United States Department of the Interior

BUREAU OF RECLAMATION
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IN REPLY REFER TO:
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March 08, 2019

VIA ELECTRONIC MAIL AND USPS

Mr. Jim Simondet
National Marine Fisheries Service
1655 Herndon Road
Arcata, CA 95521

Subject: Addendum 2 to the Bureau of Reclamation's December 21, 2018, *Final Biological Assessment on the Effects of the Proposed Action to Operate the Klamath Project from April 1, 2019 through March 31, 2029 on Federally-Listed Threatened and Endangered Species*, as modified on February 15, 2019: Inclusion of and Request for Essential Fish Habitat Consultation Associated with Klamath Project Operations under the Magnuson-Stevens Fishery Conservation and Management Act

Dear Mr. Simondet:

The Bureau of Reclamation (Reclamation) has prepared the enclosed Essential Fish Habitat (EFH) Assessment on the continued operations of the Klamath Project (Project) and requests initiation of EFH consultation. EFH is designated for commercially fished species under the Magnuson-Stevens Fishery Conservation and Management Act Public Law 94-265 as amended by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (P.L. 109-479) (Magnuson-Stevens Act). Pursuant to section 305(b)(2) of the Magnuson-Stevens Act (16 U.S.C. 1855(b)), Federal agencies are required to consult with the National Marine Fisheries Service (NMFS) on actions that may adversely affect EFH for species managed under the Pacific Coast Salmon Fishery Management Plan.

Under the Proposed Action, as described in the modified 2018 Biological Assessment, Reclamation would continue to: 1) Store waters of the Upper Klamath Basin and Lost River; 2) Operate the Project, or direct the operation of Project facilities, for the delivery of water for irrigation purposes or National Wildlife Refuge needs, or releases for flood control purposes, subject to water availability; while maintaining conditions in Upper Klamath Lake and the Klamath River that meet the legal requirements under section 7 of the Endangered Species Act (ESA); and 3) Perform O&M activities necessary to maintain Project facilities.

The objective of this EFH Assessment is to determine whether Reclamation's operations of the Project under the Proposed Action may adversely affect designated EFH for relevant commercially, federally managed fisheries species within the Proposed Action area. This Assessment covers Chinook salmon *(Oncorhynchus tshawytscha*) and coho salmon (*Oncorhynchus kisutch*). This analysis applies to the Proposed Action as defined in Reclamation's *December 21, 2018, Final Biological Assessment on the Effects of the Proposed Action to Operate the Klamath Project from April 1, 2019 through March 31, 2029 on Federally-Listed Threatened and Endangered Species*, as modified on February 15, 2019 (modified 2018 BA), as part of the ESA Section 7 reinitiated consultation. This EFH assessment should be addended to and included as Part 13 of the 2018 modified BA.

Reclamation has determined that the Proposed Action will result in adverse effects to Chinook salmon and coho salmon EFH. Reclamation has also determined that adverse impacts resulting from the Proposed Action, when considered in the context of the net effect of the both negative and positive impacts of the PA and paired with the flow components and conservation measure, Reclamation believes the adverse effects have been sufficiently minimized.

Reclamation requests acknowledgment of our request to initiate EFH consultation. Reclamation appreciates the collaboration and inter-agency coordination that has taken place to date and intends to continue that effort as we complete the consultation process.

Please feel free to contact Kristen Hiatt by phone at (541) 883-6935 or email at khiatt@usbr.gov should you have any questions.

Sincerely,

/s/ JARED BOTTCHER For

Jeffrey Nettleton

Area Manager

Enclosure

cc: Daniel Blake & Evan Childress
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Klamath Falls, Oregon 97601

RECLAMATION

Managing Water in the West

Essential Fish Habitat Assessment

Implementation of the Bureau of Reclamation's December 21, 2018, *Final Biological Assessment on the Effects of the Proposed Action to Operate the Klamath Project from April 1, 2019 through March 31, 2029 on Federally-Listed Threatened and Endangered Species*, as modified on February 15, 2019

Klamath Project, Oregon and California

U.S. Department of the Interior
Bureau of Reclamation
Klamath Basin Area Office

March 2019

(Please note this document will be integrated in the Bureau of Reclamation's 2018 modified Biological Assessment (herein referred to as "modified 2018 BA) as the new Part 13.)

13. ESSENTIAL FISH HABITAT ASSESSMENT

13.1 Introduction and Background

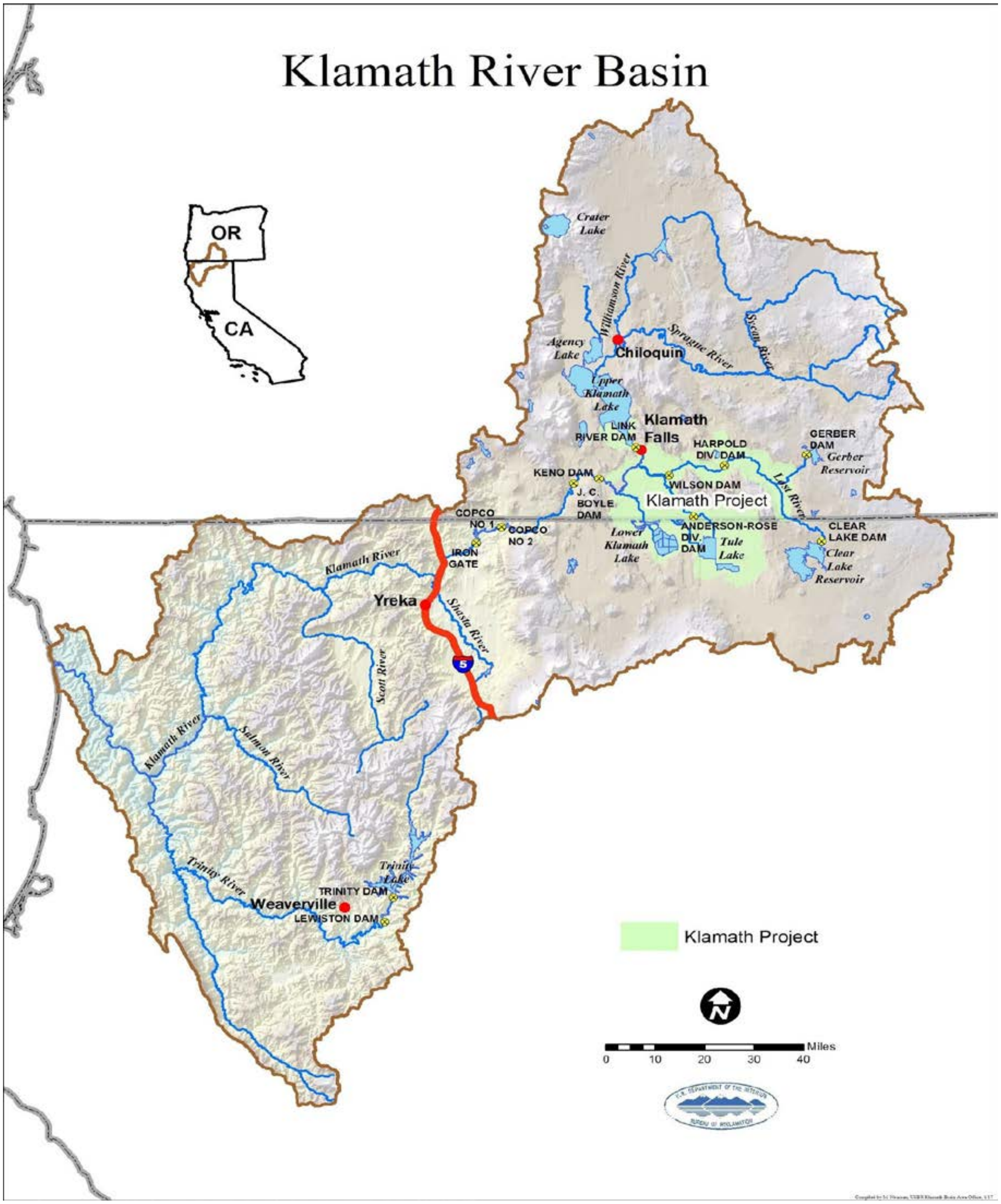
Essential Fish Habitat (EFH) is designated for commercially fished species under the Magnuson-Stevens Fishery Conservation and Management Act Public Law 94-265 as amended by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (P.L. 109-479) (Magnuson-Stevens Act). The Magnuson-Stevens Act requires federal fishery management plans, developed by National Oceanic Atmospheric Administration's National Marine Fisheries Service (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 non-fishing 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. This section also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

The Magnuson-Stevens Act clarifies that EFH *means* those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. The following clarifications are important for the purpose of interpreting the definition of EFH: 1) "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include areas historically used by fish where appropriate; 2) "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; 3) "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and 4) "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

Managed Pacific salmon species (including Chinook and coho salmon) EFH and life histories are discussed in Appendix A to the Pacific Coast Salmon Fishery Management Plan (PFMP) as modified by Amendment 18 to the PFMP (PFMP 2014), which is summarized here for Chinook and coho salmon with specific life history information for the Klamath River. Habitat Areas of Particular Concern (HAPC) have also been identified in Appendix A of the PFMP. HAPC for salmon are: complex channel and floodplain habitat, spawning habitat, thermal refugia, estuaries, and submerged vegetation.

This EFH analysis covers Chinook salmon *(Oncorhynchus tshawytscha*) and Southern Oregon Northern California Coast (SONCC) coho salmon (herein referred to as coho salmon; *Oncorhynchus kisutch*). Chinook salmon and coho salmon are managed under the Magnuson-Stevens Act, under the authority of which EFH for coho salmon is described in Amendment 14 to the PFMP (50 CFR § 660.412). Freshwater 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 Iron Gate Dam (IGD) and upstream to Lewiston Dam on the Trinity River (Figure 13-1). Freshwater EFH includes the water quality and quantity necessary for successful spawning, fry, and parr habitat for coho salmon and Chinook salmon. Estuarine and marine EFH contains habitat elements for juvenile, smolt, and adult life histories. It covers an extensive area, that varies seasonally and interannually.

Figure 13-1. The Klamath River Basin including the action area for Reclamation's modified Proposed Action. EFH, for Chinook and coho salmon, includes all waterways accessible to anadromous fish.



The objective of this EFH assessment is to determine whether the operations of Reclamation's Project under the modified PA may adversely affect designated EFH for Chinook and coho salmon. Adverse effect means 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 (50 CFR 600.810).

The EFH determinations for Chinook and coho salmon within the action area will include the mainstem Klamath River from IGD (river mile (RM) 190) to the Klamath River mouth and all accessible tributaries (excluding the Trinity River to Lewiston Dam) where restoration actions may occur as described in the proposed Conservation Measure "Coho Restoration Grant Program" (Part 4.5.4. of the 2018 modified BA). This Conservation Measure includes funding conservation, instream flow, and restoration projects/efforts on these tributaries, which could provide benefits to Chinook and coho salmon populations and the corresponding EFH.

13.2 Chinook and Coho Salmon Habitat Requirements for EFH

The diversity of freshwater, estuarine, and marine habitats utilized by Chinook and coho salmon is complex and therefore difficult to specify all stream reaches, wetlands, and water bodies essential for the species survival. Given the importance of tributaries for spawning, rearing, and habitat needs, evaluating specific reaches of a tributary, not the entire tributary, may exclude important tributaries or tributary reaches from designation as EFH. The low densities of juvenile salmonids and lack of thorough understanding of the species' freshwater distribution, both current and historical, and habitat requirements in the Klamath River Basin makes defining specific river reaches complicated. Adopting a watershed-based approach to EFH is appropriate, because it: 1) recognizes the species' use of diverse habitats and underscores the need to account for all of the habitat types supporting the species' freshwater and estuarine life stages, from small headwater streams to migration corridors and estuarine rearing areas; 2) takes into account the natural variability in habitat quality and use (e.g., some streams may have fish present only in years with plentiful rainfall) that makes precise mapping difficult; and 3) reinforces the important linkage between aquatic areas and adjacent upslope areas.

Additional and more detailed habitat requirements for coho salmon are described in Part 5.2 of the modified 2018 BA. Since Chinook salmon are not listed under the Endangered Species Act and thus not described in the modified 2018 BA, their habitat requirements are described below.

13.2.1 Chinook Salmon

Chinook salmon, also known as king salmon, are the largest of the anadromous Pacific salmonids and have a diverse range of migratory strategies. These fish migrate to the ocean at less than 30 grams (0.06 pounds) and return after one to eight years of marine growth weighing

10-50 pounds. Chinook salmon populations in the Klamath Basin tend to exhibit one of two distinct adult freshwater entry times – spring (March – July) and fall (August – November). Therefore, freshwater adult migration periods are used to categorize Chinook salmon runs as "spring-run" or "fall-run." Differences in Chinook salmon population run timing are driven by migration distances and spawning and rearing habitat preferences. Other differences in life history also exist among Chinook salmon sub-populations. For example, juveniles are known to migrate as sub-yearlings or at one or more years of age. In general, spring-run Chinook salmon most often adopt a "stream-type" (age 1+) freshwater rearing strategy. However, fall-run Chinook are more prone to adopt an "ocean-type" rearing strategy, whereby juveniles begin migrating slowly downstream at less than one year of age, continuing to feed and rear as they emigrate. Although one juvenile life history type may predominate in a population, Chinook salmon are known to express a diversity of migration strategies.

These primary life history strategies (spring-run versus fall-run) often exhibit different behavioral characteristics:

Spring-run: Spring-run Chinook salmon have some slight differences in distribution and spawning than their fall counterparts. Spring-run Chinook salmon in the Klamath Basin are distributed mostly in the Salmon and Trinity rivers and in the mainstem below these tributaries only during migratory periods with few fish occasionally observed in other areas (Stillwater Sciences 2009). In the Klamath basin, the spring-run Chinook salmon life history trait is somewhat uncommon, and these fish generally exist downstream of the area influenced by IGD flow releases. Spring-run Chinook salmon 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 2009). Fry emergence takes place from March and continues until early-June (West et al. 1990). Based on data from 1992 to 2001 (CDFG 2004; unpublished data), it appears 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-origin escapement. No spawning has been observed by spring-run Chinook salmon in the mainstem Klamath River (Shaw et al. 1997).

There appears 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). 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 run of juvenile fish. Spawning, incubation, rearing, and smolting habitat characteristics for spring-run Chinook salmon are similar to fall-run Chinook salmon.

Fall-run: Fall-run Chinook salmon are distributed throughout the Klamath River downstream of IGD and spawn later in the year in the mainstem as well as in several tributaries. 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). Spawning peaks in late October and early November. Fall-run Chinook salmon fry in the Klamath River emerge from redds between December and late February (Reclamation 2011), although timing may vary somewhat depending on water temperatures in different years and tributary conditions.

Fall-run Chinook salmon in the Klamath Basin exhibit three juvenile life-history types: Type I (ocean entry at age 0[1] 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-origin Chinook salmon outmigrants are Type I, 37 percent are Type II, and less than 1 percent are Type III.

Female Chinook salmon deposit their eggs in cool rivers and streams in pool tailouts or in transition areas between riffles and other slower velocity habitat types with suitable gravel size, depth, and water velocity. 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 centimeter (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 consequently reduce survival of incubating eggs. Fine sediment deposition or capping of redds can also impede emergence of fry. Bjornn and Reiser (1991) reported that in laboratory studies, swim-up fry had difficulty emerging when the percentage of fine sediment in the substrate exceeded 30-40 percent by volume.

To survive high water velocities in the winter and spring and avoid predation, emergent Chinook fry often seek refuge in the interstitial spaces within the stream substrate. Fry will also move into shallow and slow-moving margins of stream channels. As juvenile Chinook salmon grow, they begin to inhabit areas with deeper water, a wider range of velocities, and larger coarse substrate materials (NPPC 1990). Chinook salmon are capable of spawning in larger rivers relative to other anadromous salmonids due to their body size and ability to move larger coarse substrate material.

Temperature ranges for Chinook are 5.0 to 19.4 degrees Celsius (°C), although preferred rearing temperatures are 13.0 to 18.0°C (Moyle 2002). Upper threshold lethal temperatures have been reported as high as 25.0°C (Hardy et. al. 2006). Extensive mortality of juvenile Chinook salmon will occur as temperatures reach 22 to 23°C (Moyle 2002).

For Chinook salmon that adopt a stream-type life history, summer rearing takes place primarily in the fast-moving portions of pools, although juveniles can also be found in glides and riffles. Winter rearing occurs more uniformly, at low densities across a wide range of habitat types. Productive salmon habitat is characterized by rough streambed elements, primarily in the form of

[1] 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.

large and small pieces of wood or large boulders that help scour pools and generate complex stream habitat. As their swimming ability improves, Chinook salmon parr and subadults move into feeding lanes behind boulders in riffles or in heads of pools. These areas provide maximum feeding opportunity on drifting aquatic insects, while minimizing swimming effort. Habitat areas with cover such as large woody debris, undercut banks, or boulders are also popular rearing areas. Therefore, a stream's capacity to support a robust Chinook salmon population is determined by the quantity and quality of these habitat types.

The diet of Chinook salmon varies considerably according to life history stage and fish size, as well as food availability. Juvenile salmon are opportunistic feeders but prey primarily on benthic macroinvertebrates associated with the stream substrate, such as immature aquatic insects (e.g., mayfly and stonefly nymphs, caddisfly, dipteran, and beetle larvae), amphipods, snails, and aquatic worms. Other common food items include terrestrial insects and emerging adult aquatic insects drifting in the current, as well as fish eggs.

13.2.2 Coho Salmon

Coho salmon migration, spawning, and rearing timing and habitat requirements differ from the previously discussed Chinook salmon. Coho salmon typically migrate into the Klamath River during mid-September through mid-January. Upstream migrations are typically associated with pulse flows due to fall rain events. Most coho salmon spawning occurs in large tributaries such as the Scott, Shasta, and Trinity rivers, as well as some higher-order tributaries. Although coho salmon primarily spawn in tributary streams from November through January, they have been observed spawning in side channels, at tributary confluences, and suitable shoreline habitats in the mainstem Klamath River. Egg incubation lasts approximately seven weeks and typically occurs November – March. Alevins remain in the gravel approximately two to three weeks and then emerge as free-swimming fry during February to mid-May with the peak in April and May. Coho salmon will typically rear in freshwater for one-year before migrating to the ocean. Smoltification usually occurs in the spring following the first winter. Outmigration can begin as early as February and continues through mid-June, with peak numbers arriving in the estuary during April and May. Optimal temperature ranges for coho salmon are 3.3 to 20.5°C, although preferred rearing temperatures are 12.0 to 14.0°C (Moyle 2002). Upper lethal temperatures have been reported as high as 25.6°C (Hardy et. al. 2006).

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 (64 FR 24049; May 5, 1999). These features are necessary to provide sufficient growth and reasonable likelihood of survival to smoltification. Juvenile migration corridors need to have sufficient water quality, water quantity, water temperature, water velocity, and safe passage conditions 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. Adult migration corridors should provide satisfactory water quality, water quantity, water temperature, water velocity, cover/shelter and safe passage conditions for adults to reach spawning areas. Adults generally migrate in the fall or winter months to spawning areas. Spawning areas for the 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 primarily spawn in smaller tributary streams from November through January in the Evolutionary Significant Unit (ESU).

Coho salmon critical habitat was designated on May 5, 1999 (64 FR 24049) for the ESU and includes all accessible waterways, substrate, and adjacent riparian zones between Cape Blanco, Oregon, and Punta Gorda, California. While critical habitat designation differs from EFH, it contains many similarities as indicated. Within the ESU, critical habitat can be separated into five essential habitat types related to the species' life cycle. These habitat types include: 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. Juvenile summer and winter rearing areas and spawning habitats are often located in small headwater streams, higher-order tributaries and mainstem side channels; however, some juveniles have been observed rearing in the mainstem during the summer (near thermal refugia) and winter. Juvenile and adult migration corridors include the tributaries as well as mainstem reaches and estuarine zones. Areas for growth and development to adulthood occurs primarily in near- and offshore marine waters, although final maturation takes place in freshwater tributaries when the adults return to spawn. Also, areas for growth and development to adulthood are restricted to the marine environment for coho salmon (NMFS 2010) and therefore not impacted by the implementation of Reclamation's modified Proposed Action (PA).

Furthermore, within the five essential habitat types, essential features (also known as - primary constituent elements) of critical habitat include adequate quantity and/or quality of: 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) provide safe passage conditions. In addition, designated freshwater and estuarine critical habitat includes riparian areas that provide the following functions: shade, sediment, nutrient or chemical regulation, streambank stability, and input of large woody debris or organic matter (64 FR 24049, May 5, 1999). Of these essential features, water quantity/quality, water velocity, water temperature, substrate, and overall habitat quantity are most impacted by implementing the modified PA.

13.3 Chinook and Coho Salmon EFH Requirements

Chinook and coho salmon EFH for freshwater habitats consists of four major components: 1) spawning and incubation; 2) juvenile rearing; 3) juvenile migration corridors; and 4) adult migration corridors and holding habitat. The freshwater EFH for both species depends on lateral (e.g., floodplain, riparian), vertical (e.g., hyporheic) and longitudinal connectivity to create habitat conditions for spawning, rearing, and migration including: 1) water quality (e.g., dissolved oxygen, nutrients, temperature, etc.); 2) water quantity, depth, and velocity; 3) riparian-stream-marine energy exchanges; 4) channel gradient and stability; 5) prey availability; 6) cover and habitat complexity (e.g., large woody debris and aquatic and terrestrial vegetation, etc.); 7) space; 8) habitat connectivity from headwaters to the ocean (e.g., dispersal corridors, floodplain connectivity); 9) groundwater-stream interactions; and 10) substrate composition.

The important elements of Chinook salmon and coho salmon estuarine and marine EFH factors are: 1) estuarine rearing; 2) ocean rearing; and 3) juvenile and adult migration. For Chinook salmon, the critical features of these habitats are: 1) good water quality; 2) cool water temperatures; 3) abundant prey species and forage base (food); 4) connectivity with terrestrial ecosystems; and 5) adequate depth and habitat complexity including marine vegetation and algae in estuarine and near-shore habitats. However, the critical features of the estuarine and marine habitats for coho salmon are: 1) adequate water quality; 2) cool water temperatures; 3) adequate prey species and forage base (food); and 4) adequate depth, cover, and marine vegetation in estuarine and nearshore habitats. Overall, Chinook and coho salmon marine distributions are extensive, vary seasonally and interannually, and can be identified in general terms only.

13.3.1 EFH Affected by the Project

The existing condition of freshwater EFH within the action area and variables that may influence Chinook or coho salmon habitats are factors of flow (discharge, velocity, and depth), water temperature, and important habitat indices (sediment). These variables and their relationship to EFH are discussed in detail below. The four major components of EFH and associated habitat conditions are covered by the described variables:

- Water Quality – water quality (nutrients, dissolved oxygen (DO), temperature), prey availability, and riparian-stream-marine energy exchanges;
- Flow Variables – water quality, water quantity, depth, and velocity, riparian-stream-marine energy exchanges, channel gradient and stability, cover and habitat complexity, habitat connectivity, groundwater-stream interactions, and substrate composition; and
- Habitat Parameters – channel gradient and stability; prey availability; cover and habitat complexity; and substrate composition.

13.3.1.1 Water Temperature

Water temperatures in the Klamath Basin vary seasonally and by location. Downstream from IGD, water released from Iron Gate Reservoir is 2.5°C (range 1 to 4.5°C) cooler in the spring but is 2 to 10°C (range 3.6 to 18°C) warmer in the summer and fall, as compared with modeled conditions without the hydroelectric dams (PacifiCorp 2004, Dunsmoor and Huntington 2006, NCRWQCB 2010, Risley et al. 2012). Immediately downstream from IGD (RM 190.1), water temperatures are also less variable than those documented farther downstream in the Klamath River (Karuk Tribe of California 2009 and 2010).

Downstream of the Shasta River, water temperatures are more influenced by solar energy, the natural heating and cooling regime of ambient air temperatures, and tributary inputs of surface water. Meteorological control of water temperatures results in increasing temperature with distance downstream from IGD. For example, daily average water temperatures between June and September are approximately 1 to 4°C higher near Seiad Valley (RM 129) than temperatures just downstream from the IGD (Karuk Tribe of California 2009 and 2010). Just upstream of the confluence with the Salmon River (RM 66), the influence of the hydroelectric dams on Klamath River water temperature are significantly diminished. Downstream from the confluence of the Salmon River, the influence of the dams on water temperature in the Klamath River is not discernible from the modeled data (PacifiCorp 2005, Dunsmoor and Huntington 2006, NCRWQCB 2010).

Summer water temperatures downstream from the Salmon River (Klamath RM 66) 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. However, the slight decrease in water temperatures in this reach is generally 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 just upstream from the confluence with the Trinity River (Weitchpec at RM 43.5), decreasing to 24.5°C near Turwar Creek (RM 5.8; Yurok Tribe Environmental Program 2005, Sinnott 2010).

Juvenile salmonids cope with high mainstem Klamath River temperatures by moving to pockets of thermal refugia such as confluences of cold-water tributaries, off-channel habitats, and beaver ponds. The mainstem Klamath River regularly exceeds 24 °C during the summer (NRC 2004), which can limit juvenile rearing due to these temperatures being above thermal stress tolerances. Moyle (2002) found upper thermal limits for juvenile Chinook salmon of 22 to 23°C, a point at which extensive mortality occurs. Sutton and Soto (2012) found that when water temperatures in the mainstem Klamath River approach approximately 19°C, juvenile coho begin to use thermal refugia. These authors also noted that use of refugia declined as water temperatures exceeded 22 – 23°C, an indicator of unsuitable habitats. Thermal refugia are spatially and temporally variable with many factors impacting the size, shape, and function of the refugia habitat (Deas et al. 2006). In the mainstem Klamath River, changes in flow at IGD, meteorological conditions, and tributary contributions influence both the amount and extent of available refugia (Deas et al. 2006). Although the mainstem Klamath River offers only limited and patchy rearing habitats during the summer due to higher water temperatures, it provides a corridor for redistribution to refugia in tributaries, and as tributary conditions improve through conservation measures and active restoration programs, thermal refugia in the mainstem Klamath River could provide more habitat.

13.3.1.2 Flow Variables (Discharge, Water Velocity, and Water Depth)

Chinook and coho salmon require spawning sites within the stream or river where water velocity, depth, and gravel size are optimal for the incubation of developing eggs (gravel sizes are discussed in Part 11.3.1.3. Substrate and Sediments). Successful incubation requires stable flow rates that are adequate to supply the required level of DO but not high enough to cause gravel movement and streambed scour that could expose eggs to predators or wash them downstream. Areas with uniform water velocity are often preferred and fine sediments are avoided because the incubating eggs require a steady supply of cool (4-14ºC), oxygenated water and fine sediments restrict hyporheic flow. Velocity is also important in redd construction because the water carries dislodged substrate materials from the nesting site (Reiser and Bjornn 1979). Spawning/redd water depths were greater than or equal to 18 cm with velocities ranging from 0.30 – 0.91 meters per second (m/s) for Chinook and coho salmon (Thompson 1972). Chinook salmon prefer redd sites with subsurface flow that are 25 – 100 cm deep with velocities ranging from 0.3 – 0.8 meters per second (m/s) (Moyle 2002). However, coho optimal spawning grounds are sites that are groundwater influenced with depths ranging from 10.2 – 20.1 cm (Bjornn and Reiser 1991), and velocities of 0.3 – 0.5 m/s (CDFG 2002 *in* CDWR 2004); these differences could be related to differences in spawning locations. Chinook salmon primarily spawn in mainstem rivers, while coho are primarily tributary spawners.

Water depth and associated velocities are critical for the growth and survival and vary by life history stages of Chinook and coho salmon. Thompson (1972) indicated that adult Pacific Northwest Chinook salmon require a minimum depth of 0.24 m with velocities less than 2.44 m/sec for migration, while coho salmon require a minimum depth of 0.18 m, with velocities less than 2.44 m/s for migration (Thompson 1972, Hassler 1987 *in* CDWR 2004). Water depth criteria for salmon in spawning areas are estimated to be 24 – 30 cm for Chinook, and approximately 18 cm for coho (Bjornn and Reiser 1991). Juvenile Chinook salmon utilize depths up to 3 m when water velocities are not limiting and avoid depths less than 6.0 cm during their free-swimming stage. Chinook salmon juveniles are associated with low velocities 0.3 – 6.0 m/s, depending on fish size, and are typically found in pools along the margins of riffles or current eddies. Juvenile coho salmon use habitat with shallower water depths ranging from 0.06 - 0.88 m, favoring depths between 0.21 – 0.4 m (Hardy et al. 2006). Coho fry also prefer slower velocities, favoring velocities between 0.1 – 0.5 m/s (Hardy et al. 2006). Juvenile coho remain closely associated with slow velocity, low-gradient habitats (Lestelle 2007, Quinn 2005) for feeding, cover, and predator avoidance. Excessive velocities and shallow water may impede migrating adult fish or re-distribution of juvenile fish for both species.

The magnitude of flow events (discharge) and their recurrence interval, timing, and duration contributes to the complexity of channel form, instream habitat (depth and velocity), and substrate composition which impacts salmon disease such as the myxozoan parasite, *Certanova shasta*. Altered flow regimes due to dam construction and/or irrigation withdrawals will affect physical and ecological responses of a river (Rathburn et al. 2009 *in* Som et al. 2016), leading to changes in aquatic fauna and myxozoan life cycles. Fine sediment accumulation on the channel bed and margins are of concern because high densities of the polychaete invertebrate host for *C. shasta* (*Manayunkia speciosa*) have been observed in these habitats in the Klamath River (Conor et al. 2016). Suitable polychaete habitat (e.g., weighted usable area (WUA)) deceases with increasing flows (Som et al. 2016), and evidence suggests that the prevalence of *C. shasta* infection in polychaetes is negatively correlated with the peak flow regime (Som et al. 2016). Increases in flow (discharge) may also reduce spore concentrations (myxospores and actinospores); however, additional studies are required to determine effectiveness at reducing *C. shasta* infection rates (Som and Hetrick 2016).

High water or flushing flows increase water velocities and decrease substrate stability, dislodging the polychaetes, which could directly influence the distribution of polychaetes by restricting habitat use to stable substrates (Malakauskas et al. 2013 *in* Som et al. 2016). Alexander et al. (2016) found that increasing peak discharge is associated with decreases in predicted WUA for polychaetes. Infected polychaetes were more associated with deeper and lower-velocity depositional habitats (Shea et al. 2016), and these habitat conditions can be attributed to alterations in the natural flow regime (e.g., reduced frequency of flushing flows). These disease prevalence and flow altering factors contributed to Hillemeier et al. (2017) recommending sediment flushing and/or geomorphic flows to control infected polychaete populations and promote a more functional hydrologic and geomorphic regime in the Klamath River. Restoring the variability of the flow regime will also enable the sediment mobilization that is required to maintain spawning areas and gravels.

13.3.1.3 Habitat Parameters

River discharge influences the channel's planform, cross-sectional area, and riparian attributes, as well as sediment transport and substrate composition (Leopold 1994). Changing a river's natural flow regime (via magnitude, frequency, duration, timing, and/or sequencing of both high and low flow events) can alter sediment transport and change substrate composition, all of which affects aquatic species (Poff et al. 1997). On the Klamath River, natural flow regimes have been altered by water storage, power-generating dams, and extensive irrigation water withdrawals. The altered flows have limited sediment mobilization as well as channel maintenance flows, which can enable sediment accumulation, alter invertebrate composition and densities, and impact spawning gravels (Shea et al. 2016).

Chinook and coho salmon have different life histories as it relates to spawning locations but similar redd and substrate habitat requirements. In the Klamath River basin, Chinook salmon primarily spawn in the mainstem Klamath and Trinity rivers, while coho primarily spawn in tributaries (with some overlap for both species). Most of the coho mainstem spawning in the Klamath River occurs within 12 river miles of IGD (Magneson and Gough 2006), and it is speculated these fish could have originated from Iron Gate Hatchery (NMFS 2010). Chinook and coho salmon redds are predominantly constructed in areas with subsurface flow, with loose gravel and/or cobble substrates that are small enough to be moved by the fish and large enough to allow good intra-gravel water flow to the incubating eggs and developing alevins. Chinook salmon redds tend to be in areas of coarser gravel and are often characterized by having a few large cobbles in the bottom of the nest. Since Chinook salmon eggs are the largest of all the Pacific salmon and therefore have a small surface-to-volume ratio, adequate subgravel flow is vital to egg survival. Spawning areas with slightly larger gravel size and low rates of sedimentation consistently generate higher survival rates; however, in cases where large amounts of silt build up in spawning beds, survival rates for both species are greatly reduced.

Adult Chinook and coho salmon substrate requirements and sediment interactions are dynamic, variable, and interact with river flow; a brief discussion is included here (for detailed descriptions refer to Reclamation (2011)). Chinook salmon require about 13.4 - 20.1 square meters (m^2) gravel per spawning pair and 11.7 m^2 for coho salmon (Bjornn and Reiser 1991), but other studies have found greater variabilities in the area required for pairs of spawning Chinook (2.0 – 44.8 m^2) (numerous authors *in* CDWR 2003) and coho salmon (up to 38.4 m^2) for redd and inter-redd space (CDFG 2002 *in* CDWR 2004). Individual redds encompass 3.3 – 10.0 m^2 for Chinook and 2.8 m^2 for coho salmon (Chinook: Neilson and Banford 1983, Burner 1951, Reiser and White 1981 *all in* Bjornn and Reiser 1991; Coho: Burner 1951 *in* Bjornn and Reiser 1991, respectively). However, Hassel (1987 *in* CDWR 2004) found that coho redds could vary from 1.7 to 5.2 m^2. Thompson (1972) found that Chinook and coho salmon spawn in substrates sized 13 – 102 millimeters (mm) (Medium Gravel – Medium Cobble; Wentworth Size Classes for Wolman Pebble Counts: Wolman 1954, Bevenger and King 1995). Chinook salmon have been recorded spawning in substrates ranging from 30 – 150 mm (Raleigh et al. 1986 *in* CDWR 2003), however a review of several studies found coho preferences ranged from 13 – 152 mm (numerous authors *in* CDWR 2004). While most coho redds (approximately 85 percent) were found in areas with substrate 150 mm or smaller (CDFG 2002 *in* CDWR 2004), coho salmon preferred substrates 75 – 150 mm in diameter in the Trinity River (Hassler 1987 *in* CDWR 2004). Suitable substrate for Chinook salmon embryos is a gravel/cobble mixture with a mean diameter of 25.4 – 101.6 mm and a composition including less than 5 percent fines (particles less than 7.6 mm) (CDWR et al. 2000 *in* CDWR 2003). The differences in redd and substrate sizes may be attributable to the species' spawning locations.

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. Information on both concentration and duration of suspended sediment is necessary for understanding the potential severity of its effects on salmonids (Reclamation 2011).

13.4 Effects of modified Proposed Action on Chinook Salmon and Coho Salmon EFH

Reclamation's modified PA provides additional flow volume in May and June in years when the April 1 Environmental Water Account (EWA) estimate is greater than 400,000 acre-feet (AF) (407,000 AF in even years) and less than 576,000 AF (which occurs in 13 of the 36 years in the period of record [1981 - 2016]). This volume is intended to provide for increased May and June flows in those years. The hydrological models and coho salmon habitat descriptions are in Part 8 of the BA and Figure 8-7 and Tables 8-1 (below) and 8-6 to 8-10 in the modified BA that was transmitted to the National Marine Fisheries Service on February 15, 2019. The updated figures and tables for Chinook salmon based on the modified PA to augment May and June flows are included in this document. The models used to develop the percent maximum WUA curves and exceedance tables are described in Part 8.5. Effects on Designated Coho Salmon Critical Habitat. Flow characteristics for the Klamath River are described Part 8.3. Ecological Effects (pages 8-2 through 8-11). Coho salmon habitat area model results and WUA habitat curves (Figure 8-7) and exceedance tables (Tables 8-6 to 8-10) were included in the modified BA and will not be reprinted in the EFH discussions. Additionally, water quality parameters (temperature, nutrients, and DO) and their habitat relationships are described in Parts 8.3.2. Water Quality (pages 8-5 through 8-9) and 8.4.2. Temperature Effects (pages 8-16 through 8-21) of the BA.

13.4.1 Modified Proposed Action

The Action Area (Part 1.4), modified PA (Part 4), and Period of Record (Part 8.2) are described in detail in the modified BA. The modified PA is Reclamation's continued operation of the Project and implementation of conservation measures such as the Coho Restoration Grant Program. Reclamation's PA consists of three major elements to meet authorized Project purposes, satisfy contractual obligations, and address protections for listed species and certainty for Project irrigators. The period covered by this BA is 5 years, from 2019 – 2024.

The modified PA contains four elements that pertain to EFH:

1. Store waters of the Upper Klamath Basin and Lost River;
2. Operate the Project, or direct the operation of Project facilities, for the delivery of water for irrigation purposes or NWR needs, or releases for flood control purposes, subject to

water availability; while maintaining conditions in UKL and the Klamath River that meet the legal requirements under section 7of the ESA;

3. Perform operation and maintenance activities necessary to maintain Project facilities
4. Implement the Conservation Measure to support the Coho Restoration Grant Program with funding to reduce the effects of the modified PA.

13.4.2 Water Quality Effects to EFH

The hydrological models and coho salmon habitat descriptions are in Part 8 of the modified 2018 BA. The model(s) used to develop the percent maximum WUA curves and exceedance tables are described in Part 8.5. Effects on Designated Coho Salmon Critical Habitat. Flow characteristics for the Klamath River are described in Part 8.3. Ecological Effects. Coho salmon habitat area model results and WUA habitat curves (Figure 8-7) and exceedance tables (Tables 8-6 to 8-10) are displayed in Part 8.5.2. and will not be reprinted in the EFH discussions. Additionally, water quality parameters (temperature, nutrients, and DO) and their habitat relationships are described in Parts 8.3.2. Water Quality and 8.4.2. Temperature Effects.

Water quality: The effects of the modified PA on Chinook and coho salmon EFH are to water quality, including nutrients, DO, and temperature. The contribution of nutrients from the Project relative to the PA is described in Part 8.3.2.2. Nutrient Loading. UKL is considered the source of greatest nutrient and BOD loads during the summer months (ODEQ 2017, Schenk *et al*. 2018) and the Project may act as a nutrient sink, reducing nutrient load from UKL, but any negative effect of these loads on water quality parameters is shrouded by algal biomass from UKL and the reservoirs, dams, and meteorological and hydrologic conditions downstream of the Project.

The concentrations of DO in the Klamath River and the contributions from the Project relative to the PA are described in Part 8.3.2.3. Dissolved Oxygen. DO concentrations in the Klamath River downstream of IGD are not a concern in the late fall, winter, and early spring given relatively cold-water temperatures and increased discharge due to changing weather conditions and increased precipitation. Klamath River DO concentrations are inversely correlated with water temperature during the summer season (Asarian and Kann 2013) and can be affected by periphyton dynamics (Asarian et al. 2015). Fluctuations in discharge below IGD affects DO concentrations and is influenced by Project operations. In most years and months, the PA results in an average increase in daily Klamath River discharge at IGD relative to what was observed in the POR (Table 8-3). The modified PA increases IGD releases and therefore DO concentrations should improve in the Klamath River.

Klamath River water temperatures are largely correlated with air temperature (see Part 6.4.1.2.5.) but may also be affected by discharge. Water temperatures in the fall and winter are not a concern to salmonids and no additional effects are anticipated from the PA on Klamath River during these seasons. However, Asarian and Kann (2013) found statistically significant negative relationships between mean monthly flow and mean water temperature for June and July (2001 – 2011) in lower Klamath River reaches (Orleans, Weitchpec, Tully Creek, and Turwar) but not in the upper reaches. The modified PA provides augmented flows in May and June in specific water year types, which could decrease water temperatures, especially in the lower reaches.

As described in Part 8.3.2.1. Temperature, Reclamation analyzed RBM10 output from March – October for 1981 to 2014 (Appendix 8, Tables 8-3 through 8-6). These analyses suggest an overall decrease in water temperatures most of the time due to implementation of the PA; however, in some sites and years depicted temperature increases. The greatest increases in water temperatures were 1.2°C and occurred during the months of May and June 2001 (RM136.8 just below the confluence with the Scott River, Table 8-5), but increases are also predicted for other flow years, months, and sites, most of which were ≤ 0.5°C. Consequently, implementation of the PA will reduce overall water temperatures but may increase average monthly water temperatures in few years (for about a month) in the Klamath River below the confluence of the Shasta River.

13.4.3 Flow Effects to EFH

Flow Variables: The flow variables include discharge, water velocity, and depth, all of which are interrelated. Discharge was assessed using subsistence flow, base flow, high-flow pulses, overbank flow, and flow variability and are defined in Part 8.3.1. Altered Hydrology and displayed in Table 8-1, which has changed due to the revised flow regimes in May and June (see Modified Table 8-1 below). The effects of altering discharge are apparent in sediment mobilization, maintenance of channel form, riparian health, and disease (*M. speciosa* and *C. shasta*). Water velocity and depth are also part of the WUA analyses (Part 11.4.1. Habitat Parameters (WUA) Effects to EFH). For coho salmon, the graphs and tables are displayed in Part 8.5.2. Habitat Area Simulation Results (Figure 8-7 and Tables 8-6 to 8-10), and for Chinook salmon, the graphs and tables are displayed below (Figure 11-2 and Tables 11-2 to 11-6).

Subsistence flow was set at 1,000 cfs to provide sufficient flow to maintain connectivity to tributaries for re-distributing juvenile coho salmon (NMFS 2013), which is separate from base flows. Approximately 17.9 percent of the daily average flows are below 1,000 cfs, and implementation of the PA will result in a reduction in the frequency and magnitude of daily average flows below 1,000 cfs when compared to the POR, which will improve EFH for both species. Base flows (1,000 cfs to 6,000 cfs) accounted for 78.9 percent of PA flows during the POR and implementation of the modified PA would increase the frequency but reduce the magnitude of these flows. These flows will be most critical for temperature, DO, nutrient, and periphyton affects and should reduce the effects of the modified PA on salmon EFH.

High-flow pulses (6,000 cfs to 12,000 cfs) and overbank flows are needed to maintain channel form, transport sediments (including spawning gravels), and rejuvenate riparian health. Fewer high-flow pulses may stabilize gravel bars, promote thick riparian vegetation at the river edges, and cause alluvial barriers to seasonally form at the mouths mainstem tributaries (NMFS 2012a). The PA produces flows of approximately 6,030 cfs (surface flushing flow) in nearly every year; however, flow pulses in the upper portion of the disturbance range (6,000 to 12,000 cfs) occur infrequently under this PA. The reduced high-flow pulses will impact EFH; however, the introduction of the surface flushing flows will offset some of these impacts due to the mobilization of fine sediments (see *Disease*).

The BA defined overbank flows, or geomorphically effective flows, to be greater than 12,000 cfs, even though other studies set this level higher, for example at 13,000 cfs (Hardy et al. 2006) and 15,000 cfs (Shea et al. 2016). These flows are needed to maintain channel form and reduce riparian encroachment, and implementation of the PA would result in infrequent occurrences of overbank flows. Shea et al. (2016) analyzed the flood frequency analysis for Klamath River below Iron Gate Dam and found that at a 10-year return period the discharge should be 15,610 cfs. In the PA, there are no 3-day periods with flows exceeding 15,610 cfs; however, there are three years with flows greater than 12,000 cfs (1982, 1986, and 1997; n=9 days and 0.07% of flows), but only two of those periods last for at least 3-days (Modified Table 8-1).

The PA will allow for greater daily IGD flow variability compared to past water management practices during the POR. A summary of IGD daily exceedance flows and flood frequency are included in Appendix 8, Tables 8-1 and 8-2 for Chinook and coho salmon.

Disease: The altered hydrology will lead to changes in the river's channel form or fluvial processes over time, which can influence the life cycle of *M. speciosa*. High velocities can disrupt the parasite's life-cycle by disrupting and constraining suitable polychaete habitat and thereby limiting effective parasite transmission (Bjork and Bartholomew 2008; Malakauskas et al. 2013; Alexander et al 2016). Decreases in *M. speciosa* density can lead to diminished *C. shasta* actinospore production and decreased disease incidence in salmonids (Hillemeier et al. 2017, Reclamation 2018). The PA includes a surface flushing flow (at least 6,030 cfs for 72 hours) for disease mitigation, consistent with the Disease Management Guidance #1 in the Disease Management Guidance document (Hillemeier et al. 2017), with the exception that Reclamation proposed for surface flushing flows (forced and opportunistic) to be implemented between March 1 – April 15 (Part 4.3.2.2.2. Disease Mitigation and Habitat Flows, pages 4-25 through 4-27).

The objective of the surface flushing flow is to mobilize sediment to scour *M. speciosa* from benthic substrate, thereby decreasing *M. speciosa* density in preferred habitats. The PA should mitigate disease impacts by providing surface flushing flow conditions more frequently than historic conditions, because flow stability is thought to promote *C. shasta* proliferation. Specifically, the flow regime in the modified PA resulted in flows meeting the intent and purpose of a surface flushing flow in 35 of the 36 years within the modeled POR (approximately a one-year recurrence interval), which is likely to result in lower *M. speciosa* densities. Specifically, 1992 was the only year where a surface flushing flow did not occur; in three other years the flushing event either occurred prior to March 1 (1997), concluded after April 15 (2014), or the daily average flow was not greater than 6,030 cfs for three consecutive days (2005).

The effectiveness, short- or long-term, of surface flushing flows on *M. speciosa* densities, actinospore concentrations, POI, and *C. shasta*-related mortalities are not well understood, and therefore additional monitoring to refine hypotheses regarding the effect of surface flushing flows on *C. shasta* infection in fish is critical. However, implementing surface flushing flows should improve Chinook and coho salmon EFH by mobilizing sediment, scouring benthic substrates, and providing a more natural hydrologic flow regime.

Manipulating flows may be effective at reducing *M. speciosa* distribution (Bartholomew et al. 2018); however, reducing *M. speciosa* densities and/or preferred habitat in the Klamath River needs additional research and modeling (Bartholomew et al. 2018). IGD flows between 8,700 and 11,250 cfs are critical in removing fine sediment deposited within the armored layer of the riverbed (i.e., large boulders, bedrock), which is something that cannot be accomplished with surface-flushing flows alone (Shea et al. 2016). Reclamation's deep flushing flows (11,250 cfs for 24 hours) will occur in 4 years (1982, 1986, 1996, and 1997) of the 36-year modeled POR, which is less than the approximately 5-year recurrence interval for this discharge below IGD (Shea et al. 2016). Water availability will determine the timing and frequency Reclamation is able to implement a deep flushing flow; as such, Reclamation is unable to "guarantee" a managed deep flushing flow but will attempt to do so as hydrologic conditions and public safety allow. If implemented, deep flushing flows could reduce *M. speciosa* distribution, densities, and habitat, which would benefit Chinook and coho salmon EFH.

13.4.4 Habitat Parameters (WUA) Effects to EFH

The modified PA is expected to reduce discharge below IGD throughout the year, relative to historic conditions. The effects of reduced flows on habitat availability for Chinook and coho salmon fry and parr depends on the flow volume and habitat area at each site (Figures 11-2 and 8-7, respectively). The methods used in the hydrodynamic model developed for the mainstem Klamath River (Hardy et al. 2006) and weighted usable area (WUA) curves are described in Part 8.5.1. Habitat Area Simulation Methods. For coho salmon, the WUA habitat descriptions, graphs, and exceedance tables are displayed in Part 8.5 Effects on Designated Coho Salmon Critical Habitat of the original BA as well as the modified BA information (Figure 8-7 and Tables 8-16 to 8-10, and for Chinook salmon, the graphs and tables are displayed below (Figure 13-2 and Tables 13-2 to 13-6).

IGD flow releases are not the only driver of coho habitat availability due to flow accretions and habitat/flow relationships. Flow accretions, as affected by meteorological and hydrologic conditions, play a major role. Consequently, Reclamation cannot feasibly optimize flows at IGD to maximize WUA without considering the influence of tributary inputs. The relationship between flow and habitat area is nonlinear as suitable Chinook and coho salmon habitat includes variables such as velocity and depth preferences of fish. There are times and locations where greater flow releases at IGD may increase suitable habitat area, but other instances where less water released from IGD increases suitable habitat area. Consequently, there is no single IGD release that maximizes average percent maximum WUA for Chinook or coho fry or parr in all stream reaches.

Habitat (WUA) – Coho Salmon: Coho salmon fry during the spring months (March through June) will see a reduction of habitat at a variety of flows for specific stream reaches (Figure 8-7):

- IGD to the Shasta River flows roughly less than 1,300 cfs (< 1,100 cfs for parr)
- Shasta River to the Scott River flows roughly less than 1,200 cfs (< 6,000 cfs for parr)
- Scott River to the Salmon River flows roughly less than 1,600 cfs or 1,900 to 2,600 cfs (< 8,000 cfs for parr)

Typically, at a greater range of flows, coho parr habitat will be less than the 80 percent WUA when compared to fry habitat, and coho parr will also experience a greater range of reductions in habitat.

The modified PA will reduce habitat for coho salmon at a wide range of flows. The PA reduces coho fry habitat availability in the mainstem Klamath River between IGD (RM 190) and the Shasta River (RM 177.6) in May and June with the highest frequency of negative effects occurring between the Scott and the Salmon River (RM 65.5 to 143.8) (Figure 8-7, Table 8-6). The effects of the modified PA would likely be most influential during dry years when average daily spring flows range from 1,000 - 2,600 cfs because negative effects on habitat availability March-May were predicted to occur most frequently at flows from 60-95 percent exceedance.

The modified PA reduces parr habitat availability across a broad range of flow exceedance values at the R Ranch, Trees of Heaven, Seiad Valley, and Rogers Creek sites during the spring (Tables 8-7 through 8-10; Appendix 8, Figures 8-8 through 8-11). Negative effects were predicted to occur most frequently at the Trees of Heaven and Seiad Valley sites.

Habitat (WUA) – Chinook Salmon: Chinook salmon fry and parr during the spring months (March through June) will see a reduction of habitat at a variety of flows for specific stream reaches (Figure 11-2):

- IGD to the Shasta River flows roughly less than 2,200 cfs (< 500 cfs for parr)
- Shasta River to the Scott River flows roughly less than 3,200 cfs (< 4,500 cfs for parr)
- Scott River to the Salmon River flows roughly less than 5,100 cfs (< 6,200 cfs for parr)

The WUA habitat curves are quite similar for Chinook fry and parr; however, they both show a reduction in habitat over a wide range of flows.

The modified PA reduces Chinook fry habitat availability in the mainstem Klamath River between IGD (RM 190) and the Salmon River (RM 65.5) in March-June with the highest frequency of negative effects occurring in June followed by May (Figure 13-2, Table 13-2). The effects of the PA would likely be most influential during dry years when average daily spring flows range from 1,000 – 5,000 cfs because negative effects on habitat availability March-May were predicted to occur most frequently at flows from 50-95 percent exceedance; however, in June, negative effects on habitat availability occur at flows from 15-95 percent exceedance. The greatest impacts occur in June in all the stream reaches.

The modified PA reduces parr habitat availability across a broad range of flow exceedance values at the R Ranch, Trees of Heaven, Seiad Valley, and Rogers Creek sites during the spring (Figure 13-2 and Tables 13-2 to 13-6). Negative effects increased as you progressed downstream even though there are several tributaries providing accretions. These effects were predicted to occur most frequently at the Trees of Heaven, Seiad Valley, and Rogers Creek sites.

13.5 Determination of Effects on Chinook Salmon and Coho Salmon EFH

The modified PA includes surface flushing flows for disease and habitat/substrate maintenance, protective ramping rates for transitions between flow regimes, slight decreases summer water temperatures due to increased flows, and was modified to increase May and June flows and available outmigration habitat. The modified PA will provide an overall decrease in summer water temperatures during critical migration and rearing periods for Chinook salmon and coho salmon. However, during some years there will be an increase in water temperatures up to 1.2℃ for short periods of time, and some months may experience reduced flow. The modified PA also provided funding for coho restoration actions which will increase habitat availability via restoration projects in major tributaries. The modified PA also includes minimum flows in the Klamath River that should ensure adequate passage into tributary habitats where the restoration projects will occur, thereby mitigating some of the adverse effects of the modified PA.

The Coho Restoration Grant Program has provided approximately $3 million in funding for restoration projects on the mainstem Klamath River and its tributaries. The Conservation Measure (Part 4.5.4. Coho Restoration Grant Program) provides for an increase in coho restoration funding for years 2019 and 2020 with the potential for further financial supplementations should appropriations materialize. However, the funding options are contingent on budget appropriations. Reclamation remains committed to the implementation of restoration projects that should have beneficial effects to both critical habitat for coho salmon and EFH for Chinook salmon. Restoration projects will likely improve access to, and the spatial extent of, cold-water plumes at tributary mouths within the mainstem Klamath River, where any potential adverse effects of the modified PA may occur.

Reclamation’s analysis included both qualitative and quantitative analysis of Project effects, which resulted in a determination that implementation of the modified PA would result in adverse effects to Chinook salmon and coho salmon EFH. The minimum flow component of the modified PA and conservation measure described in the 2018 modified BA and EFH are considered useful to minimize adverse effects on the water quality, cover, access and passage, disease, and habitat connectivity components of Chinook salmon and coho salmon EFH. Adverse effects to habitat suitability components of EFH will remain; however, when considered in the context of the net effect of both negative and positive impacts of the modified PA and paired with the flow components and conservation measure, Reclamation believes the adverse effects have been sufficiently reduced.

Modified Table 13-1. Summary of the Iron Gate Dam historical (actual) average daily flows during the Period of Record (October 1, 1980 to November 30, 2016), and for the modeled average daily flows with the implementation of the modified Proposed Action when applied to the same period.

Criteria	Modeled Proposed Action	Actual	Difference
Count (Total Daily Flows)[1]	13,210	13,210	0
Average Daily Flow (cfs)[1]	1815.14	1824.43	-9.29
Percent of the Modeled Proposed Action[1]	100	100.5	-0.5
Count (Flows < 1,000 cfs)[2]	2,358	3,230	-872
Percent of Total Count[2]	17.9	24.5	-6.6
Average Daily Flow (cfs)[2]	937	815	122
Count (Flows ≥ 1,000 cfs but < 6,000 cfs)[3]	10,417	9,506	911
Percent of Total Count[3]	78.9	72.0	6.9
Average Daily Flow (cfs)[3]	1,775	1866	-91
Count (≥ 6,000 cfs but < 12,000 cfs)[4]	426	463	-37
Percent of Total Count[4]	3.2	3.5	-0.3
Average Daily Flow (cfs)[4]	7,386	7,721	-335
Count (≥ 12,000 cfs)[5]	9	11	-2
Percent of Total Count[5]	0.07	0.08	-0.02
Average Daily Flow (cfs)[5]	14,549	14,444	105

[1] – Total Daily Flows
[2] – Flows less than 1,000 cfs
[3] – Flows greater than or equal to 1,000 cfs but less than 6,000 cfs
[4] – Flows greater than or equal to 6,000 cfs but less than 12,000 cfs
[5] – Flows greater than or equal to 12,000 cfs

Table 13-2. Summary of predicted effects of the modified Proposed Action on Chinook salmon and coho salmon habitat conditions in the mainstem Klamath River.

EFH Feature	**Chinook Salmon**	**Coho Salmon**
Substrate Composition	The surface flushing flows will improve substrate composition by mobilizing fine sediments, which will disrupt (*M. speciosa*) habitats, which could lead to decreased densities and reduced *C. shasta* infections.	The surface flushing flows will improve substrate composition by mobilizing fine sediments, which will disrupt (*M. speciosa*) habitats, which could lead to decreased densities and reduced *C. shasta* infections.
Water Quality	Water quality should improve for both temperature and DO. Cooler water temperatures are expected to provide the most benefit in the summer when water temperatures exceed optimum thresholds for salmon growth and survival.	Water quality should improve for both temperature and DO. Cooler water temperatures are expected to provide the most benefit in the summer when water temperatures exceed optimum thresholds for salmon growth and survival.
Habitat Suitability	Habitat suitability is expected to decrease for juvenile parr and fry during certain flow events.	Habitat suitability will decrease for both parr and fry during some months in average to dry flow years. The most pronounced effects of the PA on habitat WUA were predicted to occur during wet and dry water years.
Channel Gradient and Stability	Channel stability will decrease slightly due to the reduced geomorphically effective flows to maintain channel form and riparian habitats as well as the reduction in overbank flows. This reduction may be due to over-stabilization of the streambanks from riparian vegetation encroachment.	Channel stability will decrease slightly due to the reduced geomorphically effective flows to maintain channel form and riparian habitats as well as the reduction in overbank flows. This reduction may be due to over-stabilization of the streambanks from riparian vegetation encroachment.
Cover and Habitat Complexity (large woody debris, channel complexity, aquatic vegetation)	The Coho Restoration Grant Program incorporates habitat improvements that increase streambank stability and channel complexity, connectivity between habitats, the viability of cold-water plumes, in addition to constructing additional off channel refugia habitats. The restoration program is expected to provide benefits to both species and is proposed as a measure to mitigate adverse effects associated with the PA.	The Coho Restoration Grant Program incorporates habitat improvements that increase streambank stability and channel complexity, connectivity between habitats, the viability of cold-water plumes, in addition to constructing additional off channel refugia habitats. The restoration program is expected to provide benefits to both species and is proposed as a measure to mitigate adverse effects associated with the PA.
Access and Passage	Increased discharge and decreased water temperatures during summer are expected to improve adult Chinook migration and holding conditions.	Increased discharge and decreased water temperatures are expected to improve adult Chinook migration and holding conditions.
Floodplain Connectivity	Floodplain connectivity will decrease slightly due to the reduced geomorphically effective flows to maintain channel form and riparian habitats as well as the reduction in overbank flows.	Floodplain connectivity will decrease slightly due to the reduced geomorphically effective flows to maintain channel form and riparian habitats as well as the reduction in overbank flows.

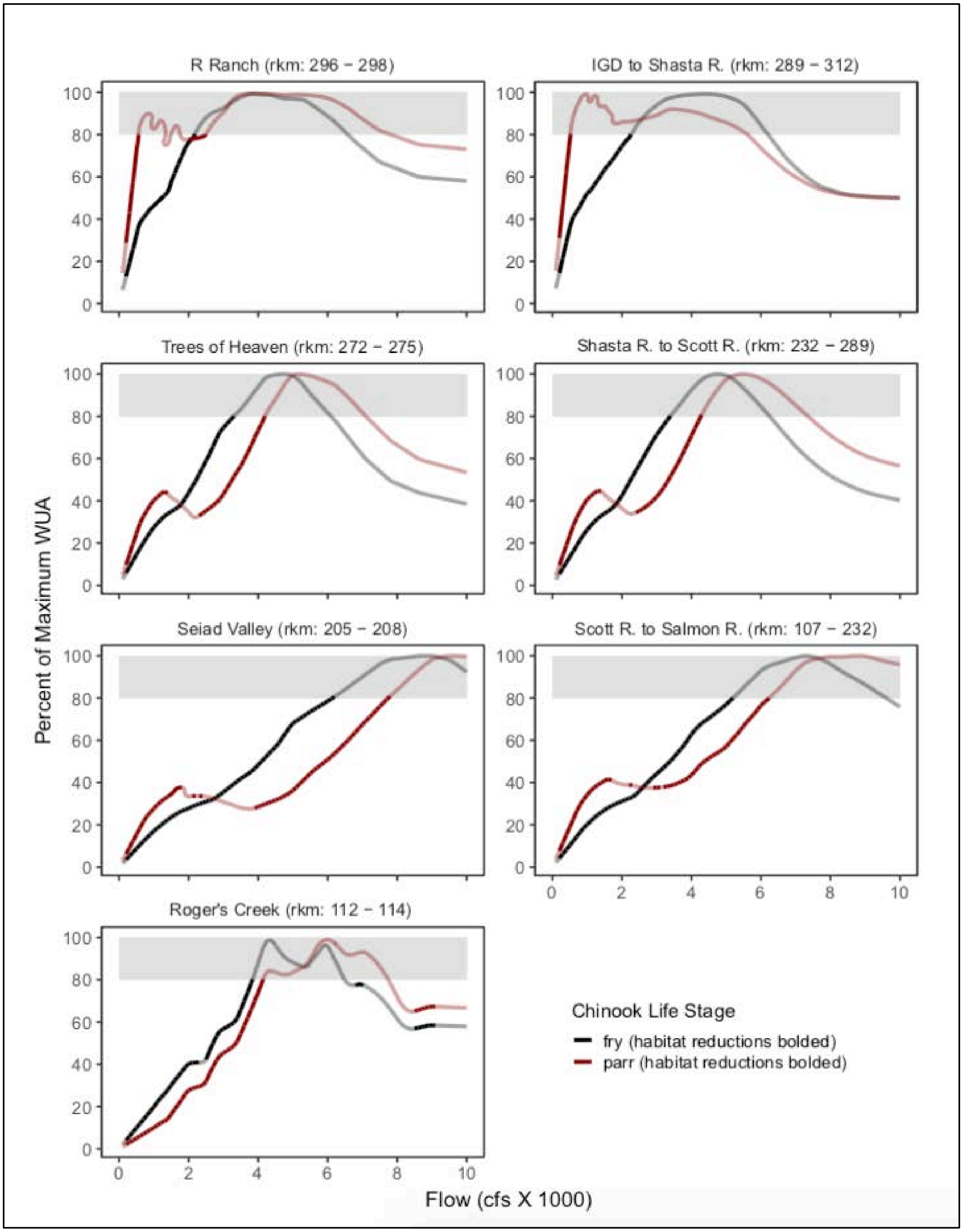


Figure 13-2. Chinook salmon fry and parr habitat availability relative to mainstem flows for three reaches and four sites downstream of Iron Gate Dam. Flows account for tributary accretions and were estimated for each habitat unit when calculating weighted usable area (WUA). Gray horizontal bands indicate WUA values ≥ 80 percent of maximum. Potential habitat reductions due to the modified Proposed Action are bolded.
Source: Mount Hood Environmental 2018

Table 13-3. Daily average mainstem flows (cubic feet per second; cfs) within nearest 5 percent exceedance where the modified Proposed Action will likely reduce Chinook salmon fry habitat availability to below 80 percent of maximum (orange highlight). Flows estimated for the midpoint of each reach with Reach 1 from river kilometer (rkm) 289 to 312 (totaling 23 km), Reach 2 from rkm 232 to 289 (totaling 57 km), and Reach 3 rkm 107 to 232 (totaling 125 kilometers).
Source: Mount Hood Environmental 2018

Exceedance	Reach 1 March	Reach 1 April	Reach 1 May	Reach 1 June	Reach 2 March	Reach 2 April	Reach 2 May	Reach 2 June	Reach 3 March	Reach 3 April	Reach 3 May	Reach 3 June
95%	1113	1429	1244	1056	1433	1641	1404	1126	2560	2494	1931	1341
90%	1302	1463	1280	1073	1731	1711	1467	1175	2932	2711	2197	1481
85%	1606	1518	1362	1099	1954	1848	1608	1229	3240	3027	2477	1603
80%	1782	1559	1483	1124	2165	1938	1742	1292	3620	3397	2684	1728
75%	1912	1695	1550	1159	2329	2097	1858	1345	3971	3849	2964	1816
70%	2122	1858	1611	1190	2589	2291	1978	1397	4340	4134	3334	1936
65%	2352	2004	1672	1227	2864	2446	2088	1441	4699	4473	3666	2065
60%	2582	2195	1766	1266	3174	2734	2221	1487	5231	4884	4003	2214
55%	2848	2430	1894	1312	3519	2983	2389	1539	6170	5395	4312	2392
50%	3140	2689	2072	1348	3884	3306	2537	1604	6716	5859	4609	2599
45%	3372	3013	2315	1400	4164	3675	2824	1690	7238	6476	5098	2855
40%	3735	3289	2590	1489	4613	3962	3230	1820	7643	6981	5804	3126
35%	4237	3640	2796	1626	5181	4467	3504	2012	8362	7733	6444	3434
30%	4668	3986	2999	1783	5818	4899	3729	2202	9173	8339	6923	3829
25%	5228	4631	3274	1917	6449	5544	4029	2381	10115	8937	7326	4410
20%	6082	5080	3555	2089	6897	6099	4402	2682	11237	9603	7889	4962
15%	6467	5611	3974	2416	7669	6537	4934	3026	12429	10198	8822	5556
10%	7148	6103	4403	2818	8693	7083	5474	3589	14272	11235	9797	6469
5%	8582	6669	5062	3464	10588	7806	6320	4271	17531	12322	10744	7755

Reach 1 = The mainstem Klamath River from Iron Gate Dam to the confluence of the Shasta River (rkm 289-312).
Reach 2 = The mainstem Klamath River from the confluence of the Shasta River to the confluence of Scott River (rkm 232-289).
Reach 3 = The mainstem Klamath River from the confluence of the Scott River to the confluence of the Salmon River (rkm 107-232)

Table 13-4. Daily average mainstem flows (cubic feet per second; cfs) within nearest 5 percent exceedance where the Proposed Action will likely reduce Chinook salmon juvenile habitat availability (blue highlight) in the R Ranch reach (river kilometer 296.7-298.0).
Source: Mount Hood Environmental 2018

Exceedance	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
95%	1007	1023	983	1002	1027	1113	1325	1175	1025
90%	1013	1031	992	1017	1050	1302	1325	1175	1025
85%	1025	1038	1001	1038	1073	1606	1325	1175	1025
80%	1043	1044	1009	1062	1102	1782	1350	1175	1025
75%	1066	1051	1021	1084	1150	1912	1501	1175	1025
70%	1091	1062	1030	1104	1202	2122	1654	1175	1025
65%	1111	1090	1042	1131	1280	2352	1770	1241	1025
60%	1125	1112	1059	1187	1386	2582	1938	1392	1025
55%	1145	1149	1085	1264	1546	2848	2130	1562	1025
50%	1162	1199	1130	1395	1789	3140	2349	1722	1025
45%	1178	1226	1189	1563	2099	3372	2628	1959	1078
40%	1195	1257	1276	1753	2396	3735	2936	2156	1227
35%	1211	1273	1455	2010	2740	4237	3208	2369	1347
30%	1227	1309	1709	2407	3044	4668	3503	2589	1503
25%	1254	1369	1924	2728	3487	5228	4147	2834	1652
20%	1296	1433	2284	3212	4068	6082	4520	3095	1786
15%	1318	1521	2685	3731	4773	6467	5044	3418	2055
10%	1382	1691	3382	4894	5866	7148	5565	3844	2438
5%	1486	3177	5317	6563	8625	8582	6095	4501	3018

Table 11-4. Daily average mainstem flows (cubic feet per second; cfs) within nearest 5 percent exceedance where the modified Proposed Action will likely reduce Chinook salmon juvenile habitat availability (blue highlight) in the Trees of Heaven reach (river kilometer 272.9-275.1).
Source: Mount Hood Environmental 2018

Exceedance	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
95%	1114	1184	1146	1187	1229	1331	1547	1333	1095
90%	1135	1198	1163	1213	1267	1564	1591	1375	1129
85%	1162	1211	1188	1253	1305	1837	1699	1490	1171
80%	1184	1227	1199	1280	1348	2013	1766	1630	1214
75%	1202	1241	1218	1320	1407	2156	1912	1710	1258
70%	1226	1262	1241	1357	1481	2423	2057	1788	1307
65%	1246	1286	1263	1396	1568	2641	2257	1876	1345
60%	1260	1320	1293	1456	1710	2908	2466	1997	1377
55%	1286	1356	1328	1559	1905	3216	2704	2124	1415
50%	1315	1394	1392	1703	2182	3547	3005	2303	1466
45%	1343	1419	1454	1887	2442	3813	3349	2569	1540
40%	1364	1451	1576	2106	2750	4274	3636	2894	1660
35%	1389	1471	1766	2417	3120	4757	4039	3155	1832
30%	1408	1534	2027	2776	3471	5233	4447	3339	1975
25%	1440	1595	2293	3186	4032	5946	5127	3611	2156
20%	1466	1661	2676	3770	4749	6465	5576	3970	2373
15%	1511	1774	3188	4378	5561	7146	6155	4417	2683
10%	1573	1955	4047	5740	6937	7974	6547	4847	3222
5%	1712	3812	6112	7861	10689	9817	7216	5689	3858

Table 13-5. Daily average mainstem flows (cubic feet per second; cfs) within nearest 5 percent exceedance where the modified Proposed Action will likely reduce Chinook salmon juvenile habitat availability (blue highlight) in the Seiad Valley reach (river kilometer 205.8-208.1).
Source: Mount Hood Environmental 2018

Exceedance	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
95%	1154	1265	1290	1390	1578	1980	2065	1685	1210
90%	1180	1330	1340	1474	1710	2269	2228	1894	1315
85%	1212	1360	1390	1640	1848	2600	2485	2148	1433
80%	1253	1380	1437	1750	1970	2835	2734	2315	1536
75%	1280	1417	1490	1852	2112	3108	2952	2535	1598
70%	1305	1454	1576	1949	2221	3382	3194	2832	1694
65%	1330	1499	1650	2068	2437	3708	3486	3139	1806
60%	1357	1538	1730	2202	2744	4163	3891	3332	1925
55%	1387	1560	1850	2376	3083	4824	4343	3551	2052
50%	1425	1611	2006	2622	3419	5230	4657	3869	2247
45%	1457	1643	2178	2944	3770	5643	5138	4233	2467
40%	1498	1712	2374	3280	4191	6083	5624	4737	2667
35%	1535	1780	2653	3593	4608	6851	6320	5247	2944
30%	1575	1866	2951	4358	5213	7559	6863	5591	3244
25%	1611	1959	3465	5251	6089	8239	7390	6002	3730
20%	1668	2073	4324	5949	7257	9025	7961	6580	4189
15%	1739	2255	5171	7369	8463	10233	8555	7110	4749
10%	1845	2765	7126	9201	10357	11443	9167	8164	5507
5%	2008	5691	10546	12605	16578	14180	10192	9111	6528

Table 13-6. Daily average mainstem flows (cubic feet per second; cfs) within nearest 5 percent exceedance where the modified Proposed Action will likely reduce Chinook salmon juvenile habitat availability (blue highlight) in the Rogers Creek reach (river kilometer 112.6-114.5).
Source: Mount Hood Environmental 2018

Exceedance	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
95%	1257	1509	1686	1926	2749	3741	3222	2500	1643
90%	1324	1601	1858	2369	3184	4284	3799	2873	1796
85%	1361	1737	2013	3011	3674	4889	4407	3128	1992
80%	1417	1810	2254	3369	4081	5437	4843	3405	2190
75%	1507	1876	2511	3661	4506	6018	5649	3965	2339
70%	1564	1932	2790	4021	5001	6562	6223	4460	2522
65%	1609	1975	3111	4493	5549	7087	6729	4850	2692
60%	1649	2041	3508	4947	6106	8036	7414	5470	2906
55%	1671	2102	3948	5397	6680	9226	8001	5922	3137
50%	1713	2182	4360	6079	7145	10159	8601	6458	3421
45%	1776	2296	4865	6970	7791	10793	9392	7293	3810
40%	1807	2472	5504	7692	8749	11549	10396	8216	4198
35%	1862	2662	6214	8522	9693	12674	11084	9125	4611
30%	1933	2999	7282	9961	11397	14058	11988	9722	5147
25%	2092	3319	8641	11865	12890	15490	12888	10418	5834
20%	2185	3933	9958	14586	15268	16844	13494	11617	6476
15%	2424	4808	12895	17418	18376	18150	14741	12531	7523
10%	2657	7402	18207	20915	22986	20701	16245	13656	8707
5%	3553	12371	27044	26670	31399	25082	18268	14706	10792