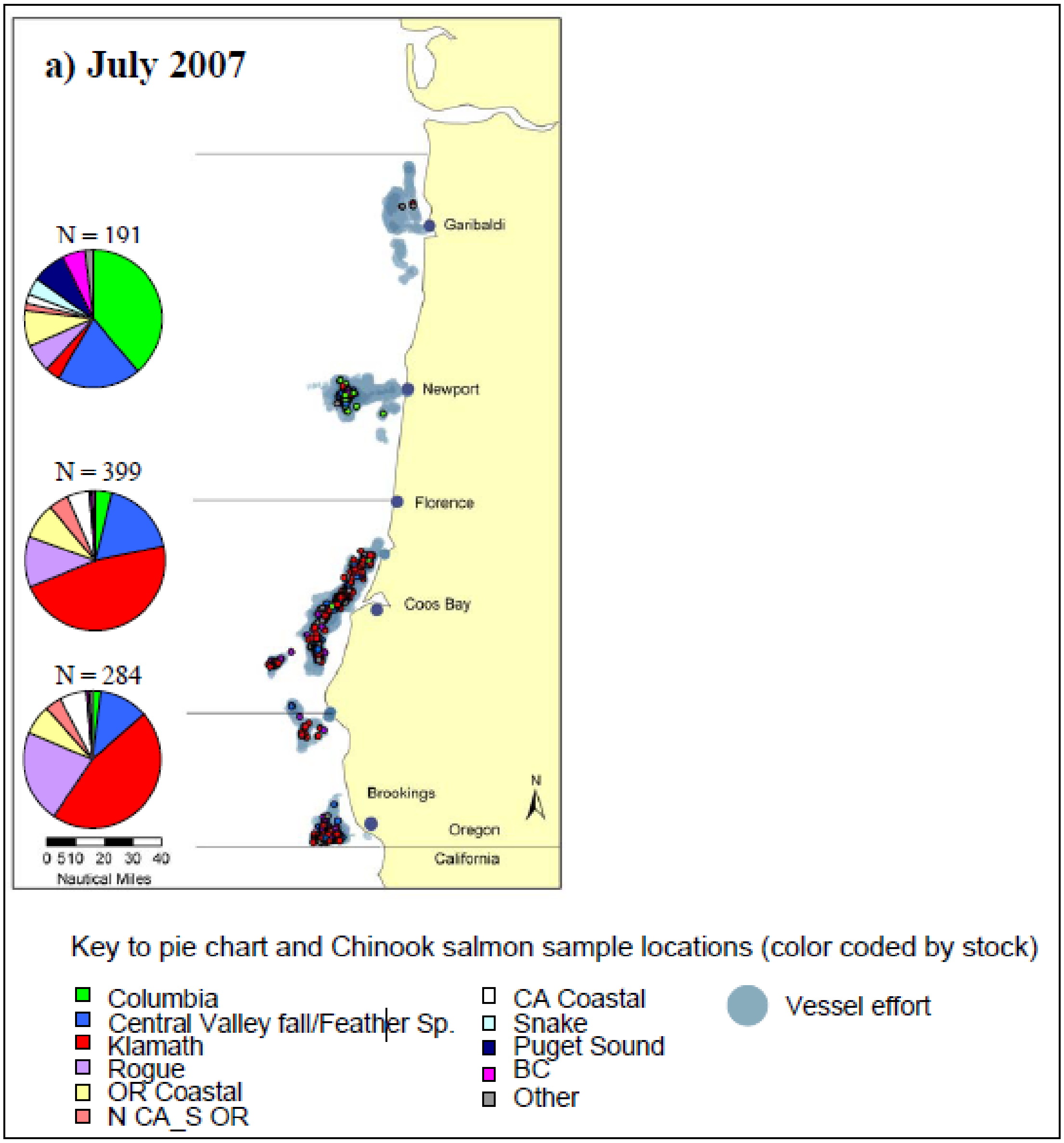


Figure 5-13. Preliminary Stock Compositions, Fishing Effort, and Locations of Fish Sampled South of Cape Falcon to the California/Oregon Border during July 2007 (Figure from Project CROOS 2010)

5.1.8.2 Long-Term Effects

Interrelated to the Proposed Action is the potential closure of the IGH eight years after dam removal (because PacifiCorps will terminate funding for IGH during this time and CDFG has not indicated they would continue operating the hatchery without PacifiCorps funding). This would result in the loss of production of about 5.1 million Chinook salmon smolts and 900,000 yearlings. Using coded wire tag data collected since 1978, CDFG estimated that an average of 0.89% of IGH releases survive to adulthood in the ocean (CDFG unpublished data). Therefore, 53,400 adult Chinook salmon from IGH would not be available as prey for the Steller sea lion.

Using the Liermann et al. (2010) equation, Lindley and Davis (2011 draft) predicted a non-fished equilibrium population of 41,000 adult Chinook salmon in the ocean that will be from the newly accessible upper Klamath Basin. Assuming the Proposed Action would result in an additional 41,000 adult Chinook salmon in the ocean within eight years after removing the Klamath dams, there would be a net loss of about 12,400 hatchery adult Chinook salmon from the sea lion's prey base.

As reported by the Klamath River Technical Team to the Pacific Fisheries Management Council in 2011, Klamath Chinook salmon ocean abundance averaged 434,411 between 1985 and 2010[5]. Using the average Klamath Chinook salmon ocean abundance data as a comparison, the 12,400 adult hatchery Chinook salmon represents a loss of approximately 2.9% of the total Klamath Chinook ocean abundance. The 2.9% loss of adult Klamath hatchery Chinook salmon could be multiplied by the 35 to 45% Klamath stock contribution to the contribution to the Chinook salmon ocean abundance between Fort Bragg and Florence (Figures 5-12 and 5-13). Thus, the loss of Chinook salmon production would account for between 1 and 1.3% of available Chinook prey base for the Steller sea lion. Assuming Chinook salmon make up 2% of the Steller sea lion's diet (Sigler et al. (2009), then the actual dietary loss would be about 0.02 to 0.026%. This level of dietary loss is insignificant.

Using the abundance forecast from the EDRRA model to predict percent increases in Klamath Chinook populations after active reintroduction ceases and IGH production ceases (2033 – 2061) provides a 95% credibility interval region that the range of Chinook abundance in the Klamath River basin in the absence of fishing is between -61.2% and 779.4%, with a median of 70.8% (refer to Section 3.1.2). As a result, the population of Klamath Chinook abundance from 2033 through 2061 is estimated to be in the range of 168,551 to 3,385,799, with a median value of 741,974 when compared to the 1985 through 2010 average ocean abundance value of 434,411 (which is the predicted mean value for Klamath Chinook abundance under the No Action).

(434,411 average ocean abundance) – (434,411 x 0.612) = 168,551
(434,411 average ocean abundance) x (7.794) = 3,385,799
(434,411 average ocean abundance) x (1.708) = 741,974

Using the average ocean abundance value, the low end of the 95% credibility interval range represents a net deficit of 265,860 or -61.2%. The -61.2% loss could be multiplied by the 35 to 45% Klamath stock contribution to the Chinook salmon ocean abundance between Fort Bragg and Florence. Thus, the potential loss of Chinook salmon from 2033 through 2061 could account for up to 27.5% of available Chinook prey base for the Steller sea lion. Assuming Chinook salmon make up 2% of the Steller sea lion's diet (Sigler et al. 2009), then the actual dietary loss would be up to 0.55%.

The high end of the credibility interval range represents a net increase of 2,951,388 or 779.4% and the median population value represents a net increase of 307,563 or 70.8%. Both of these values represent an increase over the average ocean abundance value, which could subsequently contribute to a net increase in Klamath Chinoook prey abundance for Steller sea lions.

In addition, the Klamath River Hatchery also produces approximately 75,000 coho salmon and 200,000 steelhead smolts per year. This is about 4.4% of the total hatchery salmonid production. Assuming coho salmon and steelhead hatchery returns are similar to Chinook salmon, then there would be an incremental reduction of 4.4% of the Klamath-origin salmonid food resources for Steller sea lions. Given that 96% of the Klamath River Hatchery production is Chinook salmon, accounting for up to 0.55% of the sea lion's food base, the incremental loss of coho salmon and steelhead would not be measurable and food substitution would occur. **Therefore, when considering the range of modeled Klamath Chinook abundance, the potential closure of the IGH may affect but is not likely to adversely affect Steller sea lions in the long-term.**

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[5] Pacific Fisheries Management Council website: http://www.pcouncil.org/salmon/background/document-library/

5.1.8.3 Critical Habitat

Designated critical habitat for Steller sea lions is located at Pyramid Rock 105 km (65 mi) north of Klamath River Estuary, and at Sugarloaf Island and Cape Mendocino, about 125 km (80 mi) south of the Klamath River Estuary. Although the reservoir drawdown and sediment release will not affect the critical habitat areas, the potential loss of 2,115 redds (about 8%) may affect Steller sea lion food resources, which is a PCE of critical habitat.

Klamath-origin Chinook salmon may make up to 0.55% of the Steller sea lion diet. As Steller sea lions are prey generalists, any reduction in the Chinook salmon component of the sea lion's diet could be substituted by other prey species. **Therefore, the Proposed Action may affect, but is not likely to adversely affect the food resources PCE of critical habitat of the Steller sea lion in the short-term.**

Based on the analysis presented above and considering the range of modeled Klamath Chinook abundance for the period 2033 through 2061, the potential closure of the IGH may affect, but is not likely to affect the food resources element of critical habitat of the Steller sea lion in the long-term.

5.1.9 Southern Resident DPS Killer Whale

The southern resident killer whale DPS consists of three pods, identified as J, K, and L pods. 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 (Heimlich-Boran 1988, Felleman et al. 1991, Olson 1998, Osborne 1999, Ford et al. 2000, Krahn et al. 2002). Pods visit coastal sites off Washington and Vancouver Island (Ford et al. 2000), but travel as far south as central California and as far north as the Queen Charlotte Islands. Therefore, the Southern Residents may be off Oregon and California during the winter and early spring. Southern Residents survival and fecundity are correlated with Chinook salmon abundance (Ward et al. 2009, Ford et al. 2009).

5.1.9.1 Short-Term Effects

Chinook salmon comprise over 71% of the identified salmonids taken by killer whales (Ford and Ellis 2006). In particular, Ford and Ellis (2006) and Hanson et al. (2010) found that Chinook salmon comprise at least 84% of the diet of Southern Resident killer whales (Southern Residents) while the whales are in the Puget Sound/Juan de Fuca area. This preference occurred despite the much lower numerical abundance of Chinook in the study area in comparison to other salmonids and is probably related to the species' large size, high fat and energy content and year-round occurrence in the area (NMFS 2006b). Because we do not have any data on the diet of Southern Residents,outside of the Puget Sound/Juan de Fuca area, we therefore assume that the proportion of Chinook salmon in the Southern Residents' diet continues to be at least 84% when they are in the Oregon and California coasts.

The reservoir drawdown will result in the release of sediment that would have significant short-term adverse effects on Chinook salmon production in the mainstem Klamath River. Approximately 2,115 redds (about 8% of the Klamath Basin redd production) in the mainstem will suffer 100% mortality during the reservoir drawdown period (Appendix E of the Klamath Facilities Removal EIS/EIR). The reduction in Chinook salmon production may affect individual killer whales by reducing food intake. However, this does not take into account the implementation of the salmon spawning conservation measure, which will trap adult Chinook and coho salmon and transport them to locations where SSC are less impactive. Hatchery smolts are not expected to be killed by the reservoir drawdown SSC, since implementation of the hatchery management conservation measure would occur.

The greatest potential effect of reservoir drawdown-related reduced food supply to Southern Resident DPS killer whales would occur while the whales are between Fort Bragg, California and Florence, Oregon. This is because the area off the Klamath is where the greatest concentration of Klamath River Chinook salmon occurs. Depending on the strength of the salmon run, the month and the location, the Klamath River stock can make up to 37% of the adult Chinook salmon off of Fort Bragg (Figure 5-12) during the spring and up to about 45% off of the southern Oregon coast (Figure 5-13) in July. No information was found regarding ocean Chinook salmon stock composition during the winter months. As stated in the Steller sea lion section above, these stock composition percentages are highly variable on an annual or even monthly basis. The stock composition percentages used in this analysis were the highest reported and as such the following analysis should be considered conservative.

A rough estimate of the short-term loss of the Klamath River component of killer whale food resources can be calculated using a worst case approach and an assumption that the loss of 8% of the Klamath Basin’s redd production would equate to a proportional loss of offshore Chinook salmon stocks. Multiplying 8% production by the maximum observed 37 to 45% Klamath stock contribution to the Chinook salmon ocean abundance between Fort Bragg, California and Florence, Oregon would equal a loss of between 3 and 3.6% of available Chinook prey for the short period of time that the Southern Resident DPS killer whales are off the southern Oregon/northern California coast. Assuming that Chinook salmon represent at about 84% of the Southern Resident’s diet, the net loss in potential Klamath-origin prey for Southern Residents would be between 2.5 and 3.0% for one year. This loss of potential prey would be reduced by implementation the salmon spawning conservation measure, substitution of other Chinook salmon stocks or other Klamath River year classes, and utilization of other fish species. Southern Residents also inhabit the Puget Sound area during the late spring, summer and fall months while the Klamath River Chinook salmon are mostly concentrated in southern Oregon and northern California ocean waters. In addition, Southern Resident killer whales may only transit through the Northern California waters for a short period of time during the winter, which further reduces the potential for adverse impact on this species. The small percentage (3%) of potential Klamath-origin short-term prey loss when coupled with the spawning conservation measure and the mitigative factors above would result in an insignificant impact to Southern Resident killer whale food resources. **Therefore, the potential loss of prey base that would occur due to the reservoir drawdown may affect, but is not likely to adversely affect the Southern Resident DPS killer whales in the short-term.**

5.1.9.2 Long-Term Effects

Interrelated to the Proposed Action is the potential closure of the IGH eight years after dam removal (because PacifiCorps will terminate funding for IGH during this time and CDFG have not indicated they would continue operating the hatchery without PacifiCorps funding). This would result in the loss of production of about 5.1 million Chinook salmon smolts and 900,000 yearlings. Using coded wire tag data between 1978 and 1999, an annual average of 0.89% of IGH releases survived to adulthood in the ocean (CDFG unpublished data). Therefore, an average of 53,400 adult Chinook salmon from IGH would not be available as prey for the Southern Resident DPS killer whale.

Using the Liermann et al. (2010) equation, Lindley and Davis (2011 draft) predicted the non-fished equilibrium population of 41,000 adult Chinook salmon in the ocean that will be from the newly accessible upper Klamath Basin. Assuming the Proposed Action would result in an additional 41,000 adult Chinook salmon in the ocean within eight years after removing the Klamath dams, there would be a net loss of about 12,400 hatchery adult Chinook salmon from the Southern Residents’ prey base.

Between 1985 and 2010, Klamath River adult Chinook salmon ocean abundance averaged 434,411 (KRTT 2011). Using the average Klamath Chinook salmon ocean abundance data as a comparison, the 12,400 adult Chinook salmon represents a loss of approximately 0.2.9% of the total Klamath adult

Chinook salmon ocean abundance. The 2.9% loss of adult Klamath Chinook salmon could be multiplied by the maximum 45% Klamath stock contribution to the Chinook salmon ocean abundance between Florence, Oregon and Fort Bragg, California. Thus, the loss of Chinook salmon production would account for 1.3% of available Chinook prey for the Southern Resident DPS killer whales when they are near the southern Oregon/northern California coast. Assuming Chinook salmon represent about 84% of the Southern Resident's diet, the net loss in potential prey for Southern Residents is approximately 1.1% during the two to three month winter period when the whales are typically not inhabiting the Puget Sound, Straits of Juan de Fuca, or Vancouver Island area.

As discussed earlier in Sections 3.1.2 and 5.1.8.2, the EDRRA model was used to predict percent increases in Klamath Chinook populations after active reintroduction ceases and IGH production ceases (2033 – 2061). The 95% credibility interval region provides a range of -61.2% to 779.4%, with a median value of 70.8%. When taking into consideration the 1985 through 2010 average ocean abundance value of 434,411 for Klamath Chinook salmon (KRTT 2011), the 95% credibility interval can be used to estimate the population range during the period 2033 through 2061. As a result, the estimated abundance of Klamath Chinook in the absence of fishing ranges from 168,551 (-61.2%) to 3,385,799 (779.4%), with a median value of 741,974 (70.8%). When compared to the average ocean abundance value of 434,411 (KRTT 2011), the estimated abundance range could potentially result in a net deficit of 265,860 to a net increase of 2,951,388. The median value provides for a net increase of 307,563.

On the low end of the range, the potential loss of -61.2% could be multiplied by the maximum 45% Klamath stock contribution to the Chinook salmon ocean abundance between Florence, Oregon and Fort Bragg, California. Thus, the potential loss of Klamath Chinook salmon from 2033 through 2061 could account for up to 27.5% of available Chinook prey base for the Southern Resident DPS killer whales when they are near the southern Oregon/northern California coast. Assuming Chinook salmon represents about 84% of their diet (Ford and Ellis 2006, and Hanson et al. 2010), the net loss in potential prey for Southern Resident DPS killer whales is approximately 23.1% during the two to three month winter period when the whales are typically not inhabiting the Puget Sound, Straits of Juan de Fuca, or Vancouver Island areas. However, both the high and median values of the range represent a net increase (2,951,388 for the high and 307,563 for the median) over the average ocean abundance value, which could subsequently contribute to a net increase in Klamath Chinook prey abundance for Southern Resident killer whales.

The loss of potential prey from the potential closure of IGH would be reduced by substitution of other Chinook salmon stocks, utilization of other fish species, increased salmon productivity in the Klamath Basin from the reduced hatchery predation and competition, increased juvenile survival from the likely reduction in *C. shasta* and/or *P. minibicornis* infection from the reduction in polychaete habitat downstream of IGD, and increased salmon production from future habitat restoration programs. The mean and maximum increase in potential Klamath Chinook prey abundance estimated for the period 2033 through 2061 would be beneficial to Southern Resident DPS killer whales in the long-term. **Therefore, when considering the range of modeled Klamath Chinook abundance, the potential closure of IGH may affect, but is not likely to adversely affect the Southern Resident DPS killer whales in the long-term.**

5.1.9.3 Critical Habitat

Based on the natural history of the Southern Residents and their habitat needs, the following physical or biological features were identified as essential to conservation: (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging. From observed sightings and other data, three "specific areas" were identified within the geographical area occupied by the species, containing important physical or biological features. The designated areas are: (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, which comprise approximately 2,560 square miles of marine habitat within the area occupied by Southern Resident DPS killer whales in Washington. Although designated critical habitat for the Southern Resident DPS killer whales is several hundred miles to the north of the Action Area, the Proposed Action has the potential to affect the Klamath River-origin Chinook salmon that range into the Puget Sound and thus affect PCE relating to prey species.

As stated above, the reservoir drawdown will result in the release of sediment that would have significant short-term adverse effects on Chinook salmon production in the mainstem Klamath River. It is estimated that up to 2,115 redds (about 8% of Chinook salmon production) in the mainstem will suffer 100% mortality during the reservoir drawdown period (Appendix E of the Klamath Facilities Removal EIS/EIR). It is estimated that between 0 and 1.9% of the killer whale diet in Puget Sound (location of Southern Resident DPS killer whale critical habitat) is composed of Central Valley, California Chinook salmon (Hanson et al. 2010). Given that Hanson et al. (2010) did not observe Klamath-origin Chinook salmon in the killer whale diet, the potential contribution of these fish is likely extremely low. This very low level of Klamath-origin food resource availability is unlikely to reach the level where take would occur. **Therefore, the Proposed Action may affect, but is not likely to adversely affect food resources in the designated critical habitat of the Southern Resident DPS killer whale.**

5.2 Interrelated and Interdependent Action Effects

The potential effects of the KBRA are also included below at a Plan level only, because the actions that would be undertaken under the KBRA are not well-defined at this time. Due to the KBRA's lack of detail describing the actions, the USFWS and NMFS will not develop an ITS for that program at this time. Individual actions associated with the KBRA will undergo individual ESA Section 7 consultation in the future. Therefore, this BA will not analyze the effects of the KBRA on the Klamath Basin's ESA-listed species. As previously discussed in Section 2.3.2, the following IMs are being undertaken by PacifiCorp.

5.2.1 Interim Measure 7

The objective of this IM is to place suitable gravel in the J.C. Boyle bypass and peaking reach using a passive approach before high flow periods, or to provide for other habitat enhancement providing equivalent fishery benefits in the Klamath River above Copco Reservoir. This project has already been subject to consultation between the BLM and the USFWS.

Project is located in the reach between the upstream end of Copco 1 reservoir and J.C. Boyle Dam and as such will have no effect on bull trout, southern DPS green sturgeon, coho salmon, southern DPS eulachon, Steller sea lions, or southern resident killer whales. Any suspended sediment generated by placement of the gravel will be mixed with turbid water generated by the November rainstorms and settle out in the reservoirs downstream. **No effect from the production of turbid water to these species is expected. No effect on critical habitat components of these species is expected.**

SNS were documented within the J.C. Boyle peaking reach and bypass reach during r elicensing surveys conducted by PacifiCorp in 2001 and none were collected in 2002. No LRSwere collected either year (FERC 2007). It is likely that the presence of listed suckers in the J.C. Boyle reach is limited to downstream emigration of juveniles and adults from their preferred lake habitat (PacifiCorp 2004c). In addition, they do not maintain self-sustaining populations below Keno dam and due to the timing of the project, sensitive/vulnerable life stages (larvae) of suckers would be absent. As such, the potential for shortnose and Lost River suckers to occur within the proposed project area is limited. It is possible that the proposed action may result in temporary physical displacement of the species due to gravel placement and/or short-term, localized increases in background turbidity. **These effects would not be meaningfully measurable and would be considered insignificant, and therefore a determination of “may affect, not likely to adversely affect” has been made by the BLM for these species.**

Gravel placement activities will occur during the month of November 2011–2019. NSO in the vicinity of the project may experience short-term noise disturbance resulting from operation of the gravel shooter and/or helicopter. However, given that proposed actions would occur outside of the spotted owl nesting season (February 1–September 15) and would not impact suitable nesting, roosting or foraging habitat for this species. **The proposed project would have no effect on nesting or roosting spotted owls. No NSO critical habitat will be removed or modified by the gravel augmentation and therefore there will be no effect.**

5.2.2 Interim Measure 8

The IM 8 project is located in a high gradient riffle in the J.C. Boyle bypass reach at RM 223.3 has been identified as a potential barrier for migrating adult fish. The riffle has large, side-cast boulders in the river channel that effectively cover all surface flow at low flow levels; removal of some of these boulders to improve passage for resident redband trout and future migrating adult anadromous salmonids is proposed. This project has already been subject to consultation between the BLM and USFWS.

Since there is no direct vehicle access to this site, a rock expansion technique, using a commercially available and non-hazardous material such as Bustar®, would be used to fracture the boulders to manageable sized pieces. This would eliminate the need for constructing a road and disturbing the hillside for equipment access. A standard battery powered rock drill would be used to bore holes into the boulders selected for removal. T he proposed rock expansion compound is comprised primarily (97%) of limestone and dolomite, and becomes an inert material when cured. To ensure that the compound does not come into contact with the river during placement into the drilled holes, a PVC funnel and temporary plastic liner would be used to cover the immediate area. As the inert product sets and expands it causes the rock to fracture. Once reduced to proper size, the liner would be removed and the fractured rock would be repositioned within the channel. No rock would be removed from the site, and with the possible exception of hand operated winches, no heavy equipment or machinery would be used. All proposed work would be done during agency-approved in-water work periods.

Since the project is located in the J.C. Boyle Dam bypass reach it will have no effect on bull trout, Southern DPS green sturgeon, coho salmon, Southern DPS eulachon, Steller sea lions, or southern resident killer whales. Only very minor amounts of suspended sediment, if any, will be generated by removal of the barrier. Any SSC that is produced will settle out in the reservoirs downstream. **No effect from the production of turbid water to these species is expected. No effect on critical habitat components of these species is expected.**

SNS were documented within the J.C. Boyle peaking reach and bypass reach during relicensing surveys conducted by PacifiCorp in 2001 and none were collected in 2002. No LRS were collected either year (FERC 2007). It is likely that the presence of listed suckers in the J.C. Boyle reach is limited to downstream emigration of juveniles and adults from their preferred lake habitat (PacifiCorp 2004c). The high gradient/cascade barrier that is proposed for removal is not suitable habitat for suckers. As such, the potential for shortnose and Lost River suckers to occur within the proposed project area is limited. It is possible that the proposed action may result in temporary physical displacement of the species due to short-term, localized increases in background turbidity. **These effects would not be meaningfully measurable and would be considered insignificant, and therefore a determination of “may affect, not likely to adversely affect” has been made by the BLM for these species.**

NSO in the vicinity of the project may experience short-term noise disturbance resulting from truck traffic. However, given that proposed actions would occur outside of the spotted owl nesting season (February 1–September 15) and would not impact suitable nesting, roosting or foraging habitat for this species. **The proposed project would have no effect on nesting or roosting spotted owls. No NSO critical habitat will be removed or modified by the barrier removal and therefore there will be no effect.**

5.2.3 Interim Measure 16

PacifiCorp shall remove the screened diversions from Shovel and Negro creeks prior to the time that anadromous fish are likely to be present upstream of Copco Reservoir following the breach of Iron Gate and Copco dams.

The IM 16 Project is located in the reach between the upstream end of Copco 1 reservoir and J.C. Boyle Dam and as such will have no effect on bull trout, Southern DPS green sturgeon, coho salmon, Southern DPS eulachon, Steller sea lions, or southern resident killer whales. Any suspended sediment generated removal of the diversions and screens will settle out in the reservoirs downstream. **No effect from the production of turbid water to these species is expected. No effect on critical habitat components of these species is expected. However, the increase in flow in these creeks will have a beneficial effect on reintroduced salmonids and therefore, may affect but is not likely to adversely affect reintroduced salmonids.**

It is likely that the presence of listed suckers in the J.C. Boyle reach is limited to downstream emigration of juveniles and adults from their preferred lake habitat (PacifiCorp 2004c). In addition, they do not maintain self-sustaining populations below Keno dam and due to the timing of the project, sensitive/vulnerable life stages (larvae) of suckers would be absent. As such, the potential for shortnose and Lost River suckers to occur within the proposed project area is limited. **Therefore, the proposed IM 16 project may affect, but is not likely to adversely affect LRS or SNS or their proposed critical habitat.**

The nearest NSO activity center is located at least 2.5 miles west of Shovel Creek. Diversion and screen removal activities will occur outside of the NSO breeding season. However, given that proposed actions would occur outside of the spotted owl nesting season (February 1–September 15) and would not impact suitable nesting, roosting or foraging habitat for this species. **The proposed project would have no effect on nesting or roosting spotted owls.** The nearest NSO critical habitat is located 1.25 miles west of Shovel Creek. **No critical habitat will be removed or modified by IM 16 activities so there will be no effect.**

5.3 Climate Change

Under the Proposed Action, the hydrograph and seasonal water temperature regime would more closely mimic conditions under which native salmonid species evolved. Dam removal would enable salmonids to fully realize the benefits of groundwater sources and the associated thermal refugia above UKL, in the Hydroelectric Reach reach, and downstream of the Hydroelectric Reach reach. The groundwater and thermal refugia will to some extent mitigate climate change effects in late summer for rearing juvenile salmonids and for adult salmonids, particularly upstream migrating or holding spring Chinook salmon. In addition, the removal of the four dams would provide anadromous salmonids access to coldwater springs that are currently inundated by the reservoirs. Therefore, although the effects of climate change are significant, the Proposed Action will likely provide some protection from effects. **Therefore, the Proposed Action is likely to have no effect on climate change.**

6 CUMULATIVE EFFECTS

This section describes the cumulative effects of the Proposed Action. A cumulative effects analysis needs to consider the "future state, tribal, local or private actions that are reasonably certain to occur in the Action Area" (USFWS and NMFS 1998). Any federal actions (including hatcheries, National Forest timber harvest, water projects, instream restoration activities) that require future consultations and are not considered cumulative (USFWS 2008a and NMFS 2010a) and are not included in this analysis. Non-Federal actions (e.g., timber harvest on private land) or those with an uncertain timeframe are speculative and are not included in this analysis. If the Proposed Action has been determined to result in no effect on, or is not likely to adversely affect a species (Tables 4-3 and 4-4), then future projects would not contribute to any cumulative effects and are thus not discussed in this section. The only project which meets the criteria above is in-river harvest.

6.1 Projects Considered and Effects Analysis

The only project identified in the Action Area that meets the cumulative effects criteria defined above is in-river harvest of coho salmon, green sturgeon, and Southern DPS eulachon.

Harvest of coho salmon has been prohibited in the Klamath River since 1994, with the exception of sanctioned tribal harvest for subsistence, ceremonial, and commercial purposes by the Yurok, Hoopa Valley, and Karuk tribes. The Yurok Tribal Fisheries Program reported that annual harvest of coho salmon from reservation lands on the lower Klamath River has ranged from 25 to 2,452 fish per year and averaged 612 fish between 1992 and 2009 (Williams 2010). Williams (2010) estimated that the Yurok Tribal harvest captured between 0.9 and 16.9% (average 3.7%) of the Klamath River coho salmon escapement. No information was found regarding Hoopa Valley and Karuk coho harvest. Recreational harvest of coho salmon is prohibited in the Klamath River and offshore in the Klamath Management Zone. The result of sanctioned in-river harvest can affect adult salmon populations by removing captured individuals that would spawn and repopulate.

Green sturgeon and eulachon are also harvested in the Yurok tribal fisheries, but no information on harvest rates was available. However, five eulachon were captured and turned into the Yurok Tribal Fisheries Department in 2011. Environmental effects for in-river harvest on federally-listed species were analysized and are described below.

6.2 Cumulative Effects Conclusion

6.2.1 Bull Trout

In-river harvest will not occur within bull trout habitat and thus will have no effect on ths species. Removal of the Four Facilities will have no direct effect on bull trout because the species inhabits headwater tributaries upstream of UKL. The reintroduction of Chinook salmon into their historical habitats is not likely to result in increased predation pressures and disease transmission (Section 5.1.1). The reintroduction of Chinook salmon into the UKL headwater areas would increase the prey base for bull trout, which would be beneficial. **Therefore, the Proposed Action, when combined with future actions, is not likely to cause a cumulatively considerable contribution to the overall effects on these species or their habitat.**

6.2.2 Lost River and shortnose suckers

In-river harvest will not occur within the Lost River and shortnose sucker habitat and thus will have no direct effect on these species. The Hydroelectric Reach is not within proposed critical habitat for SNS and LRS. The Proposed Action could have an indirect beneficial effect on PCE 3 by restoring MDNs into the watershed and could increase primary productivity; therefore, would not adversely affect SNS and LRS critical habitat. A conservation measure would be implemented to rescue and remove individuals prior to dam removal; however, those individuals not relocated to the Upper Basin would likely be lost. While some individuals would be lost, the individuals downstream of Keno Dam have little or no successful reproduction (Buettner et al. 2006), no connection to upstream populations, and do not contribute substantially to the achievement of conservation goals or recovery (Hamilton et al. 2010). The Proposed Action may affect, and is likely to adversely affect Lost River and shortnose suckers. **The Proposed Action, when combined with the future action, is not likely to cause a cumulatively considerable contribution to the overall effects on these species or their habitat beyond those that were already described in this BA.**

6.2.3 Coho Salmon

Although the in-river harvest does not target coho salmon for commercial purposes, an average of 3.7% of the Klamath River's escapement is taken for sanctioned purposes and is therefore likely to adversely affect adult coho salmon. The Proposed Action is likely to adversely affect coho salmon and their critical habitat in the short-term, but have long-term benefits (Section 5.1.4). Given the precarious nature of the coho salmon populations, the additional effect of sanctioned in-river harvest of adult coho salmon coupled with the Proposed Action would be cumulatively considerable. **The Proposed Action, when combined with the future action of in-river harvest and the low population levels for this species, is likely to adversely affect coho salmon at the cumulative scale.**

6.2.4 Southern DPS Eulachon

Directed in-river harvest of eulachon is allowed. However, extremely small numbers (<5) of these fish are captured and in many years no harvest occurs. Given the very small numbers of fish taken and the infrequent nature of the harvest, the in-river may affect, but is unlikely to adversely affect the southern DPS eulachon. The Proposed Action would have short-term effects related to SSCs that would likely adversely affect spawning habitat (Section 5.1.5). **The Proposed Action, when combined with the future actions, is not likely to cause a cumulatively considerable contribution to the overall effects on these species or their habitat.**

7 CONCLUSION

7.1 Fish

7.1.1 Bull Trout

Bull trout do not inhabit mainstem river reaches or tributary streams within or downstream of the Hydroelectric Rreach. **Therefore, reservoir drawdown or dam removal activities will have no effect on bull trout in the short-term.**

Steelhead spawn in the spring and emerge from the substrate later that same year and spawn in slightly different stream gradients as bull trout. Upon emergence, they would be too small (i.e. gape limited) to feed upon small bull trout that emerged earlier from the substrate and that would be larger in size than larval steelhead. Juvenile steelhead distribute themselves widely and many move into main stem riverine systems as they rear, limiting the spatial overlap between species and potential for predation on small bull trout. **Therefore, the Proposed Action may affect, but is not likely to adversely affect bull trout populations through increases in predatory pressures by anadromous salmonids and steelhead.**

Bull trout may be at risk if pathogens present downstream of IGD were not present in the Upper Klamath basin. **However, based on the presence of the same pathogens upstream and downstream of IGD and the evolution of bull trout in the presence of these pathogens, the reintroduction of anadromous salmonids upstream of IGD may affect, but is not likely to adversely affect bull trout.**

Because adult salmon do not feed during spawning migrations, there would be no competition for food resources between bull trout and Chinook salmon. Because bull trout spawn in headwater locations different than what Chinook salmon prefer, competition for space would be limited as there would be minimal spatial overlap. Steelhead do not spawn at the same time as bull trout and therefore do not pose a risk of competition for available spawning grounds. As such, the microhabitat separation and timing of spawning would cause insignificant competition for space between steelhead and bull trout species. **As a result, competition for food and space resources due to the reintroduction of salmon and steelhead may affect, but is not likely to adversely affect bull trout.**

Reintroduction of anadromous fish to the upper watershed under the Proposed Action will have an indirect benefit to bull trout by potentially restoring MDNs into the Long Creek drainage. The enrichment of the freshwater ecosystem from input of salmon carcasses may have far reaching benefits throughout the food web by increasing primary productivity. The increase in MDNs will likely increase the aquatic invertebrate biomass, thereby increasing the forage base for the reintroduced juvenile anadromous salmonids as well as bull trout and other native fishes in Long Creek. R**estoring MDNs into Long Creek is likely beneficial and therefore, may affect but is not likely to adversely affect to bull trout.**

Critical habitat for bull trout is not designated downstream of the UKL. However, the reintroduction of anadromous salmonids into designated critical habitat upstream of UKL would increase the food resources PCE of bull trout critical habitat. **The Proposed Action may have a beneficial effect on bull trout critical habitat. Therefore, the Proposed Action may affect but is not likely to adversely affect bull trout critical habitat.**

7.1.2 Lost River and Shortnose Suckers

Those LRS and SNS not relocated to the Upper Basin prior to reservoir drawdown would likely be lost. **Therefore, reservoir drawdown and dam removal may affect and is likely to adversely affect LRS and SNS in the short-term.**

The removal of the Four Facilities will eliminate all LRS and SNS habitat downstream of Keno Dam. Even though suckers in the Four Facilities' reservoirs experience little or no successful reproduction (Buettner et al. 2006), those fish upstream of Keno Dam that are displaced to downstream reaches will continue to be lost in the long-term. **Therefore, the removal of the Four Facilities may affect and is likely to adversely affect LRS and SNS in the long-term**.

The Hydroelectric Reach is not within the proposed critical habitat for the LRS and SNS. As discussed in Section 5.1.2.4, reintroduction of anadromous salmonids into the Upper Klamath Lake Unit could have an indirect beneficial effect on SNS and LRS foraging base by restoring MDNs into the watershed and could increase primary productivity (USFWS 2007a). **Therefore, implementation of the Proposed Action may affect, but is not likely to adversely affect proposed LRS and SNS critical habitat.**

7.1.3 Southern DPS Green Sturgeon

Southern DPS green sturgeon would not be exposed to elevated SSC resulting from the initial winter/spring period drawdown. The summer time worst-case SSC would be higher than existing conditions, however, green sturgeon are not sight feeders and generally feed on benthic organisms detected in fine sediments by their sensitive barbells. This trait would likely reduce the impacts of suspended sedimentation on the species in terms of feeding ability (EPIC et al. 2001, as cited in CDWR 2003). In addition, only a small proportion of the total southern DPS green sturgeon population would be expected to use the Klamath River estuary in 2020, further minimizing the potential for any short-term impacts related to the project. **Therefore, the Proposed Action may affect, but is not likely to adversely affect the southern DPS green sturgeon in the short-term**.

In the long-term, conditions in the estuary are not expected to be significantly different than the current condition. **Therefore, the Proposed Action may affect, but is not likely to adversely affect the Southern DPS green sturgeon in the long-term.**

There is no designated critical habitat in the Klamath River estuary. However, the nearshore area beyond about 1-mi area north, south, and offshore of the mouth of the river is considered critical habitat. The effect of the Proposed Action on critical habitat is expected to be less than what would occur in the estuary due to the dilutive effects of the ocean. **Therefore, the Proposed Action may affect, but is not likely to adversely affect Southern DPS green sturgeon critical habitat.**

7.1.4 Coho Salmon

The Proposed Action will result in 100% mortality of any coho salmon redds and their fry in the mainstem Klamath River below IGD during the reservoir drawdown period. Although no single year-class is expected to be completely lost, mortality of a portion of the smolt outmigration from the Upper Klamath River, Mid-Klamath River, Shasta River, and Scott River population units may affect the strength of the 2018 year class, requiring two or three generations to recover from losses. These losses will be minimized by the implementation of the mainstem spawning, smolt migration, fall pulse flows, and hatchery management conservation and protection measures. **Therefore, the reservoir drawdown and sediment release activities of the Proposed Action may affect and are likely to adversely affect**

coho salmon from the Upper Klamath, Scott River, Shasta River, and Mid-Klamath population units in the short-term and long-term.

Outmigrants from the Salmon and lower Klamath rivers juvenile coho populations will experience elevated stress levels during their migration period. This effect would be reduced by implementation of the smolt migration conservation measure. **Therefore, the Proposed Action may affect and is likely to adversely affect the Salmon River and lower Klamath River outmigrating juvenile coho populations in the short-term**.

Removal of the Four Facilities will increase coho salmon living space by an estimated 76 miles of potential habitat within the Hydroelectric Reach (Administrative Law Judge 2006).**Therefore, the effect of the Proposed Action would be beneficial for the coho salmon from the Upper Klamath River, Mid-Klamath River, Lower Klamath River, Shasta River, Scott River, and Salmon River population units in the long-term. Based on improved habitat and water quality in the mainstem Klamath River, the effect of the Proposed Action on coho salmon from the three Trinity River population units would also likely be beneficial for the long-term and therefore, may affect but is not likely to adversely affect coho salmon.**

The initial drawdown and release of sediment may affect and is likely to adversely affect the spawning sites, food resources, and water quality PCEs of mainstem Klamath River coho salmon's critical habitat in the short-term.

The Proposed Action would result in more natural sediment transport and hydrologic processes downstream of IGD, which would help create more natural substrate characteristics, increase the number and quality of spawning sites, enhance food resources, improve water quality, and expand the amount of riparian vegetation available for coho salmon. **In the long-term, the Proposed Action will have a beneficial effect on the SONCC coho salmon critical habitat and therefore may affect but is not likely to adversely affect SONCC coho salmon critical habitat.**

7.1.5 Southern DPS Eulachon

Adults entering the Klamath River in the winter and spring of 2020 may be exposed to high SCC for a portion of their migration period. Although no analysis of the effects of SCC on eulachon is available, based on application of the Newcombe and Jensen (1996) approach using studies of the effects on other estuary species, it is predicted that under a most-likely or worst-case scenario, mortality would be higher under the Proposed Action than under existing conditions. Mortality is also predicted to be higher for spawning, incubation, and larval life stages under the Proposed action than under existing conditions, with no discernable difference in predicted effects between the most-likely and worst-case scenarios. **For the short-term, SCC in the Lower Klamath River resulting from the Proposed Action's reservoir drawdown may affect and is likely to adversely affect the Southern DPS eulachon.**

The return to a temperature and flow regime that follows the Proposed Action would more closely mimic historical patterns that eulachon evolved with. **For the long-term, the Proposed Action will likely have a beneficial effect for the Southern DPS eulachon and therefore, may affect but is not likely to adversely affect Southern DPS eulachon**.

Removal of the Four Facilities is expected to result in relatively minor changes to river flows downstream of IGD. Under the Proposed Action, water velocities downstream of IGD will be lower in the fall and slightly higher during the summer; however, flows and water velocities would be similar to the existing condition downstream of Orleans, within critical habitat for eulachon. **Therefore, the Proposed Action**

may affect, but is not likely to adversely affect, the water flow essential for spawning and incubation habitat for Southern DPS eulachon.

Under the Proposed Action, sediment would be released from IGD during facility removal and would decline in concentration in the downstream direction as a result of flow accretion from downstream tributaries. As discussed in Section 5.1.5.3, increased suspended sediment is predicted to temporarily degrade habitat suitability compared to existing conditions for spawning and incubation. **Therefore, suspended sediment released during implementation of the Proposed Action may affect and is likely to adversely affect the spawning and egg incubation habitat of the Southern DPS eulachon in the short-term.**

SCCs are predicted to return to background levels within the lower Klamath River by November 2020, prior to the 2021 eulachon spawning migration and spawning season. **Therefore, the Proposed Action will have no effect on spawning and incubation habitat of the Southern DPS eulachon in the long-term.**

Eulachon spawning and egg incubation occurs in the winter and early spring. Water temperatures within the lower Klamath River are expected to be similar to the existing conditions during this time of year. **Therefore, any changes in water temperature resulting from the Proposed Action will have no effect on spawning and incubation habitat of the Southern DPS eulachon in the short- and long-term.**

There would be no Proposed Action-related change in dissolved oxygen downstream of Clear Creek, and therefore no affect within eulachon critical habitat. **Therefore, the Proposed Action will have no effect on dissolved oxygen, which is essential for eulachon spawning and incubation habitat in either the short- and long-term.**

The removal of the Four Facilities will result in a return to more natural sediment transport processes than what is currently occurring. **Therefore, the initial drawdown and release of fine and coarse sediment may affect but is not likely to adversely affect the Southern DPS eulachon spawning and incubation habitat in the short- and long-term.**

There is no information on how the elevated SSC resulting from the removal of the Four Facilities would affect substrate characteristics necessary for successful spawning and egg incubation within the lower Klamath River. However, it could be assumed that a portion of the suspended sediment may settle out in the substrate and alter the quality of the sand and pea gravel that eulachon rely upon for spawning and egg adhesion. **Therefore, the Proposed Action's release of suspended sediment may affect and is likely to adversely affect spawning and incubation habitat of the Southern DPS eulachon in the short-term.**

Rapid transport of fine sediment is predicted to result in no effect on substrate in the long-term.

Removal of the Four Facilitiesis expected to result in relatively minor changes to river flows downstream of IGD. Water velocities downstream of IGD will be lower in the fall and slightly higher during the summer; however, flows and water velocities would be similar to the existing condition at Orleans and downstream reaches. **Therefore, the Proposed Action may affect but is not likely to adversely affect the water flow essential for adult and larval migration habitat for Southern DPS eulachon.**

Under the Proposed Action, sediment would be released from IGD during facility removal, and would decline in concentration in the downstream direction as a result of flow accretion from downstream tributaries. As discussed in Section 5.1.5.3, increased suspended sediment is predicted to temporarily degrade habitat suitability compared to existing conditions for adult and larval migration. **Therefore, the**

Proposed Action may affect and is likely to adversely affect the migration habitat of the Southern DPS eulachon in the short-term.

Suspended sediment concentrations will return to background levels at Klamath by November of 2020, prior to the 2021 eulachon adult and larval migration periods. **Therefore, the Proposed Action will have no effect on adult or larval migration habitat of the Southern DPS eulachon in the long-term.**

Water temperatures are expected to be similar to existing conditions during the time of year when adult and larval migration occur. **Therefore, any changes in water temperatures resulting from the Proposed Action will have no effect on adult or larval migration habitat of the Southern DPS eulachon in the short- and long-term.**

There would be no Proposed Action-related change in dissolved oxygen downstream of Clear Creek, and therefore no affect within eulachon critical habitat. **Therefore, the Proposed Action will have no effect on dissolved oxygen, which is essential for eulachon migration habitat in the short- and long-term.**

7.2 Wildlife

7.2.1 Marbled Murrelet

The Proposed Action would result in sediment discharge downstream of the Four Facilities and ultimately the nearshore marine environment. The marbled murrelet may be potentially affected through direct and indirect primary exposure routes.

Sediment release associated with the Proposed Action could cause short-term and long-term decreases in the water and sediment quality, including the near-shore marine environment areas where marbled murrelets could forage in the marine environment. Most of the compounds of potential concern are chemicals that are likely sediment-associated and direct dermal exposure and/or ingestion of the chemicals is unlikely. In addition, tributary flows and the distance from which marbled murrelets are located downstream from the source would further decrease direct exposure of the chemicals. **As a result, direct exposure through dermal exposure and/or ingestion of chemicals in the water column may affect, but is not likely to adversely affect the marbled murrelet.**

There will be dilution with the inclusion of waters from tributaries and additional dilution from tidal influence in the estuary. The marbled murrelet also has the ability to relocate should forage be diminished either by chronic or isolated toxicity events. Therefore, it is reasonable to assume that the residual toxicity to the forage base would be insignificant. **Forage base would not be diminished by acute or chronic toxicity based on the toxicity results (CDM 2011) and therefore, may affect but is not likely to adversely affect foraging marbled murrelets.**

Potential bioaccumulation of chemicals in forage species would be reduced due to mixing of released reservoir sediments with natural river sediments. Exposure would be further reduced due to mobilization of the sediments over a large area nd over time (CDM 2011). In addition, marbled murrelets are highly mobile and are not found in high densities within the near-shore marine action area. **As a result, indirect effects from ingestion of prey that has been exposed to sediment near the mouth of the Klamath River may affect, but is not likely to adversely affect the marbled murrelet.**

7.2.2 Northern Spotted Owl

The following components of the Proposed Action were analyzed to assess the effects to the NSO:

- Disturbance will result in a may affect, but is not likely to adversely affect northern spotted owls (5.1.6.2); and

- Use of glyphosate-like herbicide will result in a may affect, but is not likely to adversely affect NSO (5.1.6.3).

Therefore, the **Proposed Action may affect, but is not likely to adversely affect NSO and will have no effect on the NSO critical habitat.**

7.2.3 Steller (=northern) Sea Lion

The percentage of the Steller sea lion's Klamath-origin Chinook salmon diet that may be lost due to the 100% mortality of mainstem redds below IGD during the reservoir drawdown period is likely between 0.7 and 0.8%. Any reduction in the Chinook salmon component of the sea lion's diet could be substituted by other prey species. **Therefore, the reduction in Klamath-origin Chinook salmon stock resulting from sediment release during reservoir drawdown may affect, but is not likely to adversely affect Steller sea lions.**

About 12,400 Iron Gate Chinook salmon may not be available for recruitment into the sea lion's food resource base between Fort Bragg and Crescent City should the IGH close in 2028. For the period 2033 to 2061 (after active reintroduction and IGH production ceases), it was estimated that the Klamath Chinook abundance could result in a net deficit of 265,860. This represents a loss of up to 27.5 % of the total Klamath-origin Chinook salmon ocean abundance. The sea lion's diet is made up of about 2% Chinook salmon. The actual dietary loss due to closure of IGH would be between up to 0.55%, which could be substituted for by other food resources. Conversely, Klamath Chinook abundance was also forecasted to result in a net increase for the period 2033 to 2061. **Therefore, the assumed IGH closure may affect, but is not likely to adversely affect Steller sea lions in the long-term.**

The percentage of the Steller sea lion diet that is comprised of Klamath-origin Chinook salmon may be between 0.7 and 0.8%. Any reduction in the Chinook salmon component of the sea lion's diet could be substituted by other prey species. **Therefore, the Proposed Action may affect, but is not likely to adversely affect the food resources PCE of critical habitat of the Steller sea lion in the short-term.**

Based on the expected upper Klamath basin Chinook salmon production, the potential closure of the IGH may affect, but is not likely to adversely affect the food resources element of critical habitat of the Steller sea lion in both the short- and the long-term.

7.2.4 Southern Resident DPS Killer Whale

The expected 100% mortality of redds in the mainstem Klamath River below IGD due to sediment release during reservoir drawdown would result in the loss of between 2.5 and 3% of available food resources for the short period of time that the Southern Resident DPS killer whales are off the northern California coast. This loss of potential prey would be reduced by implementation the salmon spawning conservation measures, substitution of other Chinook salmon stocks or other Klamath River year classes, and utilization of other fish species. Southern Residents also inhabit the Puget Sound area during the late spring, summer and fall months while the Klamath River Chinook salmon are mostly concentrated in southern Oregon and northern California ocean waters. In addition, Southern Resident DPS killer whales only transit through the Northern California waters for a short period of time during the winter, which further reduces the potential for adverse impact on this species. The small percentage (3%) of potential Klamath-origin prey loss when coupled with the spawning conservation measure and the mitigative factors above would result in an insignificant impact to Southern Resident DPS killer whale food resources. **Therefore, the potential loss of prey base that would occur due to the reservoir drawdown may affect, but is not likely to adversely affect the Southern Resident DPS killer whales in the short-term.**

About 12,400 adult Chinook salmon from IGH would not be available as prey for the Southern Resident DPS killer whale should the IGH close in 2028. This represents a loss of about 2.9% of the total Klamath-origin adult Chinook salmon from the killer whale's available prey base. The 2.9% loss of adult Klamath Chinook salmon could be multiplied by the maximum 45% Klamath stock contribution to the Chinook salmon ocean abundance between Fort Bragg, California and Florence, Oregon. Thus, the loss of Chinook salmon production could account for between 1.3% of available Chinook prey for the Southern Resident DPS killer whales when they are near the southern Oregon/northern California coast. Assuming Chinook salmon represent about 84% of the Southern Resident's diet, the net loss in potential prey for Southern Resident DPS killer whales would be about 1.1% during the winter migration period when the whales are typically not inhabiting the Puget Sound, Straits of Juan de Fuca, or Vancouver Island area. This loss of potential prey would be reduced by the substitution of other Chinook salmon stocks, utilization of other fish species, and salmon production from future habitat restoration programs. For the period 2033 to 2061, Klamath Chinook abundance was estimated to be within a 95% credibility interval range of -61.2% to 779.4%, with a median value of 70.8%. When compared to the 434,411 average ocean abundance of Klamath Chinook from 1985 to 2010 (KRTT 2011), there could be a net deficit of up to 265,860 and a net increase of up to 2951,388, with a net increase of 307,563 as the median value. On the low end of the range, potential loss in Klamath Chinook abundance could result in up to 23.1% reduction in prey base for Southern Resident DPS killer whales during the winter migration period when the whales are typically not inhabiting the Puget Sound, Straits of Juan de Fuca, or Vancouver Island areas. On the high end of the range, as well as the median value, potential increase in Klamath Chinook abundance would be beneficial to Southern Resident DPS killer whales. **Therefore, the potential closure of IGH may affect, but is not likely to adversely affect the Southern Resident DPS killer whales in the long-term.**

Given that Hanson et al. (2010) did not observe Klamath-origin Chinook salmon in the killer whale diet, the potential contribution of these fish is likely extremely low. This very low level of Klamath-origin food resource availability is unlikely to reach the level where take would occur. **Therefore, the Proposed Action may affect, but is not likely to adversely affect food resources in the designated critical habitat of the Southern Resident DPS killer whale.**

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8 ESSENTIAL FISH HABITAT ASSESSMENT

8.1 Essential Fish Habitat Background

EFH is designated for commercially fished species under the Magnuson-Stevens Act. The Magnuson-Stevens Act requires federal fishery management plans, developed by NOAA's NMFS and the Pacific Southwest Fisheries Management Council, to describe the habitat essential to the fish being managed and to describe threats to that habitat from both fishing and nonfishing activities. Pursuant to section 305(b) of the Magnuson-Stevens Act (16 U.S.C. 1855(b)), federal agencies are required to consult with NMFS on actions that may adversely affect EFH for species managed under the Pacific Coast Salmon fishery Management Plan.

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. EFH has been designated for three salmon species, 83 groundfish species, and five coastal pelagic species. Descriptions of EFH within the area of analysis are provided below.

8.1.1 Chinook Salmon and Coho Salmon

Coho salmon and Chinook salmon are managed under the Magnuson-Stevens Act, under the authority of which EFH for coho salmon is described in Amendment 14 to the Pacific Coast Salmon Fishery Management Plan (50 CFR § 660.412). EFH for coho salmon and Chinook salmon in the Klamath basin has been designated for the mainstem Klamath River and its tributaries from its mouth to IGD, and upstream to Lewiston Dam on the Trinity River. EFH includes the water quality and quantity necessary for successful adult migration and holding, spawning, egg-to-fry survival, fry rearing, smolt migration, and estuarine rearing of juvenile coho salmon and Chinook salmon.

8.1.2 Groundfish

NMFS defined EFH to include those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (16 U.S.C. § 1802 (10)). EFH for Pacific Coast groundfish includes all waters and substrate within areas with a depth less than or equal to 11,483 ft shoreward to the mean higher high water level or the upriver extent of saltwater intrusion (defined as upstream and landward to where ocean-derived salts measure less than 0.5 ppt during the period of average annual low flow). The Klamath River estuary, which extends from the River's mouth upstream about 2 miles (Klamath Facilities Removal EIS/EIR), is included in the Pacific groundfish EFH (50 CFR § 660.395).

8.1.3 Coastal Pelagic Species

EFH for coastal pelagic species, including finfish (northern anchovy, Pacific sardine, Pacific (chub) mackerel, and jack mackerel) and market squid occurs from the shorelines of California, Oregon, and Washington westward to the exclusive economic zone (3–200 mi offshore) and above the thermocline where sea surface temperatures range from 10 to 26ºC. During colder winters, the northern extent of EFH for coastal pelagic species may be as far south as Cape Mendocino, and during warm summers it may extend into Alaska's Aleutian Islands. In each of these seasonal examples the Klamath Estuary and coastline would be included as EFH for these species.

8.2 Proposed Action

Please refer to Section 2 for a description of the Proposed Action.

8.3 Essential Habitat Requirements for Chinook and Coho Salmon

8.3.1 Fall-run Chinook Salmon

Fall-run Chinook salmon (*Oncorhynchus tshawystcha*) are distributed throughout the Klamath River downstream of IGD. Historical records reviewed by Hamilton et al. (2005) and genetic information obtained from archeological sites analyzed by Butler et al. (2010) indicate that prior to the construction of Copco 1 Dam, Chinook salmon spawned in the tributaries upstream of UKL, including the Sprague, Williamson, and Wood rivers.

Adult upstream migration through the estuary and lower Klamath River peaks in early September and continues through late October (Moyle 2002, FERC 2007, Strange 2009). The ability for Chinook salmon to find their way back to their home stream in order to spawn is mainly related to the long-term olfaction memory of the salmon, but is also aided by their vision (Healey 1991) and may be stimulated by higher streamflow and changes in water turbidity, temperature and oxygen content (Allen and Hassler 1986). Optimal migratory routes are free of barriers that can impede or prevent movement upstream and downstream.

Spawning peaks in late October and early November. In general, spawning Chinook salmon require gravel and cobble areas, primarily at the head of riffles, with adequate hyporheic flow to increase the probability of embryo survival. Chinook salmon select gravel for spawning with a median diameter between 1.3 to 10.2 cm (Bjornn and Reiser 1991).

During incubation, sufficient water must circulate through the redd as deep as the egg pocket to supply the embryos with oxygen and carry away waste products (Bjornn and Reiser 1991). Infiltration of fine sediment into redds may reduce water circulation in the redd and reduce survival of incubating eggs. Fall-run Chinook salmon fry in the Klamath River emerge from redds between December and late February (Klamath Facilities Removal EIS/EIR), although timing may vary somewhat depending on temperatures in different years and tributaries. Fine sediment deposition or capping of redds can impede emergence of fry. Bjornn and Reiser (1991) reported that in laboratory studies, swim-up fry had difficulty emerging substrate when the percentage of fine sediment exceeded 30-40 percent by volume.

Fall-run Chinook salmon in the Klamath Basin exhibit three juvenile life-history types: Type I (ocean entry at age 0[6] in early spring within a few months of emergence), Type II (ocean entry at age 0 in fall or early winter), and Type III (ocean entry at age 1 in spring) (Sullivan 1989). Based on outmigrant trapping data collected at Big Bar on the Klamath River from 1997 to 2000, Schieff et al. (2001) concluded that 63 percent of natural Chinook salmon outmigrants are Type I, 37 percent are Type II, and less than 1 percent are Type III. Although juvenile Chinook salmon can tolerate relatively high turbidity conditions for short periods of time, excessive SSCs can degrade rearing and smolting habitat quality to the point where reduced growth rates, extreme stress, or mortality can occur (Newcombe and Jensen 1996).

8.3.2 Spring-Run Chinook Salmon

Spring-run Chinook salmon in the Klamath Basin are distributed mostly in the Salmon and Trinity rivers and on the mainstem below these tributaries during migratory periods, although a few fish are occasionally observed in other areas (Stillwater Sciences 2009a). Based on data from 1992 to 2001 (CDFG 2004, unpubl. data), (someone concluded that) the Salmon River contributions to the overall escapement ranged from 1 to 20 percent of the total escapement, and from 2 to 35 percent of the natural escapement. No spawning has been observed in the mainstem Klamath River (Shaw et al. 1997). Spring-

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[6] A fish emerging in spring is designated as age 0 until January 1st of the following year, when it is designated as age 1 until January 1st of the next year, when it is designated age 2.

run Chinook salmon are believed to have used habitat upstream of UKL historically (Hamilton et al. 2005, Butler et al. 2010).

There appear to be three juvenile life-history types for spring-run Chinook salmon in the Klamath Basin: Type I (ocean entry at age 0 in early spring within a few months of emergence), Type II (ocean entry at age 0 in fall or early winter [Olson 1996]), and Type III (ocean entry at age 1 in spring) (Sullivan 1989). Based on outmigrant trapping in the Salmon River from 2001 to 2006 (Kaurk Karuk Tribe, unpubl. data), around 80% of outmigrants are Type I, 20% are Type II, and less than 1% are Type III. Rearing of age-0 juveniles likely occurs to some extent in the mainstem Klamath River, although it appears that the majority remain to rear in their natal streams (i.e., Salmon and Trinity rivers). It is unclear to what extent juvenile spring-run Chinook rear in the mainstem Trinity and Klamath Rivers as trapping studies do not differentiate between the spring and fall runs.

Spring-run Chinook salmon upstream migration is observed during two time periods—spring (April through June) and summer (July through August) (Strange 2008). Snyder (1931) also describes a run of Chinook salmon occurring in Klamath River during July and August under historical water quality and temperature conditions. Adults spawn from mid-September to late-October in the Salmon River and from September through early November in the South Fork Trinity River (Stillwater Sciences 2009a). Fry emergence takes place from March and continues until early-June (West et al. 1990). Spawning, incubation, rearing, and smolting habitat characteristics for spring-run Chinook salmon are similar to fall-run Chinook salmon.

Age-0+ juveniles rearing in the Salmon River emigrate at various times of the year, with one of the peaks of outmigration occurring in April through May (Olson 1996), which would be consistent with a Type I life history type. Based on outmigrant trapping from April to November in 1991 at three locations in the South Fork Salmon River, Olson (1996) reported that greatest peak in outmigration of age-0+ juveniles (69 percent) was in mid-October, which would be considered Type II life history. Scale circuli patterns of adults with an identified Type II life history were consistent with those from juveniles outmigrating in mid-October. Sullivan (1989) reported that outmigration of Type II age-0+ juveniles can occur as late in the year as early-winter. On the South Fork Trinity River outmigration occurs in late-April and May with a peak in May (Dean 1994, 1995). Age-1 juveniles (Type III) have been found to outmigrate from the South Fork Trinity River during the following spring (Dean 1994, 1995).

It is unclear how much time the outmigrating age 0+ spring-run Chinook salmon spend in the mainstem Klamath River and estuary before entering the ocean. Sartori (2006) did identify a period of increased growth (estimated mean of 24 days) just prior to reaching an estuarine environment based on otolith analyses of returning adults to the Salmon River, but this period was never clearly linked to mainstem residence. Travel time for IGH-released young-of-the-year Chinook salmon ranged from 62 to 77 days in 2006 to 113 days in 2007 (Hiner 2008). Travel time for Trinity River Hatchery spring-run Chinook salmon ranged from 36 to 63 days in 2006 and from 27 to 112 days in 2007 (Hiner 2008).

8.3.3 Coho salmon

See Section 4.2.2 for a description of coho salmon life history and habitat requirements.

8.4 Effects of the Action

The EFH implementing regulations, 50 CFR § 600.810(a), define the term “adverse effect” as:

> any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate

> and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

8.4.1 Chinook and Coho Salmon

As stated previously, EFH for Chinook salmon and coho salmon in the Action Area includes the water quality and quantity necessary for successful adult migration and holding, spawning, egg-to-fry survival, fry rearing, smolt migration, and estuarine rearing of juvenile coho salmon and Chinook salmon. The Proposed Action includes reservoir drawdown and sediment release during the winter of 2020. Dam removal begins soon thereafter. Some retained sediment that is trapped in the post-dam removal reservoir areas may be mobilized during the fall and winter of 2020/2021. This release of sediment will affect Chinook and coho salmon EFH.

8.4.1.1 Adult Migration Habitat

Fall-run Chinook salmon
Adult fall-run Chinook salmon in the Klamath River migrate upstream from August through October, when suspended sediment levels are generally low, and typically take two to four weeks to reach their spawning grounds. Under the Proposed Action, the SSC in the mainstem Klamath River during the 2019 migratory period is predicted to the same as under existing conditions since no activities will have begun. Therefore, no adverse effect to adult Chinook salmon migration habitat is expected during the fall of 2019.

SSC within the mainstem Klamath River downstream of IGD during the late summer and early fall of 2020, immediately following removal of the dams in 2020, are expected to range from 50 to 100 mg/L during the August through October. This high suspended sediment load would be due to the mobilization of trapped sediment remaining in the reservoir footprint area. These relatively high SSC are expected to result in adverse effects to migration habitat, which may cause major stress and impaired homing for adult Chinook salmon. The release of trapped sediment from the reservoirs is expected to result in at least partial pool filling downstream of IGD. This would adversely affect holding habitat for migrating adult Chinook salmon. **Therefore, in the short-term the Proposed Action may have an adverse effect on migration habitat quality downstream of IGD during the fall of 2020. These effects are expected to be substantial in the short-term, but return to background levels with a few years.**

Spring-run Chinook salmon
Spring-run Chinook upstream migration is separated into two time periods—spring and summer. Under the Proposed Action (most-likely and worst-case scenarios), spring-run migrants are expected to be exposed to higher concentrations of SSC than under existing water quality conditions, leading to increased stress and impaired homing (Appendix E in the EIS/EIR). However, the duration of exposure to the high SSC is relatively short (<14 days), and effects are expected to be sublethal. Behavioral responses of adult salmon to high suspended sediment can include straying into nearby tributaries with lower levels of suspended sediment and ceasing or delaying upstream movements when there are no clearer waters to take refuge in (Cordone and Kelley 1961). The increased energy expenditure that may result from a delay in migration can potentially reduce spawning success (Berman and Quinn 1991), particularly if factors such as elevated temperatures or disease are a problem. Modeling shows the SSC will return to background levels by the spring of 2021 in the Orleans reach (location of the Salmon River) of the river (Figure 5-4). **Therefore, the Proposed Action will result in a more than minimal, but less than substantial effect on spring-run Chinook salmon migration habitat.**

The release of trapped bedload sediment from the reservoirs is expected to result in at least partial pool filling downstream of IGD. The effects of the bedload release are not expected to extend beyond Shasta River, which is approximately 14 miles downstream of IGD (Reclamation 2011b). The nearest spawning population of spring-run Chinook salmon occurs in the Salmon River, which is about 120 miles downstream of IGD and would not be affected by the Proposed Action’s sediment release. **Therefore, no adverse effect on holding habitat for migrating adult spring-run Chinook salmon is expected**.

Coho salmon

Under the Proposed Action, adult coho salmon would encounter elevated SSC and impaired migration habitat due to the November 1, 2019 initiation of the Copco 1 reservoir drawdown. Worst case modeled SSC at IGD under the Proposed Action is expected to range from 60 to 200 mg/L during to the Copco 1 reservoir drawdown prior to January 1, 2020.

Under the modeled existing condition, SSC from November 1, 2019 through January 1, 2020 are expected to be between 33 and 245 mg/L for five days at Seiad Valley (Appendix E of the Klamath Facilities Removal EIS/EIR). The existing condition SSC relates to a Newcombe and Jensen (1996) SEV of 6 or 7, which is expected to result in moderate stress and/or impaired homing to migrating adult Chinook salmon. The drawdown of Copco 1 is scheduled to begin on November 1, 2019, while J.C. Boyle and Iron Gate dams will begin on January 1, 2020. Sediment released from Copco 1 will be transported downstream and a portion will become trapped in the IGD reservoir, but some of the suspended load will continue downstream and result in elevated SSC. Under most likely or worst case scenario, the Proposed Action’s estimated SSC between the period of November 1 and January 1 are expected to range from 33 to 665 mg/L for up to 26 days (Appendix E of the Klamath Facilities Removal EIS/EIR). The Proposed Action SSC relates to a Newcombe and Jensen (1996) SEV of 7 or 8, which would result in major stress and/or impaired homing for adult coho salmon during the fall of 2019.

SSC within the mainstem Klamath River downstream of IGD in the fall of 2020 and early winter of 2021, immediately following removal of the dams in 2020, are expected to range from 10 to 357 mg/L for several months. These high SSC are expected to result in adverse effects to migration habitat, which may cause major stress and impaired homing for adult coho salmon during the fall of 2020. Therefore, the Proposed Action is expected to result in an incremental increase in SSC over the existing condition, which may substantially adversely affect coho salmon migration habitat in 2020.

In summary, SSC within the mainstem Klamath River would be high enough to cause moderate to major physiological stress and impaired homing during the fall of 2019 and 2020. **Therefore, the Proposed Action may have a substantial adverse effect on coho salmon migration habitat in 2019 and 2020.**

8.4.1.2 Spawning Habitat

Fall-run Chinook salmon

The bed material in the channel from IGD (RM 195) to Cottonwood Creek (RM 182) 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 2004b, Reclamation 2011b). The reach from IGD to Cottonwood Creek (RM 182.1) is characterized by coarse, cobble-boulder bars immediately downstream of the dam, transitioning to a cobble bed with pool-riffle morphology farther downstream near Cottonwood Creek (Montgomery and Buffington 1997, PacifiCorp 2004b, Stillwater Sciences 2010). The D16 (the substrate particle diameter where 16% of the material is finer than) immediately downstream of IGD is not less than 0.7 inches (18 mm) (PacifiCorp 2004b, Reclamation 2011b), which indicates that the sand component is less than 16% of the bed material.

Reclamation (2011b) concluded that downstream of IGD, there will be a substantial increase in sand content immediately following reservoir drawdown in the Bogus Creek to IGD reach. The percent of sand in the bed is expected to increase to up to 40% for the month immediately after reservoir drawdown. Under a wet year scenario, the sand would decrease to below 20% within a year; however, under a median or dry scenario, a subsequent wet year would be required to flush the sand material from the bed. Downstream of Bogus Creek, it is expected that sand may take longer to be flushed downstream and under dry or median year scenarios it could take 5–6 years for sand in the bed to return to equilibrium levels between Bogus Creek and Willow Creek and up to 10 years between Willow Creek and Cottonwood Creek (Reclamation 2011b).

A flushing flow is expected to require at least 6,000 cfs for several days to weeks to return the bed composition of mostly cobble and gravel with a sand content less than 20% (Reclamation 2011b). Based on the historical record a sufficient flushing flow would likely occur within 5 years following dam removal.

The reach between IGD and Ash Creek (RM 177.5) provides habitat for between 26 and 71% of the mainstem Chinook salmon that spawn in the river between IGD and Indian Creek (RM 108) (Magneson and Wright 2010). The sand component in the released reservoir bedload is likely to substantially degrade spawning habitat quality in the reach for several years. **Therefore, the Proposed Action would have a substantial adverse effect on fall-run Chinook salmon spawning habitat.**

Spring-run Chinook salmon

Spring-run Chinook salmon spawn primarily in the Salmon and Trinity rivers, with the vast majority (~95 percent) spawning in the Trinity River (Appendix E of the EIS/EIR). Spring-run Chinook salmon are not known to spawn in the mainstem Klamath River. **Therefore, the Proposed Action will have no adverse effect on EFH for spring-run Chinook salmon spawning habitat.**

Coho salmon

Coho salmon are typically tributary spawners (NMFS 2010), and based on Magneson and Gough (2006) spawning surveys from 2001 to 2005, only from 6 to 13 redds have been observed within the study area of the mainstem. Even though coho spawning habitat is limited in the mainstem Klamath River, it will be adversely affected by the reservoir drawdown and sediment release from the Proposed Action. Similar to the previous analysis of fall-run Chinook salmon spawning habitat (in this section of the EFH analysis suitable substrate conditions would return following flushing flows. **Therefore, due to the low number of redds that could be affected, the Proposed Action would have a more than minimal, but less than substantial adverse effect on coho salmon spawning habitat downstream of IGD.**

8.4.1.3 Egg-to-Fry Survival Habitat

Fall-run Chinook salmon

Fall-run Chinook salmon spawning in the Klamath Basin typically peaks in late October and substantially declines by the end of November (Shaw et al. 1997). It is estimated that up to 2,115 redds (about 8% of the Klamath Basin's production) in the mainstem and their fry will suffer 100% mortality during the reservoir drawdown period (Appendix E of the Klamath Facilities Removal EIS/EIR). This effect would be caused by reservoir drawdown-released sediment infiltrating spawning gravel interstices and redds (Appendix E in the EIS/EIR).

Reclamation (2011b) concluded that downstream of IGD, there will be a substantial increase in sand content immediately following reservoir drawdown in the Bogus Creek to IGD reach. The percent of sand in the bed is expected to increase to up to 40% for the month immediately after reservoir drawdown. Under a wet year scenario, the sand would decrease to below 20% within a year; however, under a median or dry scenario, a subsequent wet year would be required to flush the sand material from the bed. Downstream of Bogus Creek, it is expected that sand may take longer to be flushed downstream and under dry or median year scenarios it could take 5–6 years for sand in the bed to return to equilibrium levels between Bogus Creek and Willow Creek and up to 10 years between Willow Creek and Cottonwood Creek (Reclamation 2011b). **Therefore, the Proposed Action would have a substantial adverse effect on incubation habitat for fall-run Chinook salmon below IGD for up to 10 years**.

Spring-run Chinook salmon
Since no spring-run Chinook salmon spawning occurs in the mainstem Klamath River under existing conditions, incubation habitat for this species is not anticipated to be affected by suspended sediment resulting from the Proposed Action (Appendix E in the EIS/EIR).

Coho salmon
Similar to the previous analysis of fall-run Chinook salmon egg to fry survival, suspended sediment resulting from the Proposed Action is predicted to infiltrate spawning gravel interstices and redds, which will result in up to 100% mortality of eggs and fry in the 6 to 13 coho redds located in the mainstem Klamath River downstream of IGD. The effects of the sediment infiltration would persist until flushing flows occur, which may take up to 10 years depending on water year type. **Therefore, the Proposed Action would have a substantial adverse affect on incubation habitat for coho salmon**.

8.4.1.4 Fry-Rearing Habitat

Fall-run Chinook salmon
The SSCs experienced in the mainstem Klamath River during the reservoir drawdown and dam removal (100 to 11,000 mg/L under the worst case scenario at IGD) is expected to result in degraded fry rearing conditions in 2020 and the winter and spring of 2021. These SSC will result in major stress, reduced growth rates, and/or mortality for individuals rearing in the mainstem Klamath River. Modeling shows the SSC will return to background levels by the winter of 2021 in the Seiad Valley to estuary reach of the river (Figures 5-1, 5-2, and 5-3). SSCs that are higher than background level will persist in the IGD reach for a few years, but gradually decrease as the sediment deposits within the reservoir footprints become stabilized and revegetated. **Therefore, the Proposed Action will have a substantial adverse effect on fry rearing habitat on the mainstem Klamath River.**

Spring-run Chinook salmon
Spring-run Chinook salmon fry rearing takes place primarily in tributary streams (Appendix E in the EIS/EIR). It is possible that an unknown percentage of spring-run Chinook salmon fry move into the mainstem Klamath River and rear. Those fish would be subject to high SSC as described above, which would result in lethal to para-lethal effects. **Therefore, the Proposed Action would have an adverse effect on fry rearing habitat for this species. However, given that these fish primarily rear in tributary streams, the effect on rearing habitat would be more than minimal, but less than substantial.**

Coho salmon
Although most (assumed >50 percent) Age 0+ juvenile coho salmon rearing is believed to occur in tributaries, age-0 juveniles are observed outmigrating from tributaries in spring and early summer. Age 0+ coho salmon would be exposed to SSC that will result in major physiological stress, reduced growth (possibly no growth at all), and/or mortality for individuals rearing in the mainstem. Modeling shows the SSC will return to background levels by the spring of 2021 in the Seiad Valley to estuary reach of the river (Figures 5-1, 5-2, and 5-3). SSCs that are higher than background level will persist in the IGD reach for a few years, but gradually decrease as the sediment deposits within the reservoir footprints become stabilized and revegetated. **Therefore, the Proposed Action will have an adverse effect on coho**

salmon rearing habitat in the mainstem Klamath River. However, given that these fish primarily rear in tributary streams, the effect on rearing habitat would be more than minimal, but less than substantial.

8.4.1.5 Smolt Migration Habitat

Fall-run Chinook salmon

Approximately 60 percent of the fry produced by fall-run Chinook salmon in the Klamath River exhibit the Type I life history, in which they enter the ocean within a few months of emergence in early spring. Under the Proposed Action, SSC in the mainstem will degrade smolt migration habitat and likely result in major physiological stress and reduced growth under either the most-likely or worst-case scenario (Appendix E in the EIS/EIR). Modeling shows the SSC will return to background levels by the winter of 2021 in the Seiad Valley to estuary reach of the river (Figures 5-1, 5-2, and 5-3). SSCs that are higher than background level will persist in the IGD reach for a few years, but gradually decrease as the sediment deposits within the reservoir footprints become stabilized and revegetated.

The Type II life history is also common (~40 percent of cohort) (Sullivan 1989). These juveniles remain to rear in their natal tributaries and will only be exposed to suspended sediment in the mainstem during their outmigration to the ocean in the fall. Under the Proposed Action, SSC would be very low during the fall at Seiad Valley, Orleans, and Klamath Glen, similar to existing conditions, unless there are worst-case conditions in the fall after dam removal in 2020. SSC at IGD would be elevated during the fall of 2020 and 2021. In this case, SSC would be high enough to cause moderate to major physiological stress for a period of one to two weeks (Appendix E in the EIS/EIR).

Type III life-history fish are relatively rare (<1 percent of production) in the Klamath River fall-run population (USFWS 2001). These fish typically remain to rear in their natal tributaries and outmigrate in late winter and early spring as yearlings. Under the Proposed Action, SSC could severely degrade smolt migration habitat and cause up to 20 percent mortality, and up to 100 percent mortality in a worst-case scenario (Appendix E in the EIS/EIR).

SSCs that are higher than background level will persist for a few years, but gradually decrease as the sediment deposits within the reservoir footprints become stabilized and revegetated.

Therefore, the Proposed Action will have a substantial adverse effect on fall-run Chinook salmon smolt migration habitat on the mainstem Klamath River in the short-term.

In the long-term, the return to a more natural hydrologic regime is expected to result in river flows that are either the same or higher than the current condition for the months of March through September (Figure 8-1). The higher flows would assist smolt migration. **Therefore, the Proposed Action will result in improved migration habitat in the long-term.**

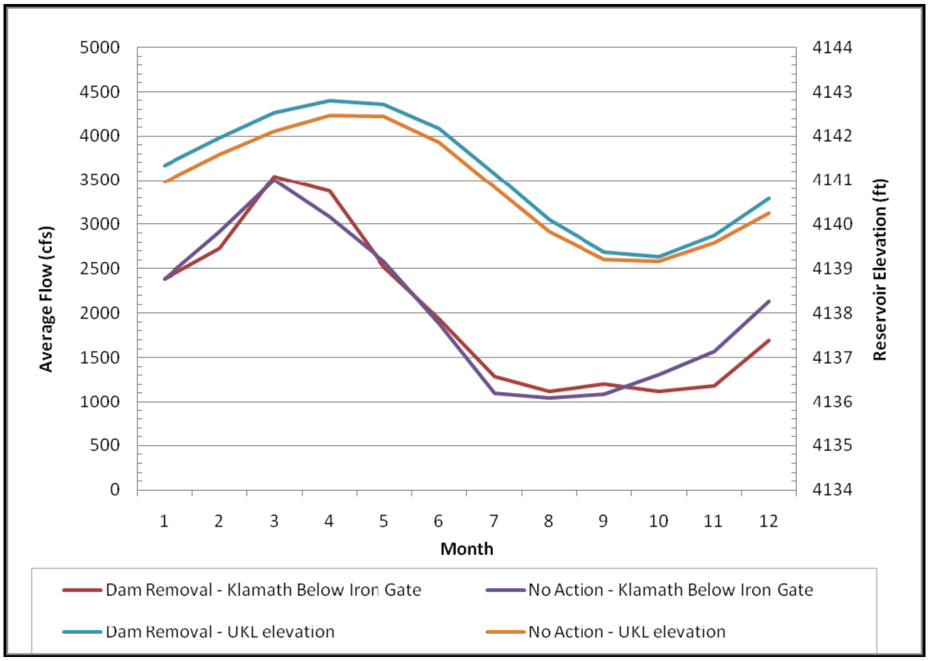

Figure 8-1. Average Monthly Flows at Iron Gate Dam and Upper Klamath Lake Elevations for the Existing Condition (Klamath Facilities Removal EIS/EIR No Action) and Proposed Action (Dam Removal) Scenarios

Spring-run Chinook salmon

Type I juveniles move from tributaries into the mainstem and continue downstream to the ocean in April and May. As described above for fall-run Chinook salmon, the Proposed Action SSC would degrade smolt migration habitat would cause moderate-to-major stress during the Type I and II outmigration (Appendix E in the EIS/EIR). Type III outmigrants that overwinter in the mainstem Klamath River when SSC are highest, or those migrating from the Salmon River (<1 percent of outmigrants within Klamath River watershed), will have the greatest exposure to suspended sediment. Suspended sediment conditions would cause major physiological stress during the Type III outmigration. **Therefore, the Proposed Action will have an adverse effect on spring-run Chinook salmon smolt migration habitat on the mainstem Klamath River. This effect would be substantial, but would gradually decrease within a few years as the sediment deposits within the reservoir footprints become stabilized and revegetate.**

In the long-term, the return to a more natural hydrologic regime is expected to result in river flows that are either the same or higher than the current condition for the months of March through September (Figure 8-1). The higher flows would assist smolt migration. **Therefore, the Proposed Action will result in improved spring-run Chinook salmon smolt migration habitat in the long-term.**

Coho salmon

Coho salmon smolts from the 2019 cohort are expected to outmigrate to the ocean beginning in late February, although most natural origin smolts outmigrate to the mainstem Klamath during April and May (Wallace 2004). As described above for fall-run Chinook salmon, under the Proposed Action, SSC would be higher during spring than under existing conditions, thereby reducing the quality of coho salmon smolt migration habitat. As a result, coho smolts outmigrating in early spring (prior to April 1) are likely to suffer up to 49 percent mortality in a worst-case scenario. Smolts outmigrating in late spring (after April 1) will be exposed to lower SSC, and may experience only slightly worse physiological stress and reduced growth rates compared with existing conditions, even under a worst-case scenario. Modeling shows the SSC will return to background levels within one year in the Seiad Valley to estuary reach of the river (Figures 5-1, 5-2, and 5-3). The greatest effects will occur in the IGD to Shasta River reach and then decrease in a downstream direction as accretion flow from tributaries dilute the SSC. **Therefore, the Proposed Action will result in substantial adverse effects on coho salmon smolt migration habitat on the mainstem Klamath River in the short-term.**

In the long-term, the return to a more natural hydrologic regime is expected to result in river flows that are either the same or higher than the current condition for the months of March through September (Figure 8-1). The higher flows would assist smolt migration. **Therefore, the Proposed Action will result in improved coho salmon smolt migration habitat in the long-term.**

8.4.1.6 Estuarine Rearing Habitat

Fall-run Chinook salmon
The Proposed Action will result in elevated SSC in the estuary, including the period that fall-run Chinook salmon rear in the estuary. The elevated SSC during the summer of 2020 (Figure 5-1) may affect the ability of these fish to acquire prey and therefore, reduce feeding opportunities. Modeling shows the SSC in the estuary will return to background levels by the winter of 2021 (Figure 5-1). **Therefore, the Proposed Action will have a more than minimal, but less than substantial effect on estuarine rearing habitat for fall-run Chinook salmon.**

Spring-run Chinook salmon
The Proposed Action will result in elevated SSC in the estuary, including the period that spring-run Chinook salmon rear in the estuary. The elevated SSC during the summer of 2020 (Figure 5-1) may affect the ability of these fish to acquire prey and therefore, reduce feeding opportunities. Modeling shows the SSC in the estuary will return to background levels by the winter of 2021 (Figure 5-1). **Therefore, the Proposed Action will have a more than minimal, but less than substantial effect on estuarine rearing habitat for spring-run Chinook salmon.**

Coho salmon
The Proposed Action will result in elevated SSC in the estuary, including the period that coho salmon rear in the estuary. The elevated SSC during the summer of 2020 (Figure 5-1) may affect the ability of these fish to acquire prey and therefore, reduce feeding opportunities. Modeling shows the SSC in the estuary will return to background levels by the winter of 2021 (Figure 5-1). **Therefore, the Proposed Action will have a more than minimal, but less than substantial effect on estuarine rearing habitat for coho salmon.**

In the long-term, the Proposed Action is expected to result in hydrologic and sediment transport processes that are closer to the conditions experienced prior to the construction of the Four Facilities. **Therefore, the Proposed Action is not expected to have any long-term effects on estuarine rearing habitat**.

8.4.1.7 Conclusion

Based upon the descriptions of effects above, Reclamation concludes that the Proposed Action will result in substantial adverse effects on EFH conditions for adult migration, spawning, egg to fry survival, juvenile rearing, and smolt migration downstream of IGD. The Proposed Action will result in more than minimal, but less than substantial effects on estuarine rearing for Chinook salmon and coho salmon.

8.4.2 Groundfish

As stated in the Klamath Facilities Removal EIS/EIR, the results of model predictions for sediment transport following dam removal under the Proposed Action indicate that dam removal would cause a release of less than 3 million tons of fine sediment to the Klamath River downstream of IGD (Figure 8-2). While estimates of long-term average annual sediment discharge to the Klamath Estuary vary considerably, they are generally well above the projected 3 million tons. For example, annual sediment supply from Trinity River alone is calculated to be 8.5 million tons based on data provided in EPA (2001). Additionally, Stillwater Sciences (2010) estimated that Klamath River annual sediment discharge to the estuary is approximately 5.8 million tons. The predicted sediment release due to dam removal under the Proposed Action ranges from less than 2 to 3 million tons depending on water year type (Figure 8-2) and is only one-eighth of the cumulative sediment transport in the Klamath River at Hoopa in a four-day period during the December 1964 flood event. Lastly, the predicted sediment release due to dam removal is approximately the same as the cumulative sediment transport over a single day at the Salmon River confluence during a very large flood event (i.e., the January 1974 flood) (Stillwater Sciences 2010).

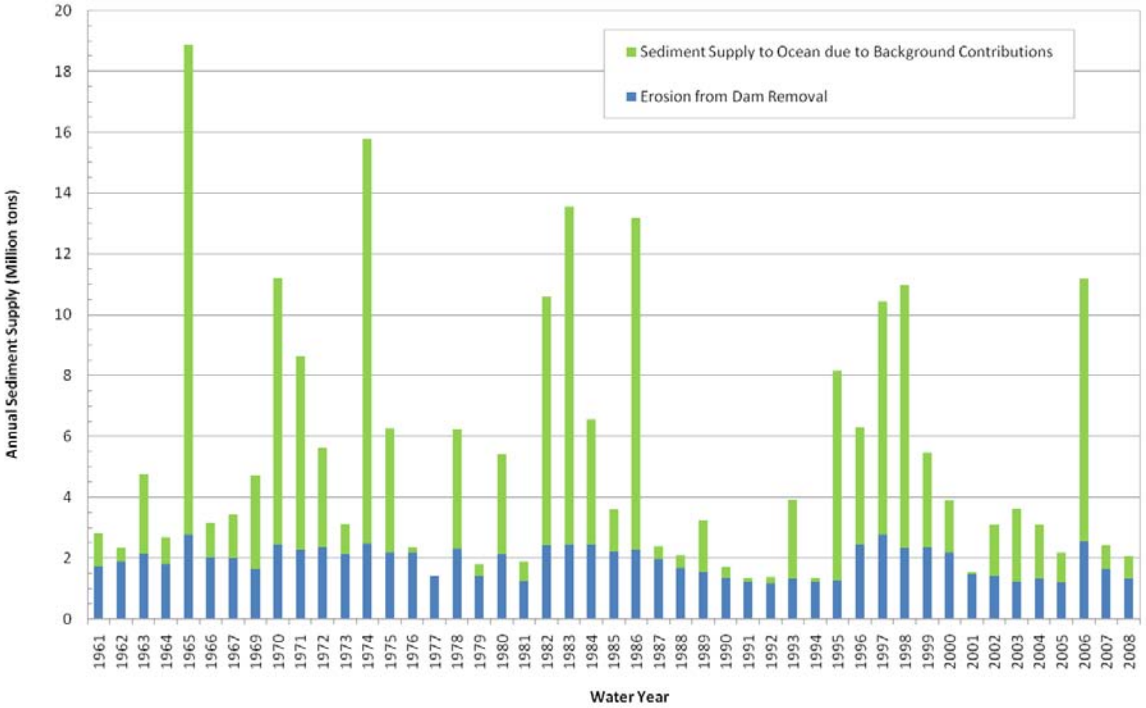

Figure 8-2. Annual Predicted Sediment Delivery to the Pacific Ocean under the Proposed Action and the Background Conditions by Water Year (Note: Model results are only valid for the year of dam removal. No significant increase in sediment loads is predicted in years following dam removal.) (Source: Greimann et al. 2011)

A 1995 Eel River flood with a 30-yr return period delivered an estimated 25 ± 3 million metric tons of fine-grained (<62 µm) sediment to the ocean (Wheatcroft et al. 1997). Transported sediments formed a distinct layer on the sea bed that was centered on the 70-m isobath, extended for 30 km along shelf and 8 km across shelf, and was as thick as 8.5 cm. Wheatcroft et al. (1997), estimated that 75 percent of the flood-derived sediment did not form a recognizable sea-floor deposit, but was instead rapidly and widely dispersed over the continental margin.

A considerable amount of fine sediment in the plume is anticipated to initially deposit on the seafloor shoreward of the 60-m isobath along the coast, with greater quantities depositing in close proximity to the mouth of the Klamath River. After this initial deposition, as described by Farnsworth and Warrick (2007), resuspension during the typical winter storms would likely occur before final deposition and burial. Much of this sediment will eventually be transported further offshore to the mid-shelf and into deeper water depths off-shelf through progressive resuspension and fluid-mud gravity flows.

Because of the complexities of the transport processes, the area and depth of the deposition of fine sediment from the Proposed Action cannot be precisely predicted. However, the short-term (< 2 years following dam removal) plume effects and long-term (2–50 years following dam removal) sediment deposit effects would be in line with what currently occurs in the nearshore environment. This is due to the relatively small amount of total sediment input, in comparison to the total annual sediment inputs to the nearshore environment, and the fact that river plume sediment inputs are a naturally occurring process. As a result, net deposition of reservoir sediments to the marine nearshore bottom substrates should be relatively less concentrated (i.e., thinner deposits in any one spot) and more widespread.

8.4.2.1 Conclusion

In summary, the Proposed Action will result in increased SSCs delivered to the nearshore environment. However, the anticipated rapid dilution of the sediment plume as it expands in the ocean, the relatively low rate of deposition of sediments to the shallow (~196–230 ft) marine nearshore bottom substrates, and the limited extent of the settlement zone (196–230 ft in a 11,483 ft deep EFH) will likely limit the effect. **Nevertheless, the Proposed Action will result in increases in SSCs and fine sediment deposition in the marine nearshore environment and will minimally adversely affect groundfish EFH in the short-term.**

In the long term, SSCs would be similar to that under existing conditions. Natural bedload transport processes would resume, as the dams would no longer trap sediments upstream of IGD. Bedload in the estuary and ocean would not be appreciably affected, because of the small contribution of the area above IGD to the total bedload in the system. With the exception of algal toxins, water quality benefits resulting from dam removal would largely have dissipated upstream of the estuary, and therefore, water quality in the estuary would be expected to remain similar to existing conditions. **Therefore, in the long-term, the Proposed Action would likely have no effect on groundfish EFH.**

8.4.3 Coastal Pelagic Species

The effects of the Proposed Action on pelagic fish EFH would be short-term increases in SSCs. These increases would occur for about 4–5 months. After this time SSCs would be expected to be similar to those under existing conditions.

Coastal pelagic fish EFH extends from the California, Oregon, and Washington shoreline to 200 mi offshore. As stated above, the sediment plume generated by the Proposed Action is expected to dilute rapidly once it enters the ocean. This dilution area is a small fraction of the pelagic fish EFH.

8.4.3.1 Conclusion

The Proposed Action may adversely affect EFH for coastal pelagic species, but the effects are minimal and short term.

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Appendix A

Minimization Measures for Herbicide Treatment Program

Minimization Measures for Herbicide Treatment

The following herbicide treatment effects minimization measures were modified from a document prepared by National Marine Fisheries Service, Arcata, California on July 13, 2011.

1. All weed treatment activities will comply with state and Federal laws and agency manuals, handbooks, and guidelines, including EPA label restrictions. Application according to all herbicide labels would be strictly enforced.

2. All herbicides shall be applied by licensed applicators and their trained employees.

3. Prior to scheduling herbicide treatments, the DRE and licensed applicator shall review the National Weather Service website (http://www.wrh.noaa.gov/mfr/) weather forecast for the Project Area. Herbicides shall not be applied on any day where there is a 25% or greater chance of rainfall predicted for the following 5 days.

4. All weeds that are pulled or cut after bud stage will be bagged and properly disposed.

5. The following minimization measures are required during mixing, loading, and disposal of herbicides:
   - All mixing of herbicides will occur at least 100 feet from surface waters or well heads.
   - All hoses used to add dilution water to spray containers will be equipped with a device to prevent back-siphoning.
   - Applicators will mix only those quantities of herbicides that can be reasonably used in a day.
   - During mixing, mixers will wear a hard hat, goggles or face shield, rubber gloves, rubber boots, and protective overalls.
   - All empty containers will be triple rinsed and disposed of by spraying near the treatment site at rates that do not exceed those on the treatment site.
   - All unused herbicides will be stored in a locked building in accordance with herbicide storage regulations
   - All empty and rinsed herbicide containers will be punctured and either burned or disposed of in a sanitary landfill.
   - Any additional herbicide label requirements will be strictly followed during the mixing, loading, and disposal of herbicides.

6. No 2,4-D ester formulations will be used.

7. No carriers or adjuvants other than water will be used, unless they are considered the least toxic for fish and approved for use around waterbodies.

8. Trained personnel would monitor weather conditions at spray sites during application. Herbicides will only be applied when no precipitation is imminent within 3 hours.

9. A Pesticide Application Record will be completed daily, or as required. This will include general treatment areas, methods, and dates, and make this information available.

10. Equipment will be calibrated often enough to ensure the proper amount of herbicide is applied.

11. Application of any herbicides to treat weeds shall be performed by or directly supervised by a state licensed applicator.

12. Mixing of herbicides will occur on a flat area more than 100 feet from streams, rivers, or lakes where accidental spill can be contained and removed before it contaminates waterbodies.
13. Herbicide applications shall be coordinated with permit holders within the project area, as appropriate.
14. Adjacent landowners will be notified prior to treating weeds on public lands adjacent to private land boundaries.
15. Only those quantities of herbicides necessary for the day will be transported to and from a treatment area.
16. Water drafting equipment for filling spray tanks will have back siphoning prevention devices.
17. Label directions and guidelines will be followed to reduce drift potential (nozzle size and pressure, additives). Equipment would be designed to deliver a median droplet diameter of 200- to 800-microns. This droplet size is large enough to avoid excessive drift while providing adequate coverage of target vegetation.
18. Herbicides will only be applied when wind speeds are less than 8 miles per hour (mph).
19. Spray detection cards will be used to demonstrate the adequacy of buffer zones. If cards indicate drift of herbicides is occurring into wetlands and streams, buffer zone widths and/or treatment methods would be revised.
20. Non-hazardous dyes will be used as necessary to ensure uniform coverage. Signs will be posted at visible sites (campgrounds, trailheads, road intersections) to notify the public of herbicide application in the area.
21. All chemicals will be applied in accordance with updated EPA registration label requirements and restrictions, and applicable laws and policies.
22. An Herbicide Emergency Spill Plan will be developed, including methods to report and clean up spills. Applicators will be required to be familiar with the plan and carry spill-containment and clean-up equipment.
23. Only glyphosate formulations with the least toxic surfactant (for example, Agri-Dex®) will be used within 50 feet of streams/wetlands, where riparian or hydrophilic plants are present, and where surface material is obvious recent deposition of sediment of any diameter(s). Application will be limited to hand spraying and the use of wipers only.
24. Only the minimum area necessary will be treated to control noxious weeds.
25. A botanist shall evaluate sites for sensitive plant habitat prior to treatment and develop site-specific guidelines for herbicide application near sensitive plant populations during broadcast treatments.
26. No chemical would be applied directly to sensitive plant species during spot treatments, and a 100-foot buffer would be maintained around known sensitive plant populations.

27. Individuals who exhibit idiosyncratic responses such as hypersensitivity to natural and synthetic compounds will not be permitted to work on herbicide spray crews.

28. Ensure all chemical storage, chemical mixing, and post-application equipment cleaning is completed in such a manner as to prevent the potential contamination of any RCA, perennial or intermittent waterway, unprotected ephemeral waterway, or wetland.

29. Evaluate the need to revegetate at treated sites. Use only certified noxious-weed free, native, seed mix or rootstock if revegetation is necessary for site restoration.

30. When scheduling treatment activities, seasonal harvesting periods of wildlife, fish, and plants to accommodate the needs of the Tribes will be considered.

31. A spill cleanup kit would be available whenever herbicides are transported or stored. All vehicles carrying herbicides shall have a standard spill kit.

32. A spill contingency plan would be developed prior to all herbicide applications. Individuals involved in herbicide handling or application would be instructed on the spill contingency plan and spill control, containment, and cleanup procedures.

33. Equipment used for transportation, storage, or application of chemicals shall be maintained in a leak proof condition.

Spill Plan

Procedures for mixing, loading, and disposing of herbicides will comply with the above measures and EPA labels and regulations. A spill prevention plan and the following procedures for mixing, loading, and disposal of herbicides will accompany all herbicide spraying operations.
A reportable herbicide spill is 1 pint of concentrate of herbicide and/or 5 gallons of mixed herbicide, even if these amounts can be contained and recovered by the weed field crew. Spills that can be contained and recovered will thereafter be applied in the field according to the label requirements for the herbicide. If an herbicide spill occurs, the field crew will contact the Dam Removal Entity Project Manager and report the spill. The National Poison Control Center (1-800-222-1222) will be contacted as necessary. If there is a spill, it will be reported on approved forms. At a minimum, the following equipment and materials will be available with vehicles or pack stock used to transport herbicides: (1) A shovel; (2) absorbent material or the equivalent; (3) plastic garbage bags or buckets; (4) rubber gloves and boots; (5) safety goggles; (6) protective clothing; and, (7) applicable Material Safety Data Sheets.

For supplemental information needed on hazards and reactions, Chemtrek will be called (1-800-424-9300). They are an information contact only; they are not used to report a spill (Example: if a truck carrying herbicides crashes and ignites, field crews may want to know if any special hazards exist from herbicide fumes, Chemtrek is the appropriate company to call.).

Appendix B

Standard Operating Procedures and Best Management Practices

B.1 Water Quality

B.1.1 Water Quality Impacts from Deconstruction/Construction and Restoration Activities

Short-term effects on water quality from deconstruction and construction activities associated with dam removal alternatives would occur. These effects would include increased sediment and turbidity from deconstruction and/or construction activities (e.g., clearing/grading/excavating, demolition and debris disposal, material delivery and storage, revegetation) and inorganic and organic contaminants from hazardous materials associated with construction equipment (i.e., fuels, oils, lubricants) entering nearby or adjacent water bodies.

For all deconstruction and/or construction related activities and restoration projects impacts could be mitigated through the implementation of standard pollution and erosion prevention measures as part of project design specifications and standard construction practices. The pollution and erosion control plan will contain the elements briefly listed below and described in this subsequent sections B.1.1.1 to B.1.1.3, and will meet requirements of all applicable laws and regulations.

- Practices to prevent storm water erosion and sedimentation associated with all deconstruction and/or construction activities such as: access roads, stream crossings, construction sites, borrow pit operations, haul roads, equipment and material storage sites, fueling operations, and staging areas;
- Practices to prevent construction debris from dropping into any stream or body of water, and to remove any material that does drop with a minimum disturbance to the streambed and water quality;
- Proper control of non-storm water discharges;
- A description of any hazardous products or materials that will be used for the Project, including procedures for inventory, storage, handling, and monitoring;
- A spill containment and control plan with notification procedures, specific clean up and disposal instructions for different products, quick response containment and clean up measures that must be available on the site, proposed methods for disposal of spilled materials, and employee training for spill containment.

B.1.1.1 Storm Water Pollution Prevention Plan

A Storm Water Pollution Prevention Plan (SWPPP) would be prepared and implemented during and after deconstruction and/or construction activities and would include an erosion control and restoration plan for each construction site, a water quality monitoring plan, a hazardous materials management plan, and post-construction best management practices (BMPs). The SWPPP would be prepared by a Qualified SWPPP Developer and submitted prior to project initiation and as part of project permitting. The SWPPP would be implemented by the Qualified SWPPP Developer or a Qualified SWPPP Practitioner. All BMPs would be maintained until areas disturbed during deconstruction and/or construction have been adequately revegetated and stabilized.

B.1.1.2 Measures to Minimize Disturbance from Instream Construction

Other measures to minimize disturbance associated with instream construction activities are presented below. Measures are excerpted from Measures to Minimize Disturbance from Construction, on page IX-50 of the California Department of Fish and Game (CDFG) Manual.

- If the stream channel is seasonally dry between June 15 and November 1, construction will occur during this dry period.
- Debris, soil, silt, excessive bark, rubbish, creosote-treated wood, raw cement/concrete or washings thereof, asphalt, paint or other coating material, oil or other petroleum products, or any other substances which could be hazardous to aquatic life, resulting from projected related activities, shall be prevented from contaminating the soil and/or entering the waters of the State. Any of these materials, placed within or where they may enter a stream or lake, by the applicant or any party working under contract, or with permission of the applicant, shall be removed immediately. During project activities, all trash that may attract potential predators of salmonids will be properly contained, removed from the work site, and disposed of daily.
- Where feasible, the construction shall occur from the bank, or on a temporary pad underlain with filter fabric.
- No mechanized equipment (e.g. internal combustion hand tools), will enter wetted channels.
- Use of heavy equipment shall be avoided in a channel bottom with rocky or cobbled substrate. If access to the work site requires crossing a rocky or cobbled substrate, a rubber tire loader/backhoe is the preferred vehicle. Only after this option has been determined infeasible will the use of tracked vehicles be considered. The amount of time this equipment is stationed, working, or traveling within the creek bed shall be minimized. When heavy equipment is used, woody debris and vegetation on banks and in the channel shall not be disturbed if outside of the project’s scope.
- All mechanized equipment working in the stream channel or within 25 feet of a wetted channel shall have a double containment system for diesel and oil fluids. Hydraulic fluids in mechanical equipment working within the stream channel shall not contain organophosphate esters. Vegetable based hydraulic fluids are preferred.
- The use or storage of petroleum-powered equipment shall be accomplished in a manner to prevent the potential release of petroleum materials into waters of the state (Fish and Game Code 5650).
- Areas for fuel storage, refueling, and servicing of construction equipment must be located in an upland location.
- Prior to use, clean all equipment to remove external oil, grease, dirt, or mud. Wash sites must be located in upland locations so wash water does not flow into the stream channel or adjacent wetlands.
- All construction equipment must be in good working condition, showing no signs of fuel or oil leaks. Prior to construction, all mechanical equipment shall be thoroughly inspected and evaluated for the potential of fluid leakage. All questionable motor oil, coolant, transmission fluid, and hydraulic fluid hoses, fitting, and seals shall be replaced. The contractor shall document in writing all hoses, fittings, and seals replaced and shall keep this documentation until the completion of operations. All mechanical equipment shall be inspected on a daily basis to ensure there are no motor oil, transmission fluid,

hydraulic fluid, or coolant leaks. All leaks shall be repaired in the equipment staging area or other suitable location prior to resumption of construction activity.

- Oil absorbent and spill containment materials shall be located on site when mechanical equipment is in operation with 100 feet of the proposed watercourse crossings. If a spill occurs, no additional work shall commence in-channel until (1) the mechanical equipment is inspected by the contractor, and the leak has been repaired, (2) the spill has been contained, and (3) CDFG and National Oceanic and Atmospheric Administration (NOAA) Fisheries Service are contacted and have evaluated the impacts of the spill.

B.1.1.3 Measures to Minimize Degradation of Water Quality during Deconstruction, Construction and Restoration Activities

Construction or maintenance activities for the projects covered under this Program may result in temporary increases in turbidity levels in the stream. In general, these activities must not result in significant increases in turbidity levels beyond the naturally occurring, background conditions. The following measures would be implemented to reduce the potential for impacts to water quality during and post-construction:

- General Erosion Control During Construction:
    - When appropriate, isolate the construction area from flowing water until project materials are installed and erosion protection is in place.
    - Effective erosion control measures shall be in place at all times during construction. Do not start construction until all temporary control devices (straw bales with sterile, weed free straw, silt fences, etc.) are in place downslope or downstream of project site within the riparian area. The devices shall be properly installed at all location where the likelihood of sediment input exists. These devices shall be in place during and after construction activities for the purposes of minimizing fine sediment and sediment/water slurry input to flowing water and of detaining sediment-laden water on site. If continued erosion is likely to occur after construction is completed, then appropriate erosion prevention measures shall be implemented and maintained until erosion has subsided. Erosion control devices such as coir rolls or erosion control blankets will not contain plastic netting of a mesh size that would entrain reptiles (esp. snakes) and amphibians.
    - Sediment shall be removed from sediment controls once it has reached one-third of the exposed height of the control. Whenever straw bales are used, they shall be staked and dug into the ground 12 cm and only sterile, weed free straw shall be utilized. Catch basins shall be maintained so that no more than 15 cm of sediment depth accumulates within traps or sumps.
    - Sediment-laden water created by construction activity shall be filtered before it leaves the right-of-way or enters the stream network or an aquatic resource area.
    - The contractor/project applicant is required to inspect and repair/maintain all practices prior to and after any storm event, at 24 hour intervals during extended storm events, and a minimum of every two weeks until all erosion control measures have been completed.

- Guidelines for Temporary Stockpiling:
  - Minimize temporary stockpiling of material. Stockpile excavated material in areas where it cannot enter the stream channel. Prior to start of construction; determine if such sites are available at or near the project location. If nearby sites are unavailable, determine location where material will be deposited. Establish locations to deposit spoils well away from watercourses with the potential to delivery sediment into streams supporting, or historically supporting populations of listed salmonids. Spoils shall be contoured to disperse runoff and stabilized with mulch and (native) vegetation. Use devices such as plastic sheeting held down with rocks or sandbags over stockpiles, silt fences, or berms of hay bales, to minimize movement of exposed or stockpiled soils.
  - If feasible, conserve topsoil for reuse at project location or use in other areas. End haul spoils away from watercourses as soon as possible to minimize potential sediment delivery.

- Minimizing Potential Scour:
  - When needed, utilize instream grade control structures to control channel scour, sediment routing, and headwall cutting.
  - For relief culverts or structures, if a pipe or structure that empties into a stream is installed, an energy dissipater shall be installed to reduce bed and bank scour. This does not apply to culverts in fish bearing streams.
  - The toe of rock slope protection used for streambank stabilization shall be placed below bed scour to ensure stability.

- Post Construction Erosion Control:
  - Immediately after project completion and before close of seasonal work window, stabilize all exposed soil with mulch, seeding, and/or placement of erosion control blankets. Remove all artificial erosion control devices after the project area has fully stabilized. All exposed soil present in and around the project site shall be stabilized within 7 days. Erosion control devices such as coir rolls or erosion control blankets will not contain plastic netting of a mesh size that would entrain reptiles (esp. snakes) and amphibians.
  - All bare and/or disturbed slopes (> 10’ x 10’ of bare mineral soil) will be treated with erosion control measures such as hay bales, netting, fiber rolls, and hydroseed as permanent erosion control measures.
  - Where straw, mulch, or slash is used as erosion control on bare mineral soil, the minimum coverage shall be 95 percent with a minimum depth of two inches.
  - When seeding is used as an erosion control measure, only natives will be used. Sterile (without seeds), weed-free straw, free of exotic weeds, is required when hay bales are used as an erosion control measure.

B.1.2 Land Management Related Water Quality Effects

Adjacent forest, agricultural and urban land use practices may cause temperature extremes, increase turbidity, increase nutrients, suspended solids or toxics, alter salinity and reduce dissolved oxygen. The following best management practices can help to reduce effects on water quality due to adjacent land management practices:

- Install fencing to keep livestock out of riparian areas.
- Irrigation tailwater reduction and/or capture projects to manage pasture runoff and reduce nutrient load.
- Construct tailwater wetlands and infiltration ponds to capture runoff from roads, development, farms, and irrigation return flows.
- Enhance the extent and function of wetlands and wet meadows.
- Conduct appropriate shade restoration activities where streamside shading has been reduced by anthropogenic activities.
- Improve upland water infiltration through road decommissioning, reduced soil compaction, direct seeding activities, increasing native vegetation cover.
- Minimize surface water withdrawals (increases stream flow) through implementation of irrigation efficiencies, quantify legal withdrawals, identify and eliminate illegal withdrawals, lease of water rights and purchase of water rights that would not impact agriculture production.

The Proposed Action would include the transfer of PacifiCorp land surrounding the Four Facilities (Parcel B lands) to a state agency. This agency would install fencing around these lands for the purposes of land management. It would prevent cattle access but would allow wildlife to pass. The fence would meet CDFG requirements for wildlife-friendly fencing.

B.2 Aquatic Resources

The best management practices described below are likely to avoid adverse effects to fish and other aquatic resources.

B.2.1 Effects on Fish Access and Passage

Road crossings (bridges and culverts), barriers (diversion dams), and unscreened water diversions are causing barriers to spawning and rearing habitat and interrupting adult and juvenile fish passage in many streams within watersheds. Removing barriers addressed limiting and causal factors such as loss of habitat quantity, habitat fragmentation, decreased habitat refugia and diversity, and increased density-dependent mortality from concentrating populations into small habitat units.

- Install bridges or appropriately sized culverts and dish screens consistent with the newest standards and guidelines. Effectively maintain culverts, screens and other instream structures.
- Remove, modify, or replace dams, culverts, diversions, and weirs that prevent or restrict access to salmon, trout, or sucker habitat and/or cause loss of habitat connectivity.
- Construct bypass channels for passage around diversion dams.

- Construct bolder weirs and roughened channels to provide passage a diversions or culverts.
- Establish and provide fish passage flows (eliminate low flow barriers).
- Reduce artificial flow fluctuations to allow or reduce volitional or voluntary movement to other suitable habitats.

B.2.2 Effects on Fish Migration, Spawning and Incubation and Juvenile Rearing

Removal of large woody debris, ditching, diking, bank armoring and gravel removal has the potential to eliminate connectivity between rivers and side channels and off-channel waters, increased speed and volume of stream flows, simplified channel structure, and degraded estuarine and nearshore habitat. The following best management practices can reduce the effects to fish migration, spawning, and incubation and juvenile rearing:

- Restore or reconnect off-channel habitats, disconnected oxbows and wetlands, including spring improvement, enhancement, and reconnection.
- Restore and/or reconnect side-channel habitats, islands, spawning channels, and reconnect back channels to increase large woody debris (LWD) deposition, channel complexity, and riparian areas.
- Re-slope vertical banks and establish wetland habitats by connecting the floodplain with the channel.
- Create diverse channel patterns to enhance water circulation through floodplain gravels.
- Add high quality spawning gravel to channel through a supplementation program.
- Use dike setbacks, removal, breaching, sloping, and/or channel reconnection to connect the channel with the floodplain.
- Increase flood-prone areas to reduce lateral scour and flow volume in main channel and protect or improve existing spawning habitats.
- Restore and reconnect wetlands and floodplains to the riverine system where appropriate.
- Decommission or relocate roads, low-priority dikes, bridges, and culverts to enhance floodplain connectivity.
- Implement setback levees recharge floodplain habitats.
- Identify, protect, and re-establish ground-water sources.
- Remove or replace existing bank stabilization structures (rip rap) and replace with bioengineered structures that allow habitat forming processes.
- Replace invasive or non-native vegetation with native vegetation
- Create or redesign pools, riffles and other habitat features
- Influence or redirect stream flows to reduce erosive forces on stream banks or stream-beds
- Installation of deflectors, barbs and vanes
- Add LWD and place in-channel engineered log jams. Add key pieces of wood to stabilize banks, provide hiding cover, and reestablish natural channel geomorphology.
- Improve riparian habitats by planting native vegetation with the potential to contribute to future LWD recruitment.
- Increase the density, maturity, and appropriate species composition of woody vegetation in riparian buffers for long-term recruitment of LWD.

- Install instream structures such as boulders and rock weirs to increase short-term pool formation and long-term habitat diversity.
- Add rock weirs or boulders to increase channel roughness.
- Install habitat boulders.
- Install instream structures to slow water velocities and increase gravel retention.

B.2.3 Effects on Riparian Areas as Fish Habitat

Riparian areas provide critical habitat elements and functions essential to many fish and wildlife life stages, such as shade, large woody debris, organic nutrients, stream bank stabilization, control of sediments, and filtration of nutrients and pollutants. Much has been removed or altered through logging, grazing, farming and land development. This has eliminated and degraded spawning and rearing habitat for salmonids and suckers and diminished water quantity and quality. The following best management practices can reduce the effects to riparian areas:

B.2.3.1 Minimizing Disturbance

- Install and maintain fencing to prevent livestock access to riparian zones and Streams.
- Manual removal of noxious weeds and replacement with native vegetation (no herbicides).
- Retain as many trees and brush as feasible, emphasizing shade producing and bank stabilizing trees and brush.
- Install Alternative Stock Water Systems or provide off-site watering opportunities.
- Use project designs and access points that minimize riparian disturbance without affecting less stable areas, which may increase the risk of channel instability.
- Prior to construction, determine locations and equipment access points that minimize riparian disturbance. Avoid entering unstable areas. Use project designs and access points that minimize riparian disturbance without affecting less stable areas, which may increase the risk of channel instability.
- Minimize soil compaction by using equipment with a greater reach or that exerts less pressure per square inch on the ground, resulting in less overall area disturbed or less compaction of disturbed areas.
- If riparian vegetation is to be removed with chainsaws, consider using saws currently available that operate with vegetable-based bar oil.
- While encouraged, removal of exotic invasive riparian vegetation in a stream with high temperatures must be done in a manner to avoid creation of additional temperature loading to fish bearing streams. If a stream has a seven day moving average daily maximum (7DMADM) temperature greater than 17.8 Celsius (C) in a coho and steelhead stream or greater than 18.5 C in a steelhead only stream, and vegetation management would reduce overstory shade canopy to the wetted channel, then the practice will not be allowed.

B.2.3.2 Revegetation and Success Criteria

- Any stream bank area left barren of vegetation as a result of the implementation or maintenance of the practices shall be restored to a natural state by seeding, replanting, or

other agreed upon means with native trees, shrubs, and/or grasses prior to November 15 of the project year. Barren areas shall typically be planted with a combination of willow stakes, native shrubs and trees and/or erosion control grass mixes.
- Native plant species shall be used for revegetation of disturbed and compacted areas. The species used shall be specific to the project vicinity or the region of the state where the project is located, and comprise a diverse community structure (plantings shall include both woody and herbaceous species).
- For projects where re-vegetation is implemented to compensate for riparian vegetation impacted by project construction, a re-vegetation monitoring report will be required after 5 years to document success. Success is defined as 80 percent survival of plantings or 80 percent ground cover for broadcast planting of seed after a period of 3 years. If revegation efforts will be passive (i.e. natural regeneration), success will be defined as total cover of woody and herbaceous material equal to or greater than pre-project conditions. If at the end of five years, the vegetation has not successfully been re-established, the applicant will be responsible for replacement planting, additional watering, weeding, invasive exotic eradication, or any other practice, to achieve these requirements. If success is not achieved within the first 5 years, the project applicant will need to prepare a follow-up report in an additional 5 years. This requirement will proceed in 5-year increments until success is achieved.
- All plastic exclusion netting placed around plantings will be removed and recycled after 3 years.
- Restore and reconnect wetlands and floodplains to the riverine system.

B.2.4 Effects of Increased Sediment on Fish

Surrounding land management can cause decreased stability of substrate, banks and channels; high levels of fine sediment; high likelihood of landslides; and increased turbidity. Forest and agricultural practices contribute substantial quantities of sediment to streams and estuaries which can ultimately impact water quality and create effects to fish. The following best management practices can reduce sediment and the effects it can have on fish:

- Remove, reconstruct or upgrade roads that are vulnerable to failure due to design or location.
- Implement a road maintenance schedule to prevent and mitigate sediment impacts.
- Implement road maintenance and decommissioning plans.
- Upgrade stream crossings, culverts and road drainage systems.
- Reconnect floodplains through dike removal or breaching.
- Implement in-channel projects that address geologic processes such as deep-seated slope failure, toe erosion, or landslides.
- Construct infiltration and tailwater ponds to capture runoff from roads, development, farms and irrigation return flow.
- Re-establish natural riparian vegetation to restore a more natural delivery and routing of sediment.

B.2.5 Effects of Stream Flows on Salmonid Life Stages

Low flow conditions can affect salmonid life stages. The problem could be caused by water withdrawals, forest and agricultural practices (e.g., diking, and draining), extent of impervious surfaces, hydropower and reservoir operation, and/or alteration of groundwater recharge areas. The following best management practices can reduce the effects of stream flows on salmonid life stages:

- Installation and maintenance of stream gages/measuring devices.
- Improve baseline instream flows via water efficiency improvements.
- Restore wetlands, reconnect and revegetate floodplains.
- Restore hydrologic connectivity and increase floodwater storage capacity between streams and wetlands and/or floodplains.
- Remove and relocate dikes, levees and other structures.
- Install Alternative Stock Water Systems or provide off-site watering opportunities.
- Reduce diversion amount through irrigation tailwater reduction and/or capture.

B.2.6 Effects of Dewatering Activities on Fish

Dewatering may not be appropriate for some projects that will result in only minor input of sediment, such as placing logs with hand crews, or installing boulder clusters. Dewatering can result in the temporary loss of aquatic habitat, and the stranding, displacement, or crushing of fish and amphibian species. Increased turbidity may occur from disturbance of the channel bed. The following are general dewatering guidelines and can help reduce potential impacts on fish, for projects that do require dewatering of a stream/creek.

- In those specific cases where it is deemed necessary to work in a flowing stream/creek, the work area shall be isolated and all the flowing water shall be temporarily diverted around the work site to maintain downstream flows during construction.
- Exclude fish from reentering the work area by blocking the stream channel above and below the work area with fine-meshed net or screens. Mesh will be no greater than 1/8 inch diameter. The bottom of the seine must be completely secured to the channel bed to prevent fish from reentering the work area. Exclusion screening must be placed in areas of low water velocity to minimize fish impingement. Screens must be checked periodically and cleaned of debris to permit free flow of water. Block nets shall be placed and maintained throughout the construction period at the upper and lower extent of the areas where fish will be removed. Block net mesh shall be sized to ensure salmonids upstream or downstream do not enter the areas proposed for dewatering between passes with the electrofisher or seine.
- Prior to dewatering, determine the best means to bypass flow through the work area to minimize disturbance to the channel and avoid direct mortality of fish and other aquatic vertebrates. Bypass stream flow around the work area, but maintain the stream flow to channel below the construction site.
- Coordinate project site dewatering with a qualified biologist to perform fish and amphibian relocation activities. The qualified biologist(s) will possess a valid State of California Scientific Collection Permit as issued by the California Department of Fish

and Game and will be familiar with the life history and identification of listed salmonids and listed amphibians within the action area.

- Prior to dewatering a construction site, qualified individuals will capture and relocate fish and amphibians to avoid direct mortality and minimize take. This is especially important if listed species are present within the project site.
- Minimize the length of the dewatered stream channel and duration of dewatering.
- Any temporary dam or other artificial obstruction constructed shall only be built from materials such as sandbags or clean gravel which will cause little or no siltation. Visqueen shall be placed over sandbags used for construction of cofferdams construction to minimize water seepage into the construction areas. The visqueen shall be firmly anchored to the streambed to minimize water seepage. Coffer dams and the stream diversion systems shall remain in place and fully functional throughout the construction period.
- When coffer dams with bypass pipes are installed, debris racks will be placed at the bypass pipe inlet. Bypass pipes will be monitored a minimum of two times per day, seven days a week, during the construction period. All accumulated debris shall be removed by the contractor or project applicant.
- Bypass pipe diameter will be sized to accommodate, at a minimum, twice the summer baseflow.
- The work area may need to be periodically pumped dry of seepage. Place pumps in flat areas, well away from the stream channel. Secure pumps by tying off to a tree or stake in place to prevent movement by vibration. Refuel in an area well away from the stream channel and place fuel absorbent mats under pump while refueling. Pump intakes shall be covered with 1/8 inch mesh to prevent potential entrainment of fish or amphibians that failed to be removed. Check intake periodically for impingement of fish or amphibians.
- If pumping is necessary to dewater the work site, pprocedures for pumped water shall include requiring a temporary siltation basin for treatment of all water prior to entering any waterway and not allowing oil or other greasy substances originating from the contractor or project applicants operations to enter or be placed where they could a wetted channel. Projects will adhere to CDFG's "Fish Screening Criteria" (2000).
- Discharge wastewater from construction area to an upland location where it will not drain sediment-laden water back to the stream channel.
- When construction is completed, the flow diversion structure shall be removed as soon as possible in a manner that will allow flow to resume with the least disturbance to the substrate. Cofferdams will be removed so surface elevations of water impounded above the cofferdam will not be reduced at a rate greater than one inch per hour. This will minimize the risk of beaching and stranding of fish as the area upstream becomes dewatered.

B.2.7 Effects of Relocation Activities on Fish

The following best management practices can help reduce the impacts to fish from relocation activities, considering the difference types of relocation methods:

- Fish relocation and dewatering activities shall only occur between June 15 and November 1 of each year.

- All seining, electrofishing, and relocation activities shall be performed by a qualified fisheries biologist. The qualified fisheries biologist shall capture and relocate listed salmonids prior to construction of the water diversion structures (e.g., cofferdams). The qualified fisheries biologist shall note the number of salmonids observed in the affected area, the number and species of salmonids relocated, and the date and time of collection and relocation. The qualified fisheries biologist shall have a minimum of three years field experience in the identification and capture of salmonids, including juvenile salmonids, considered in this Biological Assessment. The qualified biologist will adhere to the following requirements for capture and transport of salmonids:
    - Determine the most efficient means for capturing fish. Complex stream habitat generally requires the use of electrofishing equipment, whereas in outlet pools, fish may be concentrated by pumping-down the pool and then seining or dip netting fish.
    - Notify NOAA Fisheries Service one week prior to capture and relocation of salmonids to
    - Provide NOAA Fisheries Service an opportunity to attend (call Shari Anderson at 707-825-5186 or via email at shari.anderson@noaa.gov).
    - Initial fish relocation efforts will be conducted several days prior to the start of construction. This provides the fisheries biologist an opportunity to return to the work area and perform additional electrofishing passes immediately prior to construction. In many instances, additional fish will be captured that eluded the previous day’s efforts.
    - In regions of California with high summer water temperatures, perform relocation activities during morning periods.
- Prior to capturing fish, determine the most appropriate release location(s). Consider the following when selecting release site(s):
    - Similar water temperature as capture location;
    - Ample habitat for captured fish; and,
    - Low likelihood of fish reentering work site or becoming impinged on exclusion net or screen.
- Periodically measure air and water temperatures. Cease activities when measured water temperatures exceed 17.8 C. Temperatures will be measured at the head of riffle tail of pool interface.

B.2.7.1 Relocation by Electrofishing

The following methods shall be used if fish are relocated via electrofishing:

- All electrofishing will be conducted according to NOAA Fisheries Service *Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act* (2000).
- The backpack electrofisher shall be set as follows when capturing fish: Voltage setting on the electrofisher shall not exceed 300 volts.

	Initial	Maximum
A) Voltage:	100 Volts	300 Volts
B) Duration:	500 µs (microseconds)	5 ms (milliseconds)
C) Frequency:	30 Hertz	70 Hertz

- A minimum of three passes with the electrofisher shall be utilized to ensure maximum capture probability of salmonids within the area proposed for dewatering.
- No electrofishing shall occur if water conductivity is greater than 350 microSiemens per centimeter (µS/cm) or when instream water temperatures exceed 17.8°C. Water temperatures shall be measured at the pool/riffle interface. Only direct current (DC) shall be used.
- A minimum of one assistant shall aid the fisheries biologist by netting stunned fish and other aquatic vertebrates.

B.2.7.2 Relocation by Seining

The following methods shall be used if fish are removed with seines:

- A minimum of three passes with the seine shall be utilized to ensure maximum capture probability of salmonids within the area.
- All captured fish shall be processed and released prior to each subsequent pass with the seine.
- The seine mesh shall be adequately sized to ensure fish are not gilled during capture and relocation activities.

B.2.7.3 Relocation of Salmonids

The following methods shall be used during relocation activities associated with either method of capture (electrofishing or seining):

- Fish shall not be overcrowded into buckets; allowing approximately six cubic inches per 0+ individual and more for larger/older fish.
- Every effort shall be made not to mix 0+ salmonids with larger salmonids, or other potential predators, that may consume the smaller steelhead. Have at least two containers and segregate young-of-year (0+) fish from larger age-classes. Place larger amphibians, such as Pacific giant salamanders, in container with larger fish.

- Salmonid predators, such as sculpins (*Cottus sp.*) and Pacific-giant salamanders (*Dicamptodon ensatus*) collected and relocated during electrofishing or seining activities shall not be relocated so as to concentrate them in one area. Particular emphasis shall be placed on avoiding relocation of sculpins and Pacific-giant salamanders into the steelhead and coho salmon relocation pools. To minimize predation on salmonids, these species shall be distributed throughout the wetted portion of the stream so as to concentrate them in one area.
- All captured salmonids shall be relocated, preferably upstream, of the proposed construction project and placed in suitable habitat. Captured fish shall be placed into a pool, preferably with a depth of greater than two feet with available instream cover.
- All captured salmonids will be processed and released prior to conducting a subsequent electrofishing or seining pass.
- All native captured fish will be allowed to recover from electrofishing before being returned to the stream.
- Minimize handling of salmonids. However, when handling is necessary, always wet hands or nets prior to touching fish. Handlers will not wear N, N-Diethyl-meta-Toluamide (DEET) based insect repellants.
- Temporarily hold fish in cool, shaded, aerated water in a container with a lid. Provide aeration with a battery-powered external bubbler. Protect fish from jostling and noise and do not remove fish from this container until time of release.
- Place a thermometer in holding containers and, if necessary, periodically conduct partial water changes to maintain a stable water temperature. If water temperature reaches or exceeds those allowed by CDFG and NOAA Fisheries Service, fish shall be released and rescue operations ceased.
- In areas where aquatic vertebrates are abundant, periodically cease capture, and release at predetermined locations.
- Visually identify species and estimate year-classes of fish at time of release. Count and record the number of fish captured. Avoid anesthetizing or measuring fish.
- If more three percent of the steelhead or coho salmon captured are killed or injured, the project permittee shall contact NOAA Fisheries Service's biologist Shari Anderson at 707-825-5186 or via email at shari.anderson@noaa.gov and Gayle Garman or Michelle Gilroy at CDFG (707)-445-6493. The purpose of the contact is to allow the agencies a courtesy review of activities resulting in take and to determine if additional protective measures are required. All steelhead and coho mortalities must be retained, placed in an appropriately sized whirl-pak or zip-lock bag, labeled with the date and time of collection, fork length, location of capture, and frozen as soon as possible. Frozen samples must be retained until specific instructions are provided by NOAA Fisheries Service.

B.3 Terrestrial Resources

B.3.1 Temporary Construction Impacts on Wetlands

The Dam Removal Entity (DRE) or Hydropower Licensee would be required to reduce impacts on wetlands within construction areas for the Proposed Action, the Partial Facilities Removal

Alternative, the Fish Passage at Four Dams Alternative, and the Fish Passage at Two Dams Alternative. To the extent possible, wetlands within 50 feet of any ground disturbance and construction-related activities (including staging and access roads) will be clearly marked and/or fenced to avoid impacts from construction equipment and vehicles. If new temporary access roads are required, grading will be conducted such that existing hydrology will be maintained.

To reduce potential impacts on water quality in wetlands during construction, the following construction best management practices will be implemented. These measures are discussed further in Section B.1, Water Quality.

- Pollution and erosion control measures will be implemented to prevent pollution caused by construction operations and to reduce contaminated stormwater runoff.
- Oil-absorbing floating booms will be kept onsite and the contractor will respond immediately to aquatic spills during construction.
- Vehicles and equipment will be kept in good repair, without leaks of hydraulic or lubricating fluids. If such leaks or drips do occur, they will be cleaned up immediately. Equipment maintenance and/or repair will be confined to one location at each project construction site. Runoff in this area will be controlled to prevent contamination of soils and water.
- Dust control measures will be implemented, including wetting disturbed soils.
- A SWPPP will be implemented to prevent construction materials (fuels, oils, and lubricants) from spilling or otherwise entering waterways or water bodies.

B.3.2 Impacts on Special-Status Amphibian and Reptile Species and their Habitat During Construction

The DRE or Hydropower Licensee will implement actions to address the potential for mortality and disturbance of special-status invertebrate, amphibian and reptile species within construction areas for the Proposed Action, the Partial Facilities Removal Alternative, the Fish Passage at Four Dams Alternative, and the Fish Passage at Two Dams Alternative. Special-status invertebrate, amphibian and reptile species, such as Siskiyou (Chase) sideband, western toad, northwestern pond turtle, California mountain kingsnake, and common kingsnake, could be present within construction areas and could be injured or killed.

The following measures would be required:

- Biological Resources Awareness Training. Before any ground-disturbing work (including vegetation clearing and grading) occurs in the construction area, a qualified biologist will conduct mandatory biological resources awareness training for all construction personnel and the construction foreman. This training will inform the crews about special-status species that could occur on site. The training will consist of a brief discussion of the biology and life history of the special-status species; how to identify each species, including all life stages; the habitat requirements of these species; their status; measures being taken for the protection of these species and their habitats; and actions to be taken if a species is found within the project area during construction activities. Species identification cards will be issued to shift supervisors; these cards will have photos, descriptions, and actions to be taken upon sighting of special-status species during construction. Upon completion of the training, all employees will sign an acknowledgment form stating that they attended the training and understand all protection measures. An updated training will be given to new personnel and in the event that a change in special-status species occurs.

- Protocol-level Wildlife Surveys. Prior to construction, a biologist approved by the resource agencies (United State Fish and Wildlife Service (USFWS), Oregon Department of Fish and Wildlife, and/or CDFG will conduct protocol surveys to ensure no special-status animals are present within the area in which any construction activity would occur. For invertebrate species such as the Siskiyou (Chase) sideband, surveys for suitable habitat within construction areas would be conducted to determine the likelihood of presence, and if so, surveys for the species itself would be conducted consistent with the 2011 Survey & Manage settlement agreement memorandum (USFS and BLM 2011b). If special-status species are present (except for birds), they will be captured and relocated to a suitable area in consultation with the resource agencies.
- Exclusion Measures for Special-Status Wildlife. Construction areas, including staging areas and access routes, will be fenced with orange plastic snow fencing to demarcate work areas. The approved biologist will confirm the location of the fenced area prior to habitat clearing, and the fencing will be maintained throughout the construction period. Additional exclusion fencing or other appropriate measures will be implemented in consultation with the resource agencies to prevent use of construction areas by special-status amphibian or reptile species during construction.

  To prevent entrapment of wildlife that do enter construction areas during activities, all excavated, steep-walled holes or trenches in excess of 2 feet deep will be inspected by a biologist or construction personnel approved by the resource agencies at the start and end of each working day. If no animals are present during the evening inspection, plywood or similar materials will be used to immediately cover the trench, or it will be provided with one or more escape ramps set at no greater than 1,000 foot intervals and constructed of earth fill or wooden planks. Trenches and pipes will be inspected for entrapped wildlife each morning prior to onset of activity. Before such holes or trenches are filled, they will be thoroughly inspected for entrapped animals. Any animals so discovered will be allowed to escape voluntarily, without harassment, before activities resume, or removed from the trench or hole by a qualified biologist approved by the resource agencies and the animals will be allowed to escape unimpeded. A biologist approved by the resource agencies will be responsible for overseeing compliance with protective measures during clearing and construction activities within designated areas throughout the construction activities.

- General Requirements for Construction Personnel include the following:
  - The contractor will clearly delineate the construction limits and prohibit any construction-related traffic outside these boundaries.
  - Construction crews will be required to maintain a 20 m.p.h. speed limit on all unpaved roads to reduce the chance of wildlife being harmed if struck by construction equipment.

- All food-related trash items such as wrappers, cans, bottles, and food scraps generated during construction, subsequent facility operation, or permitted operations and maintenance activities of existing facilities will be disposed of in closed containers only and removed at least once a week from the site. The identified sites for trash collection will be fenced to minimize access from wildlife.
- No deliberate feeding of wildlife will be allowed.
- No pets will be allowed on the project site.
- No firearms will be allowed on the project site.
- If vehicle or equipment maintenance is necessary, it will be performed in the designated staging areas.
- Any worker who inadvertently injures or kills a federally or state listed species, bald eagle, or golden eagle, or finds one dead, injured, or entrapped will immediately report the incident to the construction foreman or biological monitor. The construction foreman or monitor will notify the resource agencies within 24 hours of the incident.

B.3.3 Impacts on Birds, Including Special-Status Bird Species, During Construction

The DRE or Hydropower Licensee will implement measures to address impacts on northern spotted owl, bald eagle, golden eagle, osprey, nesting great blue heron, willow flycatcher, and other special-status birds (as determined in consultation with the resource agencies) from disturbance during construction of the Proposed Action, the Partial Facilities Removal Alternative, the Fish Passage at Four Dams Alternative, and the Fish Passage at Two Dams Alternative.

B.3.3.1 Northern Spotted Owl

The following minimization measures for the northern spotted owl were proposed in the Biological Assessment (DOI 2011b). Final versions of the measures are anticipated in the Biological Opinion and would be implemented as part of the Proposed Action:

- Measure NSO 1: Prior to initiating any construction activities, potential impacts of ground-disturbing construction activities will be evaluated for northern spotted owl and its habitat, and construction plans will be modified as appropriate, with an overall goal of preventing or minimizing impacts. Locations of the individual components of the proposed action, noise disturbances, and habitat geographic information system (GIS) layers will be reevaluated using the best available data at the time of construction to determine whether or not additional measures are needed.
- Measure NSO 2: Protocol-level surveys will be conducted within suitable nesting and roosting habitat (assessed by using best available GIS information, aerial photos, and consultation with the USFWS) that occur within the northern spotted owl disturbance distance of the construction activity. If no nesting is observed, no seasonal restriction would be required. If nesting is observed, a California seasonal restriction (February 1–September 15) or Oregon seasonal restriction (March 1–September 30) will be followed or activity will be delayed as late as possible into the late breeding season for California (July

10–September 15) or Oregon (August 11–September 30) to minimize the disturbance to young prior to fledging.

- Measure NSO 3: To prevent direct injury of young resulting from aircraft, no helicopter flights will occur within or at an elevation lower than 0.8 km (0.5 mi) of suitable nesting and roosting habitat during the entire breeding season unless protocol level surveys identify no activity centers.
- Measure NSO 4: No component of suitable nesting, roosting, foraging, or dispersal habitat will be modified or removed during the removal of transmission lines or installation or removal of fencing.

As part of Measure NSO 2 described above, prior to construction, a biologist approved by the resource agencies (USFWS, ODFW, and/or CDFG) would conduct protocol surveys endorsed by USFWS for northern spotted owls in all areas supporting suitable nesting and roosting habitat that may be affected by construction, including along access roads and haul routes. If, during preconstruction surveys, an active nest of northern spotted owl is identified, a restriction buffer would be established in consultation with the resource agencies to ensure nests are not disturbed from construction. This would include evaluation of noise levels at the nesting site.

B.3.3.2 Bald Eagle

Bald eagle nesting trees are known to exist within or near to construction areas, and bald eagles often use the same nests in multiple years.

Prior to construction, all necessary permits in compliance with the Bald and Golden Eagle Protection Action would be obtained. The following measures would be required to avoid or reduce impacts on bald eagle:

- Complete a two-year survey for eagle use patterns prior to construction activities. Surveys will be conducted by a qualified avian biologist and will include any facilities to be removed or modified to determine bird use patterns. Surveys will be conducted during the time of year most likely to detect eagle usage.

- Prior to construction, conduct at least one focused survey for bald eagle nests within 2 miles of construction areas, including along access roads and haul routes, during the early bald eagle breeding season (January 15 through February 28). Three additional surveys would be conducted; two between March 1 and April 1, and one after April 1. Additional survey visits would be conducted to determine if eagles are nesting within 2 miles of the construction area. Before commencing construction activities during the early breeding season, at least one survey would be conducted within two weeks prior to beginning operations.

- Wherever possible, clearing, cutting, and grubbing activities shall be conducted outside the eagle breeding period (January 15 through August 15);

- If active nests are present within 2 miles of construction areas, a 0.5-mile restriction buffer would be established in consultation with the resource agencies to ensure nests are not disturbed. If active bald eagle nests are present within 0.5 miles of construction areas, construction activities would be halted until approval is obtained from the resource agencies to resume. If a nest is not within line of site of the project, meaning that trees or topographic features physically block the eagle's view of construction activities, the buffer could be reduced to 0.25 miles.

See Mitigation Measure TER-3 in Section 3.5.4.4 of the Klamath Dam Removal EIS/EIR.

B.3.3.3 Golden Eagle

Golden eagles are known to have historically nested in cliffs within the project area. Golden eagles are also known to nest within pine, juniper and oak trees.

The following measures would be required to avoid or reduce impacts on golden eagle:

- Complete a two-year survey for eagle use patterns prior to construction activities. Surveys will be conducted by a qualified avian biologist and will include any facilities to be removed or modified to determine bird use patterns. Surveys will be conducted during the time of year most likely to detect eagle usage.
- Prior to construction, at least one protocol survey for golden eagle nests would be conducted within 5 miles of construction areas, including along access roads and haul routes, during the breeding season (January through July). Before commencing construction activities during the early breeding season, at least one focused survey would be conducted within two weeks prior to beginning operations. Additional survey visits would be conducted to determine if eagles are nesting within 2 miles of the construction area.
- Wherever possible, clearing, cutting, and grubbing activities shall be conducted outside the eagle breeding period (January through July).
- If active nests are present within 2 miles of construction areas, a 1-mile restriction buffer would be established in consultation with the resource agencies to ensure nests are not disturbed. If active golden eagle nests are present within 1 mile of construction areas, construction activities would be halted until approval is obtained from the resource agencies to resume. If an active nest is not within line of site of the project, meaning that trees or topographic features physically block the eagle's view of construction activities, the buffer could be reduced to 0.5 miles.

See Mitigation Measure TER-3 in Section 3.5.4.4 of the Klamath Dam Removal EIS/EIR.

B.3.3.4 Osprey

Known osprey nests are located within or near to construction areas. Some osprey nests are located on transmission line poles or other man-made platforms that would be removed during construction, or are located within areas where construction noise or human presence would cause disturbance to the birds. To avoid nesting disturbance, the nests located within or near to construction areas would be removed prior to the breeding season and replaced with nesting platforms following construction on a 1:1 basis. In addition, a search for osprey nests within 0.25 mile of construction areas, including along access roads and haul routes, would be conducted prior to beginning operations and during the breeding season, which begins in February. If active nests are present, a 0.25-mile restriction buffer would be established and delineated on maps and resource agencies would be consulted to obtain concurrence prior to conducting construction activities. See Mitigation Measure TER-2 in Section 3.5.4.4 of the Klamath Dam Removal EIS/EIR.

B.3.3.5 Willow Flycatcher

Prior to construction during the nesting season of June 1-August 31, a focused survey for willow flycatcher would be conducted within construction areas, including along access roads and haul routes. The survey would follow the established protocol described in Bombay et al (2003). If active willow flycatcher nests are detected, a 0.5-mile restriction buffer would be established and delineated on maps and resource agencies would be consulted to obtain concurrence prior to conducting construction activities. See Mitigation Measure TER-2 in Section 3.5.4.4 of the Klamath Dam Removal EIS/EIR.

B.3.3.6 Peregrine Falcon

Peregrine falcons, a fully protected species, are known to occur along the J.C. Boyle bypass reach, and have the potential to occur elsewhere in the project area. Specific elements described below (see Other Migratory Birds) would be incorporated during construction, including nesting surveys, to avoid or reduce impacts on peregrine falcons. If nesting peregrine falcons are detected, a restriction buffer would be established prior to conducting construction activities.

B.3.3.7 Greater Sandhill Crane

Greater sandhill cranes, a fully protected species, are known to occur in the project area, and have been documented nesting along the J.C. Boyle Reservoir. Specific elements described below (see Other Migratory Birds) would be incorporated during construction, including nesting surveys, to avoid or reduce impacts on greater sandhill cranes. If nesting sandhill cranes are detected, a restriction buffer would be established prior to conducting construction activities.

B.3.3.8 Other Migratory Birds

The following measures would be required to avoid or reduce impacts on migratory birds from removal, destruction, or disturbance of active nests during construction:

- Removal or trimming of any trees or other vegetation for construction would be conducted outside of the nesting season (March 20 through August 20). This would include removal or trimming of trees along access roads and haul routes and within disposal sites.
- Where clearing, trimming, and grubbing work cannot occur outside the migratory bird nesting season, a qualified avian biologist will survey construction areas to determine if any migratory birds are present and nesting in those areas.
- For all raptors (other than eagles), inactive nests will be removed before nesting seasons begin, to the greatest extent practicable. For those nests where access is difficult, traffic cones or other deterrents in the nest platform to prevent nesting the year of construction.

All deterrents will be removed as soon as possible after construction crews have passed to a point beyond the disturbance buffer for that species. See Mitigation Measure TER-2 (Section 3.5.4.4, Table 3.5-5) of the Klamath Dam Removal EIS/EIR.

- If an active nest is located, a restriction buffer in accordance with Mitigation Measure TER-2 (Section 3.5.4.4, Table 3.5-5) of the Klamath Dam Removal EIS/EIR would be established and the resource agencies would be consulted to obtain concurrence prior to conducting construction activities.

B.3.4 Impacts on Special-Status Plant Species During Construction

Special-status plants occurring in construction areas could be destroyed by heavy equipment. Prior to the implementation of construction activities, a botanist approved by the resource agencies would conduct protocol-level surveys within construction areas for special-status plants during the peak blooming season prior to start of construction. If any special-status plants occur within the construction areas, locations of these plants would be clearly marked and/or fenced to avoid impacts from construction equipment and vehicles where possible. If it is not possible to avoid impacts to special-status plants, Mitigation Measure TER-4 of the Klamath Dam Removal EIS/EIR (Section 3.5.4.4) would be implemented to avoid or reduce impacts.

B.3.5 Impacts Related to Invasive Plants

With implementation of the Proposed Action, the Partial Facilities Removal Alternative, the Fish Passage at Four Dams Alternative, and the Fish Passage at Two Dams Alternative, there would be potential for invasive plants to recolonize and infest disturbed areas, outcompeting native plants and adversely affecting wildlife habitat. To avoid or reduce this impact, construction vehicles and equipment would be cleaned with compressed water or air within a designated containment area to remove pathogens, invasive plant seeds, or plant parts and dispose of them in an appropriate disposal facility. The Habitat Rehabilitation Plan (see Mitigation Measure TER-1 in Section 3.5.4.4 of the Klamath Dam Removal EIS/EIR) would include details for the installation of native plants to re-vegetate all areas disturbed during construction. Long-term maintenance and monitoring to control invasive species would be included.

B.3.6 Impacts on Plants and Wildlife Related to Vegetation Management

The structure and species composition of many forested stands have been altered through fire exclusion and past and on-going timber management. This includes mixed conifer forests, oak woodlands, and aspen. The alteration of these stands has resulted in the degradation of habitat for species associated with these vegetative communities.

Additionally, many of these stands exhibit high amounts of surface and ladder fuels, increasing the potential for uncharacteristically severe wildfire. The following best management practices can reduce the effects on plants and wildlife related to vegetation management:

- Small diameter thinning of overstocked upland forests to promote development of structurally diverse stands with desired species composition and variable densities, and to reduce the risk of uncharacteristically severe wildfire.

- Prescribed burning in upland forested habitats to promote the development of understory growth and reduce the amount of small to medium diameter surface fuels.
- In oak stands, small diameter thinning (typically < 9” dbh) of dense oaks to promote the development of large structurally diverse oak trees.
- Removal of encroaching juniper (up to 15” dbh).
- Installing fencing around aspen stands to exclude livestock and allow for the
- Passive restoration of aspen trees combined with planting of native shrubs.

B.4 Public Health and Safety

B.4.1 Structure Fencing

Structures retained as part of the Partial Facilities Removal of Four Dams option would be fenced to prevent public access once decommissioning activities are completed.

B.4.2 Road Repair

Road damage as a result of heavy vehicle traffic will be repaired once decommissioning activities are completed through in-lieu payments to Siskiyou and Klamath Counties or through direct repairs by the DRE as part of the decommissioning effort.

B.5 Air Quality

B.5.1 Dust Control

Soil stabilizers or erosion control fabrics must be applied to any inactive areas of the construction site.

Water must be applied to exposed surfaces at least three times daily.

Soil must remain moist during any equipment loading and unloading activities.

Haul roads must be covered in gravel with minimal silt content.

B.6 Cultural and Historic Resources

B.6.1 Klamath Hydroelectric Project Historic Property Management Plan (HPMP)

Implement the Klamath Hydroelectric Project HPMP that is part of PacifiCorp’s relicensing application to the Federal Energy Regulatory Commission (FERC); and prepare a Programmatic Agreement that includes protocols for the identification, evaluation, and protection, and resolution of adverse effects of historic properties along the Klamath River for areas beyond the FERC boundaries of the Klamath Hydroelectric Project. The participants in the Programmatic Agreement will include Federal agencies, the Advisory Council on Historic Preservation, California and Oregon State Historic Preservation Office, land management agencies, Indian tribes, other interested parties, and other agencies that are proposing and/or implementing management plans for the river or along it related to the Klamath Hydroelectric Settlement Agreement. The lead Federal agency for the Programmatic Agreement will be determined by agreement among the participants.

B.7 Toxic and Hazardous Materials

B.7.1 Health and Safety Plan

Prepare and implement a worker Health and Safety Plan prior to the start of construction activities. The contractor will prepare a Health and Safety Plan that should, at a minimum, identify the following:

- All contaminants that could be encountered during excavation activities
- All appropriate worker, public health, and environmental protection equipment and procedures
- Emergency response procedures
- Most direct route to a hospital
- Site Safety Officer

The plan will require documentation that all workers have reviewed and signed the plan.

B.7.2 Asbestos Handling

To mitigate the impacts regarding the abatement and disposal of asbestos and lead-based paint, prior to issuance of demolition permits, evidence shall be provided to the responsible federal agency that the demolition contract provides for a qualified asbestos and lead-based paint removal contractor/specialist to remove or otherwise abate asbestos and lead-based paint prior to or during demolition activities in accordance with federal, state, and local regulations. In addition, evidence shall be provided to the responsible federal agency that the demolition contract provides for construction contracts and/or land/building leases, provisions shall be included requiring continuous compliance with all applicable government regulations and conditions related to hazardous materials and waste management.

B.7.3 Hazardous Materials

To mitigate the potential impact of encountering hazardous materials during construction and restoration, prior to initiation of deconstruction or construction activities, the contractor will be required to prepare a Hazardous Material Management Plan for review by the DRE. The purpose of this plan is to have an established plan of action if hazardous materials (soil or groundwater contamination, asbestos and hazardous coatings requiring abatement, high pH generated during demolition of concrete, etc.) are encountered during construction and to establish BMPs to reduce the potential for exposure to hazardous wastes. The plan will contain the following:

- Definition of a protocol for proper handling, transport, and disposal of hazardous materials (soil or groundwater contamination, asbestos and hazardous coatings requiring abatement, high pH generated during demolition of concrete, etc.) if they are encountered during construction.
- Definition of a protocol for proper emergency procedures and handling, transport, and disposal of hazardous materials if an accidental spill occurs during construction.
- Establishment of BMPs to reduce the potential for spills of hazardous, toxic, and radioactive waste. Typical BMPs to reduce the potential for spills may include, but are not limited to:
    - Having a spill prevention and control plan with a designated supervisor to oversee and enforce proper spill prevention measures;
    - Providing spill response and prevention education for employees and subcontractors;
    - Stocking appropriate clean-up materials onsite near material storage, unloading and use areas;
    - Designating hazardous waste storage areas away from storm drains or watercourses;
    - Minimizing production or generation of hazardous materials on-site or substituting chemicals used on-site (e.g., herbicides during restoration) with less hazardous chemicals;
    - Designating areas for construction vehicle and equipment maintenance and fueling with appropriate control measures for runon and runoff; and
    - Arranging for regular hazardous waste removal to minimize onsite storage.

B.7.4 Herbicides Handling

Some restoration activities may include the handling and use of herbicides. The following best management practices measures would be implemented to protect the health and safety of herbicide handlers and prevent impacts to water quality, aquatic and terrestrial species, and special status plants, and animals near the project site(s) from herbicide treatments:

- All weed treatment activities will comply with state and Federal laws and agency manuals, handbooks, and guidelines, including United States Environmental Protection Agency (USEPA) label restrictions. Application according to all herbicide labels.
- All weeds that are pulled or cut after bud stage will be bagged and properly disposed.
- The following minimization measures are required during mixing, loading, and disposal of herbicides:
    - All mixing of herbicides will occur at least 100 feet from surface waters or well heads.
    - All hoses used to add dilution water to spray containers will be equipped with a device to prevent back-siphoning.
    - Applicators will mix only those quantities of herbicides that can be reasonably used in a day.

  - During mixing, mixers will wear a hard hat, goggles, or face shield, rubber gloves, rubber boots, and protective overalls.
  - All empty containers will be triple rinsed and disposed of by spraying near the treatment site at rates that do not exceed those on the treatment site.
  - All unused herbicides will be stored in a locked building in accordance with herbicide storage regulations.
  - All empty and rinsed herbicide containers will be punctured and either burned or disposed of in a sanitary landfill.
  - Any additional herbicide label requirements will be strictly followed during the mixing, loading, and disposal of herbicides.
- No 2, 4-D ester formulations will be used.
- No carriers of adjuvants other than water will be used.
- Trained personnel would monitor weather conditions at spray sites during application. Herbicides will only be applied when no precipitation is imminent within 3 hours.
- A Pesticide Application Record will be completed daily, or as required. This will include general treatment areas, methods, and dates, and make this information available.
- Equipment will be calibrated often enough to ensure the proper amount of herbicides is applied.
- Application of any herbicides to treat weeds shall be performed by or directly supervised by a state licensed applicator.
- Mixing of herbicide will occur on a flat area more than 100 feet from streams, rivers, or lakes where accidental spills can be contained and removed before it contaminates waterbodies.
- Herbicide applicators shall be coordinated with permit holders within the project area, as appropriate.
- Adjacent landowners will be notified prior to treating weeds on public lands adjacent to private land boundaries.
- Only those quantities of herbicides necessary for the day will be transported to and from a treatment area.
- Water drafting equipment for filling spray tanks will have back siphoning prevention devices.
- Label directions and guidelines will be followed to reduce drift potential (nozzle size and pressure, additives). Equipment would be designed to deliver a median droplet diameter of 200- to 800-microns. This droplet size is large enough to avoid excessive drift while providing adequate coverage of target vegetation.
- Herbicides will only be applied when wind speeds are less than 8 miles per hour (mph).
- Spray detection cards will be used to demonstrate the adequacy of buffer zones. If cards indicate drift of herbicides is occurring into wetlands and streams, buffer zones widths and /or treatment methods would be revised.
- Non-hazardous dyes will be used as necessary to ensure uniform coverage. Sings will be posted at visible sites (campgrounds, trailheads, road intersections) to notify the public of herbicide application in the area.
- All chemicals will be applied in accordance with updated USEPA registration label requirements and restrictions, and applicable laws and policies.

- An Herbicide Emergency Spill Plan will be developed, including methods to report and clean up spills. Applicators will be required to be familiar with the plan and carry spill-containment and clean-up equipment.
- Only glyphosate (Rodeo®) will be used within 50 feet of streams/wetlands, where riparian or hydrophilic plants are present, and where surface material is obvious recent deposition of sediment of any diameter(s). Application will be limited to hand spraying and the use of wipers only.
- Only the minimum area necessary will be treated to control noxious weeds.
- A botanist shall evaluate sites for sensitive plant habitat prior to treatment and develop site-specific guidelines for herbicide application near sensitive plant populations during broadcast treatments.
- No chemical would be applied directly to sensitive plant species during spot treatments, and a 100-foot buffer would be maintained around known sensitive plant populations.
- Individuals who exhibit idiosyncratic responses such as hypersensitivity to natural and synthetic compounds will not be permitted to work on herbicide spray crews.
- Ensure all chemical storage, chemical mixing, and post-application equipment cleaning is completed in such a manner as to prevent the potential contamination of any Riparian Conservation Area (RCA), perennial or intermittent waterway, unprotected ephemeral waterway, or wetland.
- Evaluate the need to revegetate at treated sites. Use only certified noxious-weed free, native, seed mix or rootstock if revegetation is necessary for site restoration.
- When scheduling treatment activities, seasonal harvesting periods of wildlife, fish, and plants to accommodate the needs of the Tribes will be considered.
- A spill cleanup kit would be available whenever herbicides are transported or stored. All vehicles carrying herbicides shall have a standard spill kit.
- A spill contingency plan would be developed prior to all herbicide applications. Individuals involved in herbicide handling or application would be instructed on the spill contingency plan and spill control, containment, and cleanup procedures.
- Equipment used for transportation, storage, or application of chemicals shall be maintained in a leak proof condition.

B.7.4.1 Herbicide Spill Plan

Procedures for mixing, loading, and disposing of herbicides will comply with the above measures and USEPA labels and regulations. A spill prevention plan and the following procedures for mixing, loading, and disposal of herbicides will accompany all herbicide spraying operations. A reportable herbicide spill is 1 pint of concentrate of herbicide and/or 5 gallons of mixed herbicide, even if these amounts can be contained and recovered by the weed field crew. Spills that can be contained and recovered will thereafter be applied in the field according to the label requirements for the herbicide. If an herbicide spill occurs, the National Poison Control Center (1-800-222-1222) will be contacted as necessary. If there is a spill, it will be reported on approved forms. At a minimum, the following equipment and material will be available with vehicles or pack stock used to transport herbicides: (1) A shovel; (2) absorbent material or the equivalent; (3) plastic garbage bags or buckets; (4) rubber gloves and boots; (5) safety googles; (6) protective clothing; and, (7) applicable Material Safety Data Sheets.

For supplemental information needed on hazards and reactions, Chemtrek will be called (1-800-424-9300). They are an information contact only; they are not used to report a spill (Example: if a truck carrying herbicides crashes and ignites, field crews may want to know if any special hazards exist from herbicide fumes, Chemtrek is the appropriate company to call).

B.8 Traffic and Transportation

B.8.1 Roadway Signage and Dust Abatement

Install signage, implement dust abatement, and perform proper construction traffic management at each deconstruction site and along Copco, Lakeview, and Topsy Grade/Ager-Beswick Roads.

B.8.2 Construction Signage

Install construction signage onto OR66 at the entrance to J.C. Boyle Dam in accordance with the Manual of Uniform Traffic Control Devices (MUTCD) advising motorists of slow turning vehicles and overall construction traffic in the area will mitigate significant traffic safety impacts.

B.8.3 Construction Signage

If Copco Road is open and if the recreation sites are also open, install signage in accordance with MUTCD advising motorists of the presence of construction traffic in the area.

B.8.4 Roadway Signage

Install signage, in accordance with MUTCD, at sharp turns along Copco Road and OR66 advising motorists and construction vehicle drivers to slow down and be advised of potential conflicts with bicycles, pedestrians and other vehicles.

B.8.5 Road Rehabilitation

Grade to re-smooth ruts and washboard conditions created on Copco, Lakeview and Topsy Grade/Ager-Beswick Roads and at each deconstruction and construction site.

B.8.6 Pre Construction/Deconstruction Road Integrity Study

Perform a structural integrity and load carrying capacity analysis to determine the load carrying capacity of the main access roads in the area of analysis. If it is determined these main access roads are necessary for heavy equipment to use and this analysis reveals the roads do not meet local, state, or federal standards for load carrying capacity, then these roads will be upgraded to fully meet those standards.

B.8.7 Post Construction/Deconstruction Road Integrity Study

Perform a structural integrity and load carrying capacity analysis on the existing one-lane bridges at Iron Gate Dam and at J.C. Boyle Dam to aid deconstruction engineers in mitigating substantial road condition effects. If it is determined these bridges are necessary for heavy equipment to use and this analysis reveals the bridges do not meet local, state, or federal standards for load carrying capacity, then these bridges will be upgraded to fully meet those standards.

B.8.8 Impacts to Non-Surfaced Roads in Project Area

Upon the completion of restoration activities, roads within the riparian zone damaged by the permitted activity shall be weather proofed according to measures as described in *Handbook for Forest and Ranch Roads* by Weaver and Hagans (1994) of Pacific Watershed Associates and in Part X of the CDFG Restoration Manual entitled "*Upslope Assessment and Restoration Practices*." The following are some of the methods that may be applied to non-surfaced roads impacted by project activities implemented under this Program.

- Establish waterbreaks (e.g., waterbars and rolling dips) on all seasonal roads, skid trails, paths, and fire breaks by 15 October. Do not remove waterbreaks until 15 May.
- Maximum distance for waterbreaks shall not exceed the following standards; (1) for road or trail gradients less than 10%: 100 feet; (2) for road or trail gradients 11-25%: 75 feet; (3) for road or trail gradients 26-50%: 50 feet; (4) for road or trail gradients greater than 50%: 50 feet. Depending on site specific conditions more frequent intervals may be required to prevent road surface rilling and erosion.
- Locate waterbreaks to allow water to be discharged onto some form of vegetative cover, slash, rocks, or less erodible material. Do not discharge waterbreaks onto unconsolidated fill.
- Waterbreaks shall be cut diagonally a minimum of six inches into the firm roadbed, skid trail, or firebreak surface and shall have a continuous firm embankment of at least six inches in height immediately adjacent to the lower edge of the waterbreak cut.
- The maintenance period for waterbreaks and any other erosion control facilities shall occur after every major storm event for the first year after installation.
- Rolling-dips are preferred over waterbars. Waterbars shall only be used on unsurfaced roads where winter use (including use by bikes, horses, and hikers) will not occur.
- After the first year of installation, erosion control facilities shall be inspected prior to the winter period (15 October) after the first major storm event, and prior to the end of the winter period (15 May).
- Applicant will establish locations to deposit spoils well away from watercourses with the potential to delivery sediment into streams supporting, or historically supporting populations of listed salmonids. Spoils shall be contoured to disperse runoff and stabilized with mulch and (native) vegetation.
- No berms are allowed on the outside of the road edge.

B.9 References

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