Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

Consultation on the Issuance of an ESA Section 10(a)(1)(A) Enhancement Permit to the California Department of Fish and Wildlife for Implementation of the Fall Creek Hatchery Coho Salmon Program, Including an Accompanying Hatchery and Genetic Management Plan

NMFS Consultation Number: WCRO-2023-00090

Action Agency: California Department of Fish and Wildlife

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Southern Oregon/Northern California Coast (SONCC) coho salmon (*Oncorhynchus kisutch)* ESU	Threatened	Yes	No	Yes	No
Southern DPS eulachon (*Thaleichthys pacificus*)	Threatened	No		No	
Southern Resident DPS Killer Whale (*Orcinus orca*)	Endangered	No		No	
Southern DPS green sturgeon (*Acipenser medirostris*)	Threatened	No		No	

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	No

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

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Date: June 22, 2023

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1 Introduction

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3, below.

1.1 Background

NOAA's National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.), as amended, and implementing regulations at 50 CFR part 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson–Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR part 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at the California Coastal NMFS office.

The Iron Gate Dam (IGD) was built in 1961 as part of the Klamath Hydroelectric Project. Iron Gate Hatchery (IGH) began operation in 1966 as a mitigation hatchery for lost spawning and rearing habitat between Copco No. 2 Dam and IGD. CDFW and PacifiCorp completed a Hatchery and Genetic Management Plan (HGMP) for the IGH coho program in 2014 (CDFW and PacifiCorp 2014). The primary goal of an HGMP is to devise biologically based hatchery management strategies that ensure the conservation and recovery of salmon and steelhead species. Under the 2014 HGMP, the IGH coho program was successful at increasing survival rates by life stage which resulted in a decrease in the number of coho salmon adults utilized for broodstock. The IGH coho salmon program has also increased proportionate natural influence (PNI) of the integrated population from 0.19 (pre-2014) to 0.50. The higher the PNI value the more the natural environment drives the local adaptation (i.e., fitness) of the population which is expected to result in increased survival and productivity over time (CDFW 2023a).

The Fall Creek Hatchery (FCH) coho salmon program (Program) HGMP (CDFW 2023a) is an update to the 2014 HGMP developed for the coho salmon program at IGH (CDFW and PacifiCorp 2014). CDFW and PacifiCorp anticipated that the 2014 HGMP would cover hatchery operations until mainstem Klamath River dams of the Klamath Hydroelectric Project were removed (Federal Energy Regulatory Commission Project Nos. 14803-001, 2082-063; Surrender and Decommissioning of the Lower Klamath Hydroelectric Project; FERC 2021a). Dam removal is expected to occur in 2024, with pre-drawdown activities occurring in 2023. There is reasonable certainty for dam removal to occur on that schedule given FERC's November 17, 2022 surrender order (FERC 2022b). The surrender order is the final decision by FERC on the Lower Klamath Hydroelectric project, and allows the Klamath River Renewal Corporation (KRRC) to decommission and remove the four hydroelectric dams. The IGH facilities are part of the Lower Klamath Project. IGH, which is located just downstream of IGD, will lose its water supply once Iron Gate Reservoir is drawn down, so hatchery production at IGH will be moved to a revitalized hatchery facility at Fall Creek (Figure 1).

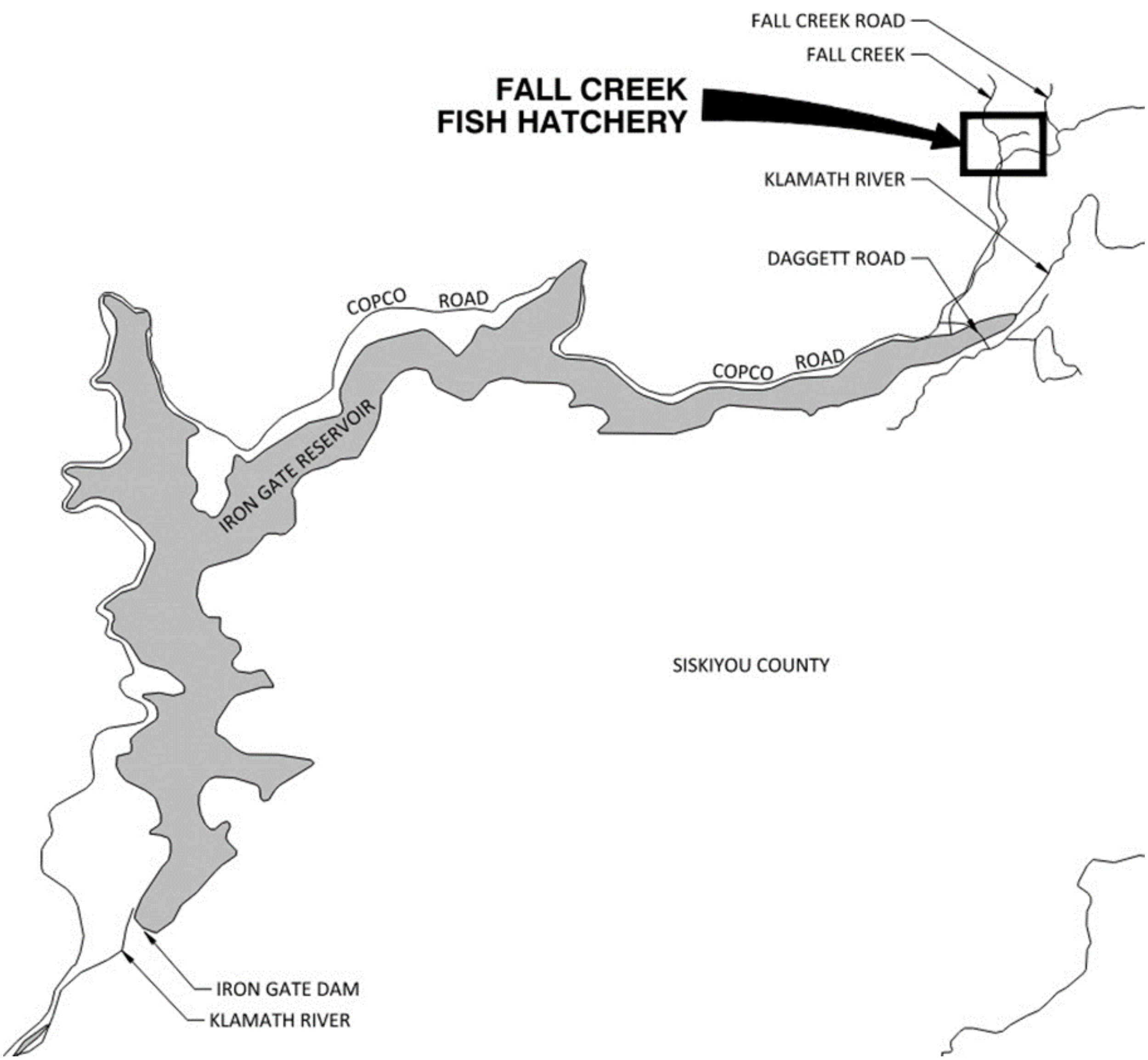

Figure 1. Fall Creek Hatchery Vicinity and Site Map (FERC 2021b).

NMFS has completed a biological opinion on the effects to ESA listed species of the dam removal project, including construction of FCH, and changes to the non-ESA listed Chinook salmon program at FCH (NMFS 2021a). To ensure that hatchery operations continue without interruption in the year of dam removal (2024), the FCH will be operational in the months prior to dam removal (November 2023). The 2023 HGMP (CDFW 2023a) covers activities related to the artificial production of coho salmon at FCH during the transition of the program from IGH, and for eight years after dam removal.

In response to receiving the 2014 HGMP (CDFW and PacifiCorp 2014) and an associated permit request, NMFS issued ESA Section 10(a)(1)(A) Scientific Research and Enhancement Permit number 15755 to CDFW for Implementation of Hatchery and Genetic Management Plan for the Iron Gate Hatchery Coho Salmon Program (NMFS 2014a). This opinion evaluates the requested issuance of a modified permit, ESA Section 10(a)(1)(A) Scientific Research and Enhancement Permit number 15755-2M, to CDFW, for implementation of the HGMP for the FCH coho salmon program for eight years following dam removal. This opinion and determinations are based on the HGMP provided by CDFW (2023a), an associated permit application, annual reports submitted by CDFW associated with Permit 15755, and other sources of best scientific and commercial data available.

1.2 Consultation History

- In February 2022, NMFS and CDFW began coordinating to develop a draft FCH HGMP for CDFW to provide to NMFS.

- On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government's request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order two days later on November 16, 2022. As a result, the 2019 regulations remain in effect, and we are applying the 2019 regulations here. For purposes of this consultation and in an abundance of caution, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

- On July 12, 2022 CDFW released a draft HGMP for comment from partners including NMFS, Tribal partners, United States Fish and Wildlife Service (USFWS), PacifiCorp, and Oregon Department of Fish and Wildlife (ODFW), Klamath River Renewal Corporation, and the City of Yreka. Comments were requested by August 19, 2022.

- Between August 19, 2022 and February 1, 2022 CDFW and NMFS coordinated to amend the draft HGMP as needed in response to comments by partners.

- On February 1, 2023 CDFW submitted a final FCH coho salmon program HGMP to NMFS as an attachment to an application for an ESA Section 10(a)(1)(A) permit for scientific research and enhancement activities associated with implementation of the final draft FCH coho salmon program HGMP. The final draft HGMP submitted on February 1, 2023 is dated December 2022.

- On March 27, 2023, NMFS announced receipt of the permit application in the Federal Register. This notice advised the public that the permit application and associated HGMP were open for a 30-day public comment period, which closed on April 26, 2023. No public comments were received during this public comment period.

1.3 Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (see 50 CFR 402.02). Under the MSA, "Federal action" means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal agency (see 50 CFR 600.910). NMFS West Coast Region proposes to issue Scientific Research and Enhancement Permit 15755-2M under the authority of section 10(a)(1)(A) of the ESA to CDFW, who proposes to implement the coho salmon program at FCH under an HGMP. Permit 15755-2M will authorize activities associated with implementation of the Program under the HGMP at FCH, for eight years following removal of the four mainstem Klamath dams. The permit will authorize lethal take of NOR and hatchery-origin (HOR) adult Southern Oregon Northern California Coast (SONCC) Evolutionarily Significant Unit (ESU) coho salmon for broodstock and other hatchery purposes. Activities that will be authorized under the permit include: capture of adult coho salmon via a fish ladder at FCH, a capture weir at the Bogus Creek Video Fish Counting Facility, from Fall Creek via seines or dip nets, or the auxiliary fish ladder that will remain at IGH; application of anesthesia on collected coho salmon; activities associated with coho salmon handling (species identification, enumeration by life stage and race, taking fork length measurements, wet weighing in grams, adult spawner surveys and juvenile outmigration trapping, handling and collection); tagging of adult and juvenile coho salmon; euthanization of adult and juvenile coho salmon; and release of adult coho salmon back into the Klamath River at the mouth of Fall Creek or to Bogus Creek. The permit will also authorize non-lethal and unintentional lethal take of adult and juvenile SONCC coho salmon during activities related to the HGMP monitoring and evaluation (M&E) program.

1.3.1 Hatchery and Genetic Management Plan

1.3.1.1 Program Purpose and Type

The primary purpose of the Program is to protect the genetic resources of the Upper Klamath Population Unit and reduce extinction risks prior to and after the removal of the four Klamath River dams for eight years. The purpose would be achieved by integrating NOR adults into broodstock and using a genetically based spawning matrix to reduce inbreeding. The NOR fish required to integrate the program will be obtained from Bogus Creek, the IGH auxiliary fish ladder, Fall Creek (e.g., via seine or dip net), and fish volitionally entering FCH as described in the broodstock collection document (CDFW 2021a).

The secondary purpose of the Program is to provide adult coho salmon that could disperse to newly accessible habitat (~76 miles) made available from dam removal (FERC 2022a). The potential dispersal of Program adult coho salmon results from fish straying to tributaries other than Fall Creek and by releasing adult coho salmon surplus to broodstock needs back to the mainstem Klamath River near Fall Creek.

The Program will culture coho salmon of the Upper Klamath Population Unit. This unit is part of the SONCC ESU, which is listed as threatened under the ESA. The HGMP (CDFW 2023a) incorporates principles of hatchery operations developed by the Hatchery Scientific Review Groups (HSRGs) of the Columbia River and California (HSRG 2004; CHSRG 2012). During the duration of the permit, the Program will function as an integrated recovery program. An integrated recovery program is defined as an artificial propagation project primarily designed to aid in the recovery, conservation, or reintroduction of natural salmon population(s), and the fish produced are intended to spawn in the wild or be genetically integrated with the targeted natural population(s). Performance standards for the program are based on those developed for an integrated type of program as defined by HSRG (HSRG 2004; CHSRG 2012). Performance standards for the Program HGMP are described in the following Performance Standards and Indicators Section (Section 1.3.1.2). The Program and HGMP also aligns with the reintroduction plans developed for the Klamath basin in Oregon (ODFW and Klamath Tribes 2021a), and California (in draft) that have been drafted in preparation for removal of the Klamath dams (NMFS 2021a).

1.3.1.2 Performance Standards and indicators

The Program will be operated to achieve performance standards as listed in Table 1. The Program's annual M&E plan will address the HGMP's performance goals through measurement of associated performance indicators (Table 2). The evaluation of performance indicators via the M&E plan is further discussed in the Program Monitoring and Evaluation (M&E) Section (Section 1.3.1.9), below.

Table 1. Performance Standards for the FCH Coho Salmon Program.

Performance Standard	Definition
Achieve Best Management Hatchery Practices	Culture practices developed by the CDFW to increase life-stage specific survival rates, protect the genetic resources of the cultured population, produce a high-quality rearing environment, and achieve effluent discharge standards.
Produce High Quality Smolts	High quality smolt is defined as having similar genetic, physical, behavioral traits and survival rates of natural produced smolts.
Achieve Production Target(s)	Collect, culture, and release the number of adults, eggs, and juveniles required to achieve yearly production targets.
Achieve Conservation Objective(s)	The conservation objective of the program is to protect the genetic resources of Klamath River coho salmon.
Achieve Harvest Objectives	Provide for future sport, commercial, and tribal subsistence and commercial harvests of FCH origin coho salmon when adult run-size allows.

Table 2. Performance Indicators and associated benefits and risks defined in the HGMP.

Performance Indicator	Benefits and Risks
Broodstock Composition, Timing and Structure Similar to Natural Fish	Benefit: Achievement of the indicators ensures that the hatchery population reflects the characteristics of the natural population to the extent possible by including NOR fish as broodstock, collecting fish randomly in proportion to run-timing and including jacks in broodstock. Risk: To the extent these indicators do not represent the natural population, the hatchery stock becomes more domesticated (selected to survive in the hatchery environment instead of the natural environment) and as hatchery fish stray and spawn with fish in the wild, the wild stock becomes less fit to survive in the wild, resulting in a less productive natural population.
High Adult Holding and Spawning Survival Rate, and Egg-to-Fry-to-parr-to Smolt Survival Rates	Benefit: Hatchery culture practices that maximize life-stage survival make the most efficient use of the resource and reduce the need to include additional NOR adults for use as broodstock which can decrease the number of spawners in the wild. Risk: Low survival rates indicate poor hatchery culture practices. Because of this, the hatchery may be inadvertently selecting for genes/traits that are more conducive for survival in the hatchery rather than the natural environment.
Mating Protocols (% Jacks, % Males, the proportion of natural origin fish in the hatchery brood (pNOB)) that Minimize Inbreeding and Conserve Existing Genetic Resources	Benefit: Proper mating protocols ensure high egg fertilization rates (increase survival) and maximize genetic diversity, gene flow between the hatchery and natural components of the population and maintains genetic continuity between generations. Risk: Poor mating protocols may reduce genetic diversity and thereby reduce overall population productivity and reproductive success of HOR and NOR adults spawning naturally.

Performance Indicator	**Benefits and Risks**
Number and Severity of Disease Outbreaks is Low	Benefit: Having fewer and less severe disease outbreaks reduces the disease risks that hatchery populations and operations pose to natural populations. This results in better natural population productivity, diversity, and spatial structure as natural populations located close to the hatchery may be more impacted than those farther away. Risk: Frequent and severe disease outbreaks reduce population productivity and require higher numbers of natural and hatchery origin broodstock to produce a similar number of fish. The use of more natural origin fish in the hatchery reduces natural spawning escapement, which may reduce population productivity, spatial structure, and diversity.
Hatchery Effluent Quality is High	Benefit: Achieving high quality hatchery effluent maintains water quality in the receiving stream. Risk: Hatchery effluent that degrades water quality may decrease the survival and overall productivity of the natural population.
Release Timing, Fish Health, Size and Condition of Released Fish Produce High Survival	Benefit: Releasing healthy fish at the correct size and time increases overall survival, decreases time migrating to the ocean and thus competition with naturally produced fish and reduces the release numbers needed to achieve conservation and harvest objectives. Risk: Releasing fish that are too large or not ready to migrate may result in increased predation on, and competition with, natural fish populations. A mismatch between release timing and environmental conditions required for good survival may reduce overall hatchery performance.
High Smolt-to-Adult Return Rate (SAR)	Benefit: High SAR is an indicator that the hatchery is producing a high quality smolt that can survive in the natural environment from point of release to return as an adult. The higher the survival rates the fewer hatchery fish that need to be produced to achieve conservation and harvest objectives. Decreased hatchery production reduces competition with the natural population, which may result in increased natural fish production. Risk: Low survival rates indicate that rearing practices may be producing a fish of lower quality. Hatchery production levels required to achieve conservation and harvest objectives may be higher than optimal and represent a risk to natural populations as more fish are needed for broodstock.

Performance Indicator	Benefits and Risks
High Natural Adult Abundance	Benefit: High natural adult abundance levels indicate that the population is healthy and has low risk of extinction. Abundance is one indicator of the need for a hatchery program. As natural production levels increase, conservation and harvest objectives can be met with less reliance on hatchery programs. Risk: Low natural abundance is indication that environmental conditions may be insufficient to maintain the population over time (high extinction risk). Hatchery production, with all its inherent risks to natural populations, is needed to achieve conservation and future harvest objectives.
Similar Adult Run-timing (HOR and NOR)	Benefit: For integrated programs, the run-timing of hatchery origin and natural origin individuals should match, as this is an indicator that the two portions of the population unit are expressing similar life histories in terms of adult rum timing, and that both are being exposed and adapting to the full range of environmental conditions present in the basin Risk: A mismatch in run timing between the two groups of individuals or run within a population (HOR and NOR) indicate that hatchery practices are selecting for life histories dissimilar to those being expressed by the natural population. The two groups of fish may become more divergent over time resulting in greater genetic impacts to natural-area versus hatchery fish spawning in the natural environment. This could include a loss in productivity, diversity, and spatial structure.
Low pHOS in Bogus Creek	Benefit: Limiting the proportion of hatchery origin fish on the spawning grounds (pHOS) reduces possible genetic impacts to the natural origin individuals in the population. Risk: The more dissimilar the two groups of spawners (e.g., natural- and hatchery origin fish) the larger the risk hatchery strays pose. In a well-integrated program pNOB must exceed pHOS. This is to ensure that the individuals within the population possess similar genetic and phenotypic traits.

Performance Indicator	Benefits and Risks
Similar Reproductive success of NOR and HOR spawning naturally (NOS and HOS)	Benefit: The reproductive success of both NOR and HOR fish in nature is an indicator of the ability of each to maintain themselves in a natural environment. The ideal conservation hatchery program should produce a fish with the reproductive success of a NOR fish. This indicates that the two components of the population are virtually identical in their ability to reproduce themselves in the wild and that hatchery culture practices have been successful. Risk: Low reproductive success of hatchery fish or decreasing productivity of natural origin fish spawning with hatchery fish, may be indicative that the hatchery is having negative impacts on population productivity.

1.3.1.3 Hatchery Facilities

The FCH will consist of adult collection facilities, adult holding ponds, an egg incubation building, juvenile rearing raceways, fish exclusion structures and water treatment ponds (Figure 2). NMFS consulted on construction of FCH facilities in our 2021 biological opinion on removal of the Klamath dams (NMFS 2021a). A concrete fish ladder (denil steep-pass design) located in Fall Creek will be used to collect adult coho salmon returning to the hatchery. The ladder terminates at a finger weir located at the downstream end of the adult trapping and sorting facility. Maximum discharge from the ladder is 10 cubic feet per second (cfs) with a minimum discharge of 4 cfs. A temporary picket weir will be used to direct adult coho salmon to the ladder entrance and prevent them from moving upstream past the ladder entrance. The FCH facility will include coho salmon specific broodstock holding, incubation, early rearing, juvenile rearing, and acclimation/release facilities as described in the HGMP (CDFW 2023a).

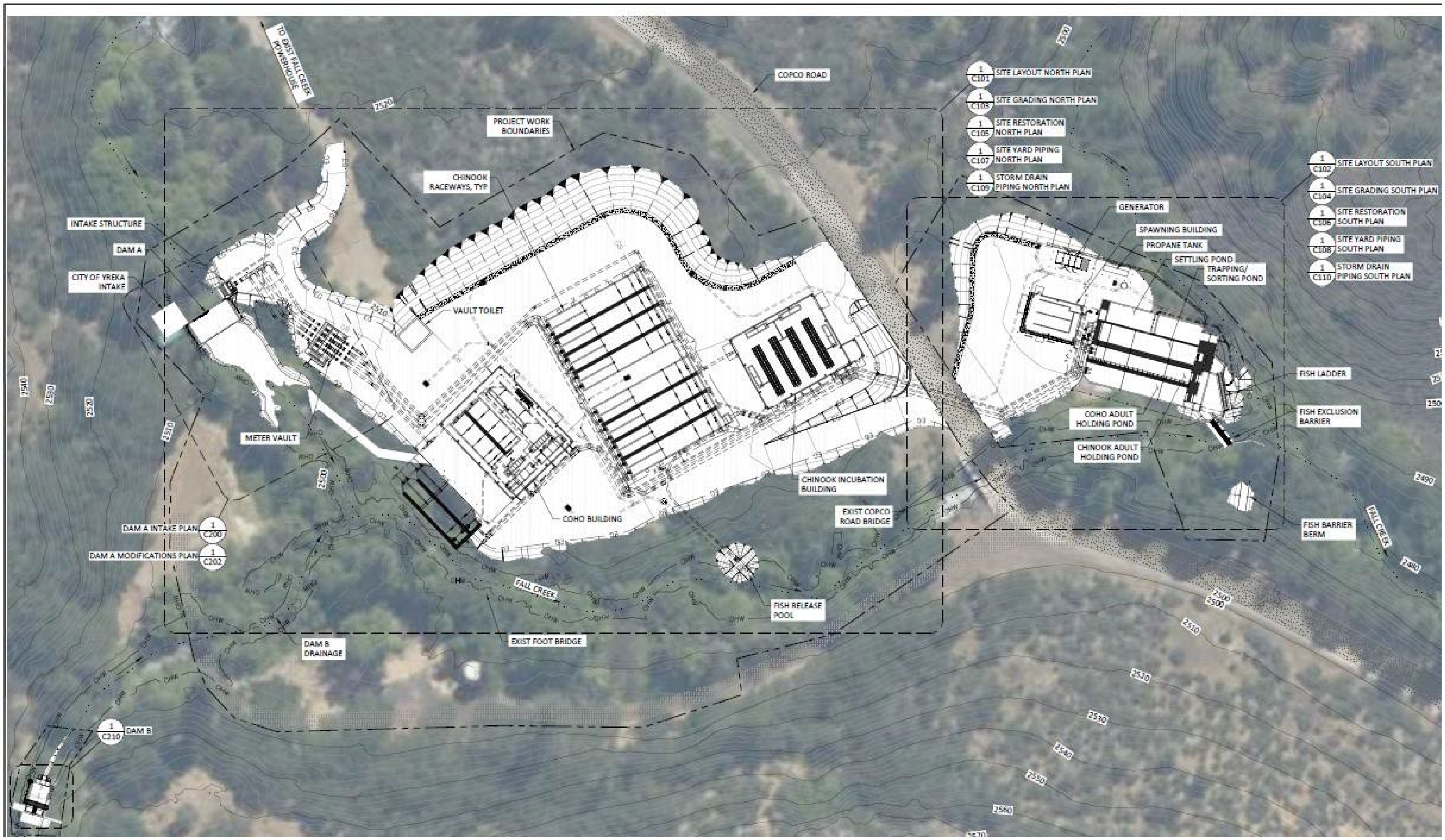

Figure 2. FCH Site Plan (KRRC and McMillen Jacobs Assoc. 2020).

1.3.1.3.1 FCH Water Supply

The hatchery will utilize 10 cfs of primarily spring-water from Fall Creek. The temperature of the water ranges from approximately 43°F to 54.5 °F, which has been found suitable for the culture of salmonids. A significant portion of Fall Creek water upstream of FCH is from PacifiCorp's Fall Creek Powerhouse water supply, which includes up to a 16.5 cfs diversion from Spring Creek. The Fall Creek water supply, including the Spring Creek diversion, is further described in a Technical Memorandum on Operations and Maintenance activities (McMillen Jacobs Assoc. 2021).

A system of fish exclusion barriers, consisting of concrete velocity aprons on the downstream side of Dam A and Dam B, will be used to prevent fish from accessing water diversion intakes (KRRC and McMillen Jacobs Assoc. 2020). Therefore, the impingement or entrainment of listed species due to water diversion for FCH, or the adjacent City of Yreka water supply diversion, is not possible. The water intake structure is equipped with a debris screen to remove particulate matter and automatic active water supply bar system to prevent clogging (KRRC and McMillen Jacobs Assoc. 2020). The debris screens will have 1-inch clear openings and will be mobilized such that any debris captured on the upstream face is lifted out of the water to a spray wash system, where any material caught on the screen will be dislodged and fall into a debris trough.

1.3.1.3.2 FCH Effluent Discharge

The North Coast Regional Water Quality Control Board (NCRWQCB) establishes conditions for hatchery operations to maintain the beneficial use of the Klamath River as authorized by the Clean Water Act (CWA) for the National Pollutant Discharge Elimination System (NPDES) Permit Program. This permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. The NCRWQCB water quality standards establish limits on effluent discharge including prohibiting direct effluent discharge from the hatchery to the Klamath River with any detectable level of chemical with exception of carbon dioxide. Regularly scheduled cleaning maintains sanitary conditions within the hatchery ponds by removing excess feed, metabolic waste, algae, silt, and other organic materials. This material is diverted into the settling pond (a converted raceway) for treatment prior to being discharged to the waste drain. The pond is being refurbished and parsed into a wet well and two distinct bays such that solids can be dried and removed as necessary over the life of the facility while the waste drain remains in operation. The downstream end of each of the settling pond bays will be equipped with an overflow structure that will divert flow-through water into the fish ladder for mixing with the adult holding pond flows and release to Fall Creek.

1.3.1.4 Expected Size of Program

The Program is expected to produce no more than 75,000 yearling coho salmon each year. This is the same as the current and recent historical production level for the IGH coho salmon program. On average, between 2010 and 2021, the 75,000 juveniles released annually has produced approximately 382 returning fish (adults and jacks) each year (Table 3). This level of adult returns has generally been sufficient to maintain broodstock and supply sufficient excess adults to address future coho salmon management goals in the basin. Approximately 57 female coho salmon are needed each year to achieve the juvenile fish production objective for the Program. The total number of males (jacks and adults combined) needed is based on a 2:1 ratio of male to female broodstock (i.e., 57*2 = 114 males required, and a total of 57+114=171 male and female broodstock). Of these, approximately half, or 86 fish would be natural origin. The permit request allows for more fish (171 NOR plus 221 HOR individuals = 392 fish) to be spawned to allow for variability in fecundity and hatchery success, but broodstock needs should be considerably less than that each year. The use of two males per female is designed to increase effective population size and reduce the impact of variation in fertilization success. Jacks (included as part of the male count) will be incorporated into broodstock as needed to reduce inbreeding and allow gene flow between brood years. However, to the extent possible, jacks would only be incorporated into broodstock at a rate lower than their natural abundance and, ideally, commensurate with their reproductive contribution in the naturally spawning population. The actual number of males used overall and per female would be developed each year in consultation with CDFW and NMFS geneticists. It should be noted that the approximate estimate 171 broodstock number is for fish spawned. The number of adults collected is expected to average 130 males, 156 females and 96 jacks as shown in Table 3. The genetically-based spawning matrix will be used to determine the way adults are spawned each year. HOR and NOR adults that are not spawned are considered surplus to broodstock needs and will primarily be released back to the Klamath River near Fall Creek or to Bogus Creek.

Table 3. Number of coho salmon returns to IGH by sex, age, females spawned and eggs harvested for Brood Year 2010 through Brood Year 2020 (CDFW 2023a).

Brood Year	Males	Females	Jacks	Total Females Spawned	NOR Females Spawned	Number of Eggs	Juveniles Released	Egg to Smolt Survival Rate
2010	193	235	57	80	5	259,490	155,480	60%
2011	248	204	134	57	6	151,241	39,250	26%
2012	98	203	343	64	2	158,651	78,000	49%
2013	552	653	63	80	9	224,071	89,500	40%
2014	39	95	250	62	13	121,421	27,658	23%*
2015	13	21	38	13	4	22,240	17,231	77%
2016	30	26	30	23	3	43,705	34,376	79%
2017	33	60	29	39	8	74,966	57,077	76%
2018	65	74	61	58	13	103,661	73,842	71%
2019	46	64	6	49	3	83,756	59,254	71%
2020	114	79	49	76	7	144,864		
Average	130	156	96	55	7	126,188	63,167	57%

* The BY 2014 egg to smolt survival rate was impacted by a failure of the moist air incubator in the hatchery.

1.3.1.5 Broodstock Collection

The goal of the broodstock collection protocol is to collect enough broodstock to maintain the production goals for the Program while also protecting the genetic diversity and genetic continuity with the naturally spawning Upper Klamath coho salmon population. The intent is also for the natural environment to drive the adaptation of both the natural and hatchery components of the Upper Klamath Population Unit. Adult coho salmon females, adult males, and precocious males (jacks) will be collected for broodstock. Only Klamath River origin coho salmon will be used for broodstock in the FCH Program. Trinity River Hatchery fish, Cole M. Rivers Hatchery, and other marked hatchery origin coho salmon will not be used as broodstock.

Broodstock will be collected at the FCH fish ladder, Bogus Creek weir, IGH auxiliary fish ladder, and using seines/dip-nets in Fall Creek. The FCH pNOB goal is to have 50% of the broodstock consist of NOR fish (i.e., pNOB of 0.5). To achieve the goal will require approximately 86 NOR adults and jacks for a release of 75,000 fish. The NOR coho salmon will be sourced from FCH, Bogus Creek, the auxiliary fish ladder at IGH, and possibly from seining/dip-netting in Fall Creek. Broodstock will be collected proportionately throughout the entire Upper Klamath Population coho salmon run to the extent practicable. In Bogus Creek, no more than 50% of the adult NOR coho salmon may be removed at the weir and used as broodstock. To maintain natural production of coho salmon in this stream, the Program may replace the removed NOR fish with HOR fish. When adult run-size allows, Bogus Creek will be managed to maintain pHOS at <0.5. Until there is a reestablished natural- spawning population in the upper river above the current dam sites, there will not be a PNI target for that area.

Adults and jacks used as broodstock will be uniquely identified (using PIT tags, Floy tags, or other means) and segregated in holding tubes so that they may be identified when spawned. The unique marker will be cross referenced with the tissue sample number to allow hatchery personnel to spawn pairs according to the genetic analysis results used in establishing mating protocols (i.e., the "spawning matrix").

Fish using the FCH ladder will directly enter the adult holding ponds and therefore will not experience trucking. Fish collected from Bogus Creek, the IGH auxiliary ladder, or other locations on Fall Creek, will be loaded into trucks and transported to the hatchery. The trucks will be equipped with oxygen tanks to maintain oxygen levels at saturation. Water temperatures in the tank will be monitored and maintained at levels that ensure high fish survival (<55.4°F, or ambient river temperature at the time of collection).

The Bogus Creek weir/trap will be checked a minimum of twice a day (7-days per week) for the presence of coho salmon adults. Caught fish will be removed from the trap and transported to the adult holding facilities at FCH if needed for broodstock. If not needed for broodstock, captured fish will be released upstream of the weir to continue their migration into Bogus Creek. The IGH auxiliary fish ladder will be operated seven days a week as needed and appropriate, if it is found that coho salmon continue to enter this structure after IGD is removed. Fish collection, handling and transport methods will be like Bogus Creek activities. Hatchery personnel will relocate salmon from Bogus Creek or other capture locations using a flatbed truck or trailer outfitted with a custom 400-gallon tank. Water re-circulates by pump, and spray bars at the top of the tank maintain aeration. The trucks will be equipped with oxygen tanks to maintain oxygen levels at saturation. Water temperatures in the tank will be monitored and maintained at levels that ensure high fish survival. The travel time from the collection locations to the FCH is expected to be less than 30 minutes. Upon arrival at FCH the fish are to be held in the adult holding ponds and acclimated for any differences in water temperature between capture, transfer, and holding locations.

1.3.1.6 Spawning Procedures

1.3.1.6.1 Selection Method

Spawner selection will use the results of genetic relatedness analysis using DNA extracted from tissue samples from all coho salmon used as broodstock. The result of this analysis will be used to develop a spawning matrix (sometimes referred to as a breeding matrix, mating matrix, or relatedness matrix) designed by geneticists to minimize inbreeding effects and to allow for gene flow between brood years. The breeding protocol will specify which male and female crosses will result in the least likelihood of inbreeding. The breeding matrix prioritizes mating among unrelated individuals and therefore will allow for spawning to occur regardless of fish origin (HOR or NOR) or age. Fish will only be spawned together if their resulting genetic relatedness coefficient (Rxy; Michod and Anderson 1979) is 0.10 or less. Highly related fish will not be mated even if FCH will not achieve the juvenile release goal of 75,000 fish. Thus, juvenile production each year could be less than the release goal. Jacks will make up 5% to 10% of the broodstock based on availability and results of the spawning matrix. Multiple males may be used to fertilize eggs per female, including jacks, which will help increase effective population size and gene flow among brood years.

1.3.1.6.2 Fertilization

HOR and NOR females will be air-spawned. NORs will also be cut open to make sure that all eggs are removed from each female. The coho salmon eggs are fertilized using the wet spawning method. Eggs from each female are placed into a one-gallon zip-lock type bag. Approximately half of the eggs are poured into one pan, and the second half of eggs poured into a second pan. Milt is stripped from one male into one of the egg pans prepared with salt solution (one ounce of salt per gallon of water) and milt extender (88.4% water, 2.5% glycine, 3.6% tris buffer, 5.5% sodium chloride). A second male is then stripped into the second pan, also prepared with the salt solution and milt extender. Immediately after adding milt to the pans, technicians gently stir the eggs and milt together by hand. In this way two males are used to fertilize each female's eggs. Disease protocols call for eggs to be treated with a 100-ppm iodine solution for a minimum of 15 minutes, allowed to water harden and then transported to the hatchery building. Each family consisting of 1/2 the eggs from one female are incubated separately. Hatchery staff entering incubation facilities are required to sterilize their gear and equipment prior to handling eggs. Equipment used for incubation is segregated for hatchery building use only.

Fertilization and incubation protocols will be evaluated each year and altered in accordance with genetic goals identified by CDFW and NMFS staff.

1.3.1.6.3 Incubation and Rearing

Coho salmon eggs are to be incubated in their own building. Oxygen levels of the water will be maintained near saturation and the building is darkened to protect the eggs from light exposure. Eggs are incubated in an eight-tray (half-stacked) gravity flow system. A total of 6 stacks (40 trays, 50 to 55 ounces of eggs per tray) are required to incubate 120,000 eggs. Water flow through the trays is set at 3 gallons per minute.

Hatchery technicians will conduct monthly weight counts to evaluate growth and estimate necessary feed volumes. Coho salmon at FCH will be fed CDFW approved feed, which is currently Bio-Oregon Bio-Vita, and Skretting slow sinking salmon diet. Fish culturists increase food pellet size with fish size to account for their ability to ingest larger food particles, as they get larger.

The FCH will maintain a clean rearing facility as a continuous part of standard hatchery operations. Hatchery workers will remove dead fish from raceway ponds each day. They also will conduct fish health maintenance and sanitation procedures, including biweekly pond cleaning, to remove accumulated solids and fish feces. FCH personnel will monitor fish health daily by counting the number of dead fish recovered in each raceway and inspecting live fish for behavioral and external signs of disease.

Use of therapeutants is not anticipated due to the high quality of the intake water, low incubation and rearing densities, and the short design life of the facility. However, if fish treatment therapeutants are used, hatchery staff can isolate and direct water flow to the waste drain system. Fish pathologists will test fingerling coho salmon for viral, bacterial, and parasitic agents at FCH as needed. Disease testing requires a sacrifice of up to 60 coho salmon fingerlings annually prior to release. If a severe disease outbreak occurs, the hatchery manager will notify the CDFW Fish Pathology Lab in Rancho Cordova to identify the pathogenic agent and recommend a prescribed treatment. Testing for severe disease outbreaks requires about 5 to 10 moribund fish, while certifying the health of emigrating smolts requires 20 fish and certifying the hatchery for specific pathogens requires 60 coho salmon fingerlings or smolts.

1.3.1.7 Juvenile Release Procedures

Coho salmon size at release will be targeted at 10 +/- 2 fish per pound (fpp), a size reflective of a naturally produced smolts. FCH personnel will physically examine coho salmon weekly for physical (e.g., silvery color, dark fin tips) and behavioral characteristics (e.g., jumping at screens) of smoltification. These signs of smoltification will be used to determine when screens should be removed, and fish allowed to volitionally emigrate from the hatchery.

Releasing fish directly from the hatchery is assumed to maximize adult homing fidelity to the hatchery as returning adults. In some years, disease or passage conditions may be such that expected survival of fish released from FCH to Fall Creek may be unacceptably low compared to a different release timing or location. Any deviations to the coho salmon release size or release location will be approved by NMFS and CDFW, in coordination with the hatchery technical team (Section 1.3.1.11), prior to implementation. All coho salmon releases will be externally marked for identification with a left maxillary-clip for identification as FCH fish. Additional marking and tagging strategies may be employed at FCH as approved by CDFW and NMFS in coordination with the hatchery technical team.

Except in an emergency, fish will not be released until CDFW pathologists or veterinarians complete the pre- release health assessment. CDFW will certify the health and disease status of coho salmon prior to release. Data are collected on length, weight, KtL (condition factor), fins, skin, eyes, gill, pseudo branch, thymus, liver, spleen, kidney, gut, hematocrit, leucocrit, plasma protein, fat and smolt index. The fish are examined for bacteria, whirling disease, viruses, and external parasites.

1.3.1.8 Disposition of Excess Broodstock and Hatchery Origin Coho Salmon

The actual number of spawners and individuals to be spawned is ultimately determined by the spawning matrix, and more individuals may be collected as broodstock than are spawned. The number of surplus HOR or NOR adults released at each broodstock collection site will be determined each year by the hatchery technical team in consultation with NMFS and CDFW. Excess HOR broodstock will be released back to the Klamath River at Fall Creek or in Bogus

Creek. NOR adult coho salmon not selected for mating, or without appropriately unrelated pairs according to the spawning matrix, will in general be returned to or near the location where they were collected. NOR collected in Bogus Creek or the nearby auxiliary ladder will be released to Bogus Creek. NORs either captured in Fall Creek or FCH will be released back to Fall Creek proper or at its confluence with the Klamath River. Surplus adult coho salmon broodstock will be given an opercular punch and/or PIT Tag prior to release.

The HGMP provides a mechanism to maintain release number of fish within 10% of the hatchery's annual production goal of 75,000 yearlings by tracking in-hatchery survival rates by life stage. It is unlikely that producing more fish than the approved program level will occur. However, if excess fish become available, they may be released as described for all yearlings in the HGMP, incorporated in potential supplementation programs conducted by others, or may be used for research and educational purpose as deemed appropriate in accordance with NMFS and CDFW.

1.3.1.9 Program Monitoring and Evaluation (M&E)

The Program M&E will be implemented throughout the duration of the HGMP. The coho salmon M&E program is focused on ensuring that in-hatchery performance indicators and standards are achieved, and that those hatchery operations required to produce healthy, disease-free fish that will survive to adulthood and return at high rates. In-hatchery and natural population monitoring and evaluation activities will be coordinated by the hatchery technical team (see Section 1.3.1.11). In addition, contingent on funding availability, the Program will monitor juvenile production in Bogus Creek via an outmigrant trap (see section 1.3.1.9.1), and adult escapement to Bogus Creek and other location in the Upper Klamath Population Unit, as described in the coho salmon Spawning Surveys section (Section 1.3.1.9.3) below. Program M&E methods are summarized from descriptions in the HGMP (CDFW 2023a) and in the application for Permit 15755-2M (CDFW 2023b).

Data gathered from Program M&E activities will provide information for future adaptive management changes to hatchery management. Changes to hatchery management may include changes to broodstock size and composition, changes to in-hatchery rearing techniques, and changes to smolt release techniques. Utilizing adaptive management will provide for flexibility as more information is gathered and HOR and NOR coho salmon populations change over time. Details on the monitoring methods for each performance indicator, performance metric, and associated M&E method are summarized in Table 4. Any changes to hatchery management will be made in coordination with the hatchery technical team (Section 1.3.1.11), and the aquatic resources group, as discussed in biological opinion on dam removal (NMFS 2021a).

Table 4. FCH coho salmon Program performance indicators, metrics, and M&E methods.

Performance Indicator	Performance Metric	Monitoring and Evaluation Method
Broodstock Composition, Timing, Age Structure	Like wild fish	Culture and monitoring staff will collect data in Bogus Creek (contingent on funding availability), hatchery and in other streams to determine that the hatchery and wild populations are similar regarding these attributes. Information will be summarized in annual reports.
Adult Holding and Spawning Survival Rate	≥ 95%	Culture staff will enumerate-data to be reported in annual operating reports.
Proportion Natural Origin Broodstock (pNOB)	~10% to 50%	Culture staff will quantify pNOB for each brood year and report it in annual operating reports.
Eyed Egg-to-Fry Survival Rate	> 90%	Culture staff will enumerate-data to be reported in annual operating reports.
Fry-to-Parr Survival Rate	> 90%	Culture staff will enumerate-data to be reported in annual operating reports.
Egg-to-Smolt Survival Rate	>75%	Culture staff to enumerate loss by life stage for each brood year. Data to be reported in annual operating reports.
Fish Size at Time of Release	10 fpp	Size at release information will be collected throughout the rearing period to ensure that fish size at release is 10 +/- 2 fpp. Fish Length frequency data will be collected as well from each raceway.

Performance Indicator	Performance Metric	Monitoring and Evaluation Method
Smolt-to-Adult survival rate (SAR).	≥ 1%	SAR will be measured from point of release to return to the hatchery. All yearling coho salmon released will be marked with a left-maxillary clip to distinguish them from coho salmon released from the Trinity River Hatchery and other hatcheries. However, additional marking and tagging strategies may be employed at FCH as approved by CDFW and NMFS in coordination with the hatchery technical team.
Disease Control and Prevention: Maximize survival at all life stages using disease control and disease prevention techniques. Prevent introduction, spread or amplification of fish pathogens.	Necropsies of fish to assess health, nutritional status, and culture conditions. Performance indicators will be based on test performed.	Pathology staff will conduct health inspections of cultured fish as needed and during any disease or parasite outbreak. Pathologist will propose corrective actions as needed and culture staff will implement the proposed recommendations.
Hatchery effluent discharge monitoring (Clean Water Act)	Various based on regulations	All hatchery facilities will operate under the "Upland Fin-Fish Hatching and Rearing" NPDES general permit which conducts effluent monitoring and reporting and operates within the limitations established in its permit.

1.3.1.9.1 Bogus Creek Outmigrant Trap

A juvenile downstream migrant trap will be operated in Bogus Creek (or just downstream in the mainstem) to collect demographic data on juvenile run-timing and abundance, size, smoltification levels and smolt-to-adult survival rates. Juvenile coho salmon will be captured, handled and marked at the weir located on Bogus Creek. Captured coho salmon may be anesthetized with CO2 (Alka-Seltzer Gold), measured, weighed, PIT tagged and then released once they have recovered. Scale samples may be collected for age determination. Only juvenile coho salmon 65 mm or larger will be tagged. Tissue and otolith samples may be collected from incidental juvenile mortalities to support ongoing genetic and microchemistry research. Passive array antennas will monitor movement. Recaptured PIT-tagged coho salmon will be measured and weighed again for condition factor analysis.

1.3.1.9.2 Bogus Creek Fish Counting Facility

CDFW will continue to operate the Bogus Creek fish counting facility located in Bogus Creek adjacent to IGH. The purpose is to monitor adult Chinook and coho salmon migration timing, composition and run size during the fall and early winter (September through early January). The video equipment will be set to run-in time lapse mode and will be operated 24 hours a day, 7 days a week, during the adult migration season. Population estimates will be derived from a direct count of all fish species recorded during the migration season.

Based on available data, Bogus Creek has one of the largest natural-origin coho salmon spawning run in the Upper Klamath Population Unit (MKWC 2022). Currently, Bogus Creek is equipped with a weir/trap that allows for video counts of returning fish passing upstream and for the possible collection of adults for broodstock. The weir also provides the opportunity to control the proportion of HOR adults spawning naturally (pHOS). The M&E plan calls for continued operation of the weir by CDFW staff during the coho salmon return migration period (September through early January). As NOR run size increases the weir will be used to collect both NOR and HOR adults for broodstock, and remove HOR adults with the goal of maintaining pHOS at 0.50 or less, when possible. The achievement of these objectives is expected to improve coho salmon fitness and encourage local adaptation overtime in Bogus Creek.

The adult weir at Bogus Creek is an Alaskan style weir. It is designed to sample 100% of the upstream migrating salmonids but allow fish to move freely through the structure in front of the viewing window and video camera. The video equipment is set to run-in time-lapse mode and will be operated 24 hours a day, 7 days a week, during the adult coho salmon migration season (typically late October to late January). As each fish swims through the counting flume a video image will be recorded at 8 frames per second on digital recording media. Live fish will be handled, tagged, and transported if needed for broodstock at FCH. Incidental take associated with the transport of adult fish from the Bogus Creek weir to the hatchery facility is anticipated to be less than 1%. The number, origin (hatchery or natural), sex, and length of fish that die during transportation operations will be recorded and included in the annual report. If the incidental mortality rate exceeds 1% of transported fish, additional measures will be implemented to improve survival during transport. Conservation measures may include increased aeration, fewer fish per trip, and/or other preventative measures that will decrease the likelihood of mortality during transport. Hatchery staff will implement these measures on an as needed basis. The facilities will be inspected daily. During each inspection the weir panels will be cleaned of debris, the video equipment will be inspected and cleaned, and all wash-back (post spawn) carcasses will be examined and sampled to collect biological data. Population estimates will be a direct count of all fish, by species, recorded during the migration season. All wash back carcasses that drift downstream and settle on the weir panels during the season will be sampled.

1.3.1.9.3 Coho Salmon Spawning Surveys

Coho salmon spawning surveys will be conducted annually in Bogus Creek, and as funding is available, in other Upper Klamath River Population Unit locations, including the mainstem Klamath River and the following creeks: Dry, Seiad, Grider, Walker, O'Neil, Jim, Mack, Tom Martin, Kinsman, Everill, Buckhorn, Collins, Horse, Kohl, Dona, McKinney, Dogget, Grouse, Beaver, Willow, Bogus, Little Bogus, Cottonwood, Ash, Humbug, Dutch, and Lumgrey. Spawning ground and carcass surveys are assumed to not result in mortality of adult fish. However, these activities will likely result in harassment of live fish on the spawning grounds. The combined carcass and redd counts will be used to estimate adult NOR and HOR escapement levels and spawn timing. Tissue samples will be collected from all post-spawn coho salmon carcasses.

1.3.1.10 Amount of Direct Take Included in the Permit Application

The HGMP (CDFW 2023a) and associated application for Permit 15755-2M (CDFW 2023b), includes various activities, as described in Section 1.3.1.1 through Section 1.3.1.9 above, that may cause direct (non-incidental), take of ESA listed SONCC coho salmon. The maximum amount of annual take included for each activity is summarized in Table 5 through Table 9.

Table 5. Annual take of SONCC coho salmon associated with egg culling, juvenile fish health monitoring, research and educational activities at FCH.

Origin/ Lifestage	Sex	Authorized Take	Authorized Indirect Mortality	Take Action	Observe/Collect Method	Procedures
Hatchery/ Juvenile	Male and Female	60	0	Intentional (Directed) Mortality	Hand and/or Dip Net	60 juvenile HOR coho salmon will be euthanized annually for fish health and disease monitoring
Hatchery/ Egg	Male and Female	100000	0	Intentional (Directed) Mortality	N/A	
Hatchery/ Juvenile	Male and Female	2000	0	Collect, Sample, and Transport Live Animal	Hand and/or Dip Net	

Table 6. Annual take of SONCC coho salmon associated with collection of broodstock and excess broodstock collected at the main fish ladder below FCH, from Fall Creek, or from the auxiliary fish ladder at IGH.

Origin	Lifestage	Sex	Authorized Take	Authorized Indirect Mortality	Take Action	Procedures
Natural	Adult	Female	57	0	Intentional (Directed) Mortality	Tag, Floy; Tag, PIT; Tissue Sample Fin or Opercle
Natural	Adult	Male	114	0	Intentional (Directed) Mortality	Tag, Floy; Tag, PIT; Tissue Sample Fin or Opercle
Natural	Jack	Male	24	0	Intentional (Directed) Mortality	Tag, Floy; Tag, PIT; Tissue Sample Fin or Opercle
Hatchery	Adult	Female	73	0	Intentional (Directed) Mortality	Tag, Floy; Tag, PIT; Tissue Sample Fin or Opercle
Hatchery	Adult	Male	148	0	Intentional (Directed) Mortality	Tag, Floy; Tag, PIT; Tissue Sample Fin or Opercle
Hatchery	Jack	Male	49	0	Intentional (Directed) Mortality	Tag, Floy; Tag, PIT; Tissue Sample Fin or Opercle
Natural	Jack	Male	425	4	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Tag, Floy; Tag, PIT; Tissue Sample Fin or Opercle
Natural	Adult	Male and Female	250	3	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Tag, Floy; Tag, PIT; Tissue Sample Fin or Opercle
Hatchery	Jack	Male	425	4	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Tag, Floy; Tag, PIT; Tissue Sample Fin or Opercle
Hatchery	Adult	Male and Female	1500	125	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Tag, Floy; Tag, PIT; Tissue Sample Fin or Opercle

Table 7. Annual take of SONCC coho salmon associated with broodstock collection at the Bogus Creek fish counting facility weir.

Origin	Lifestage	Sex	Authorized Take	Authorized Indirect Mortality	Take Action	Procedures
Natural	Adult	Female	29	1	Collect, Sample, and Transport Live Animal	
Natural	Adult	Male	50	1	Collect, Sample, and Transport Live Animal	
Natural	Jack	Male	10	1	Collect, Sample, and Transport Live Animal	
Hatchery	Adult	Female	29	1	Collect, Sample, and Transport Live Animal	
Hatchery	Adult	Male	50	1	Collect, Sample, and Transport Live Animal	
Hatchery	Jack	Male	10	1	Collect, Sample, and Transport Live Animal	
Natural	Adult	Male and Female	250	3	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Tag, Floy; Tag, PIT; Tissue Sample Fin or Opercle
Natural	Jack	Male	180	2	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Tag, Floy; Tag, PIT; Tissue Sample Fin or Opercle
Hatchery	Adult	Male and Female	250	3	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Tag, Floy; Tag, PIT; Tissue Sample Fin or Opercle
Hatchery	Jack	Male	180	2	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Tag, Floy; Tag, PIT; Tissue Sample Fin or Opercle

Table 8. Annual take of SONCC coho salmon associated with juvenile monitoring at the Bogus Creek outmigrant trap.

Origin	Lifestage	Sex	Authorized Take	Authorized Indirect Mortality	Take Action	Procedures
Natural	Fry	Male and Female	50,000	50	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Tag, PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale
Natural	Juvenile	Male and Female	250	3	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Tag, PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale
Natural	Smolt	Male and Female	250	3	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Tag, PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale
Hatchery	Fry	Male and Female	25	1	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Tag, PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale
Hatchery	Juvenile	Male and Female	25	1	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Tag, PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale
Hatchery	Smolt	Male and Female	25	1	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Tag, PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale

Table 9. Annual take of SONCC coho salmon associated with carcass and spawner surveys.

Origin	Lifestage	Sex	Authorized Take	Authorized Indirect Mortality	Take Action
Natural	Spawned Adult/ Carcass	Male and Female	2419	0	Observe/Sample Tissue Dead Animal
Listed Hatchery Intact Adipose	Spawned Adult/ Carcass	Male and Female	2419	0	Observe/Sample Tissue Dead Animal
Natural	Jack	Male	531	0	Observe/Sample Tissue Dead Animal
Listed Hatchery Intact Adipose	Jack	Male	531	0	Observe/Sample Tissue Dead Animal
Listed Hatchery Intact Adipose	Adult	Male and Female	41	0	Observe/Harass
Listed Hatchery Intact Adipose	Jack	Male	9	0	Observe/Harass
Natural	Adult	Male and Female	41	0	Observe/Harass
Natural	Jack	Male	9	0	Observe/Harass

1.3.1.11 Hatchery Technical Team

To evaluate the ongoing status of the HGMP, and make adaptive management decisions related to FCH Program activities, CDFW will convene a hatchery technical team. The hatchery technical team will consist of CDFW, NMFS, and other Klamath basin fishery managers including Klamath basin Tribes, and include hatchery staff, biologist(s), geneticist(s), and pathologist(s). The hatchery technical team will ensure that the HGMP is effectively implemented and that culture practices are consistent with best management practices. The hatchery technical team will be convened to make recommendations to CDFW and NMFS on various hatchery activities, including: the release location and timing of surplus HOR broodstock, any deviation in juvenile coho salmon release location or timing from the protocols described in the HGMP, and any variation in marking or tagging strategies for HOR fish to be released from FCH (CDFW 2023a).

1.3.1.12 Coordination with the City of Yreka

The infrastructure that is necessary for water withdrawals from Fall Creek into FCH also supports the City of Yreka diversion from Fall Creek that supplies drinking water to the City of Yreka. The City of Yreka will assist in the operation and maintenance of these structures. CDFW FCH managers have been in coordination with the City of Yreka to ensure that all operations and maintenance associated with the use of the City of Yreka water supply will not result in adverse impacts to the FCH water supply. This coordination is further described in the HGMP (CDFW 2023a). No take of ESA listed coho salmon is anticipated because of the operation of the City of Yreka water supply.

1.3.2 Expected duration of the Permit

As discussed in the Background Section (Section 1.1) above, there is reasonable certainty for dam removal to occur beginning in 2023, with volitional fish passage past the previous IGD site occurring in 2024. The dam removal entity is the KRRC, a private, independent nonprofit 501(c)(3) organization that was formed by signatories of the Klamath Hydroelectric Settlement Agreement (KHSA), as amended in April 2016 (KHSA 2016). The KHSA, which created the KRRC as the dam removal entity, includes language stipulating that PacifiCorp will fund 100 percent of hatchery operations and maintenance necessary to fulfill annual mitigation goals developed by CDFW in consultation with NMFS (KHSA 2016). PacifiCorp's funding will be provided for hatchery operations to meet mitigation requirements and will continue for eight years following the decommissioning of IGD. Proposed decommissioning and removal activities include pre-drawdown year activities from March to December 2023, and drawdown year activities, including removal of IGD, that are planned to occur from January 2024 to December 2024 (FERC 2022b). Therefore, the duration of the permit will be from time of issuance to December 31, 2031. Any hatchery operations beyond eight years, which are discussed in the Consequences of Other Activities Caused by the Proposed Action (Section 1.3.3 below), would require revised hatchery management goals and strategies, and a permit extension or development of a new HGMP and an associated ESA permit.

1.3.3 Consequences of Other Activities Caused by the Proposed Action

We considered, under the ESA, whether or not the proposed action would cause any other activities and determined that it would not. As described in the Background Section (Section 1.1) above, the mainstem Klamath River dams of the Klamath Hydroelectric Project are scheduled to be removed, and NMFS completed a biological opinion on that action, which included construction of FCH, in 2021 (NMFS 2021a). Although not part of the proposed action, that biological opinion did consider the possibility of hatchery operations continuing beyond eight years. In that biological opinion we stated that, "PacifiCorp will fund 100 percent of hatchery operations and maintenance necessary to fulfill annual mitigation goals developed by CDFW in consultation with NMFS. PacifiCorp's funding will be provided for hatchery operations to meet mitigation requirements and will continue for eight years following the decommissioning of IGD. Therefore, hatchery operations at Fall Creek as part of the proposed action are temporary. Beyond eight years after dam removal, any hatchery production at this facility would be based on the potential for the investment of resources by state regulatory agencies and Tribal partners, and other factors related to natural production of anadromous fish, which are not necessarily caused by the proposed action." Therefore, the potential for hatchery production at this facility beyond eight years after dam removal is discussed further in the cumulative effect section, Continued Hatchery Operations Beyond Eight Years (Section 2.6.3).

2 Endangered Species Act: Biological Opinion and Incidental Take Statement

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species or to adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS, and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

NMFS determined the proposed action is not likely to adversely affect the following species, or their critical habitat: the southern Distinct Population Segment (DPS) of North American green sturgeon (*Acipenser medirostris*), Southern DPS eulachon (*Thaleichthys pacificus*), or Southern Resident DPS Killer Whale (*Orcinus orca*)(Southern Residents), or their critical habitats. Our determinations are documented in the "Not Likely to Adversely Affect" Determinations section (Section 2.11).

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion also relies on the regulatory definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designations of critical habitat for the SONCC coho salmon ESU, Southern Residents, Southern DPS eulachon, and Southern DPS green sturgeon use the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414; February 11, 2016) that revised the critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The ESA Section 7 implementing regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision does not change the scope of our analysis, and in this opinion, we use the terms "effects" and "consequences" interchangeably.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Evaluate the range wide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their critical habitat using an exposure–response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species; or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.1.1 Overview of NMFS' Assessment Framework

NMFS uses a series of sequential analyses to assess the effects of federal actions on endangered and threatened species and designated critical habitat. The first analysis identifies those physical, chemical, or biotic aspects of the proposed action that are likely to have an individual or interactive effect on the environment (NMFS uses the term "potential stressors" for these aspects of an action). As part of this step, NMFS identifies the spatial extent of any potential stressors and recognizes that the spatial extent of those stressors may change with time (the spatial extent of these stressors is the "action area" for a consultation) within the action area.

The second step of the analyses starts by determining whether a listed species is likely to occur in the same space and at the same time as these potential stressors. If NMFS concludes that such co-occurrence is likely, NMFS then estimates the nature of that co-occurrence (these represent the exposure analyses). In this step of the analyses, NMFS identifies the number and age (or life stage) of the individuals that are likely to be exposed to an action's effects and the populations or subpopulations those individuals represent.

Once NMFS identifies which listed species and its life stage(s) are likely to be exposed to potential stressors associated with an action and the nature of that exposure, NMFS determines whether and how those listed species and life stage(s) are likely to respond given their exposure (these represent the *response analyses*). The final steps of NMFS' analyses are establishing the risks those responses pose to listed species and their life stages.

2.1.1.1 Risk Analyses for Endangered and Threatened Species

NMFS' jeopardy determination must be based on an action's effects on the continued existence of the listed species, which, depending on how a species is listed under the ESA, could be focused on true biological species, subspecies, or distinct population segments of vertebrate species. Because the continued existence of listed species depends on the fate of the populations that comprise them, the viability (that is, the probability of extinction or probability of persistence) of listed species depends on the viability of the populations that comprise the species. Similarly, the continued existence of populations is determined by the fate of the individuals that comprise them; populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so).

NMFS' risk analyses reflect these relationships between listed species and the populations that comprise them, and the individuals that comprise those populations. NMFS identifies the probable risks that actions pose to listed individuals that are likely to be exposed to an action's effects. NMFS then integrates those individuals' risks to identify consequences to the populations those individuals represent. NMFS' analyses conclude by determining the consequences of those population-level risks to the species those populations comprise.

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

When individuals of a listed species are expected to have reduced future reproductive success or reductions in the rates at which they grow, mature, or become reproductively active, NMFS would expect those reductions, if many individuals are affected, to also reduce the abundance, reproduction rates, and growth rates (or increase variance in one or more of these rates) of the populations those individuals represent (see Stearns 1992).

NMFS also considers species distribution when evaluating extinction risk. It is important to take into account spatial structure for two main reasons: 1) because there is a time lag between changes in spatial structure and species-level effects, overall extinction risk at the 100-year time scale may be affected in ways not readily apparent from short-term observations of abundance and productivity, and 2) population structure affects evolutionary processes and may, therefore, alter a population's ability to respond to environmental change (McElhany et al. 2000).

Reductions in one or more of the above described variables (or one of the variables NMFS derive from them) is a necessary condition for increasing a population's extinction risk, which is itself a necessary condition for increasing a species' extinction risk.

NMFS equates the risk of extinction of the species with the "likelihood of both the survival and recovery of a listed species in the wild" for purposes of conducting jeopardy analyses under section 7(a)(2) of the ESA because survival and recovery are conditions on a continuum with no bright dividing lines. Similar to a species with a low likelihood of both survival and recovery, a species with a high risk of extinction does not equate to a species that lacks the potential to become viable. Instead, a high risk of extinction indicates that the species faces significant risks from internal and external processes and threats that can drive a species to extinction. Therefore, NMFS' jeopardy assessment focuses on whether a proposed action appreciably increases extinction risk, which is a surrogate for appreciable reduction in the likelihood of both the survival and recovery of a listed species in the wild.

On the other hand, when listed species exposed to an action's effects are not expected to experience adverse effects, NMFS would not expect the action to have adverse consequences on the extinction risk of the populations those individuals represent or the species those populations comprise (Mills and Beatty 1979; Stearns 1992; Anderson 2000).

2.1.1.2 Effects Analysis for SONCC coho salmon

For Pacific salmon, steelhead, and certain other species, we commonly use four "viable salmonid population" (VSP) parameters (McElhany et al. 2000) to assess the viability of the populations that, together, constitute the species. When these parameters are collectively at an appropriate level, they maintain a population's capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment. For the SONCC coho salmon ESU, the effects analysis is based on a bottom-up hierarchical organization of individual fish at the life stage scale, population, diversity stratum, and ESU (Figure 3). The guiding principle behind this effects analysis is that the viability of a species (e.g., ESU) is dependent on the viability of the diversity strata that compose that species; the viability of a diversity stratum is dependent on the viability of most independent populations that compose that stratum and the spatial distribution of those viable populations; and the viability of the population is dependent on the fitness and survival of individuals at the life stage scale.

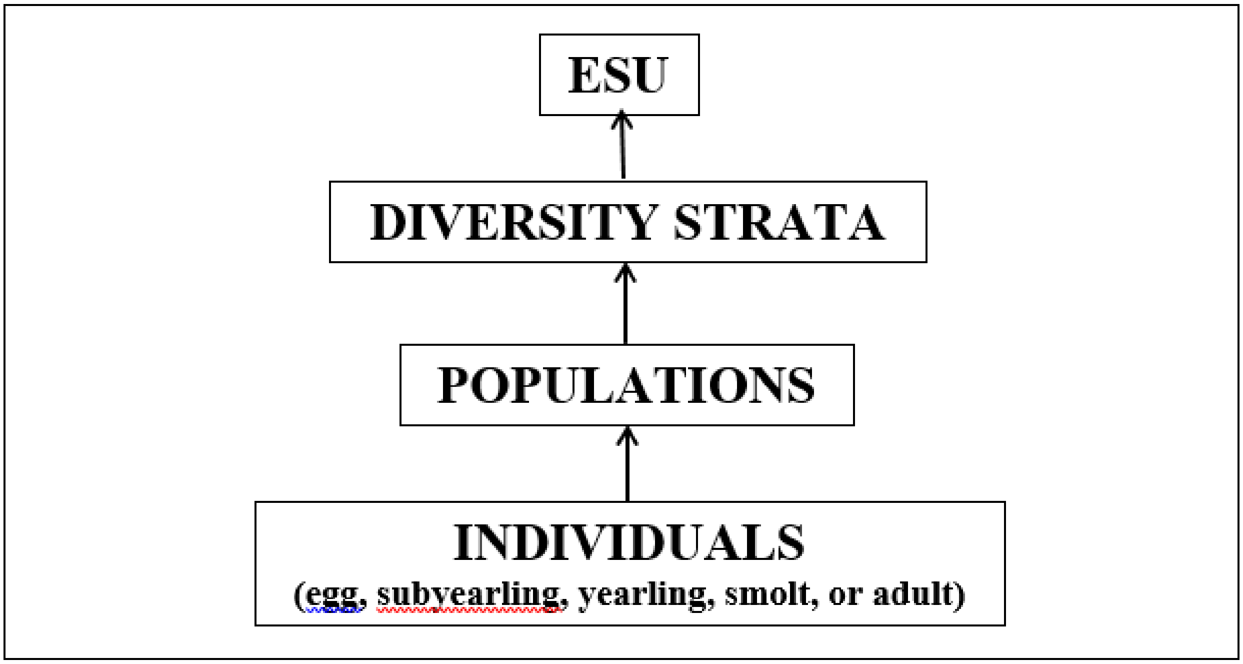

Figure 3. Conceptual model of the hierarchical structure that is used to organize the jeopardy risk assessment for the SONCC coho salmon ESU.

2.1.1.3 Viable Salmonid Populations Framework for SONCC coho salmon

In order to assess the status, trend, and recovery of any species, a guiding framework that includes the most appropriate biological and demographic parameters is required. For Pacific salmon, McElhany et al. (2000) defined a VSP as an independent population that has a negligible probability of extinction over a 100-year time frame. The VSP concept provides guidance for estimating the viability of populations and larger-scale groupings of Pacific salmonids such as an ESU or DPS. Four VSP parameters form the key to evaluating population and ESU/DPS viability: (1) abundance; (2) productivity (i.e., population growth rate); (3) population spatial structure; and (4) diversity (McElhany et al. 2000).

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)]. While the Allee effect (Allee et al. 1949) is more commonly used in general biological literature, depensation is used here because this term is most often used in fisheries literature (Liermann and Hilborn 2001). Depensation results in negative feedback that accelerates a decline toward extinction (Williams et al. 2008).

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 can lead to declining population abundance. Understanding the spatial structure of a population is important because the spatial 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).

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 smelting, 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 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.

Because some of the VSP parameters are related or overlap, the evaluation is at times unavoidably repetitive. Viable ESUs are defined by some combination of multiple populations, at least some of which exceed "viable" thresholds, and that have appropriate geographic distribution, resiliency from catastrophic events, and diversity of life histories and other genetic expression (McElhany et al. 2000).

NMFS evaluates the current status of the species to diagnose how near, or far, the species is from a viable state because it is an important metric indicative of a self-sustaining species in the wild. However, NMFS also considers the ability of the species to recover in light of its current condition and the status of the existing and future threat regime. Generally, NMFS folds this consideration of current condition and ability to recover into a conclusion regarding the "risk of extinction" of the population or species.

NMFS uses the concepts of VSP as an organizing framework in this opinion to systematically examine the complex linkages between the proposed action effects and VSP parameters while also considering and incorporating natural risk factors such as climate change and ocean conditions. These VSP parameters are important to consider because they are predictors of extinction risk, and the parameters reflect general biological and ecological processes that are critical to the growth and survival of fish (McElhany et al. 2000). These four parameters are consistent with the "reproduction, numbers, or distribution" criteria found within the regulatory definition of "jeopardize the continued existence of" (50 CFR 402.02) and are used as surrogates for reproduction, numbers, and distribution. The fourth VSP parameter, diversity, relates to all three jeopardy criteria. For example, reproduction, numbers, and distribution are all affected when genetic or life history variability is lost or constrained, resulting in reduced population resilience to environmental variation at local or landscape-level scales.

2.1.1.4 Application of the Analytical Approach to Critical Habitat Analyses

The basis of the destruction or adverse modification analysis is to evaluate whether the proposed action affects the quantity or quality of the PBFs in the designated critical habitat for a listed species and, especially in the case of unoccupied critical habitat, whether the proposed action has any impacts to the critical habitat itself. Based on the definition of "*Destruction or adverse modification*" in 50 CFR 402.02, NMFS will conclude that a proposed action is likely to destroy or adversely modify the designated critical habitat for the ESU or DPS if the action results in a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.

NMFS bases critical habitat analysis on the affected areas and functions of critical habitat essential for the conservation of the species, and not on how individuals of the species will respond to changes in habitat quantity and quality. If an area encompassed in a critical habitat designation is likely to be exposed to the consequences of the proposed action on the natural environment, NMFS analyzes if PBFs included in the designation that give the designated critical habitat value for the conservation of the species are likely to respond to that exposure. In particular, NMFS is concerned about responses that are sufficient to reduce the quantity or quality of those PBFs or otherwise reduce the value of critical habitat for the conservation of the species.

To conduct this analysis, NMFS follows the basic analytical steps related to exposure, response, and risk described above. We recognize that the value of critical habitat for the conservation of the species is a dynamic property that changes over time in response to changes in land use patterns, climate (at several spatial scales), ecological processes, the dynamics of biotic components of the habitat, etc. For these reasons, some areas of critical habitat might respond to an exposure when others do not. We also consider how the PBFs of designated critical habitat are likely to respond to any interactions with and synergisms between effects of baseline conditions and proposed action stressors or benefits.

2.1.2 Methodology for Analyzing Hatchery Effects

The proposed action is analyzed for effects on the attributes that define population viability, including abundance, productivity, diversity, and spatial structure as described above in Section 2.1.1.3. The effects of a hatchery program on the status of an ESU will depend on which of the four key attributes are currently limiting the ESU, and how the hatchery fish within the ESU affect each of the attributes. NMFS also analyzes and considers the effects of hatchery facilities, for example weirs and water diversions, on each VSP attribute and on designated critical habitat.

The presence of hatchery fish within the ESU can positively affect the overall status of the ESU by increasing the number of natural spawners, by serving as a source population for repopulating unoccupied habitat and increasing spatial distribution, and by conserving genetic resources. Conversely, a hatchery program managed without adequate consideration can affect a listing determination by reducing adaptive genetic diversity of the ESU, and by reducing the reproductive fitness and productivity of the ESU (70 FR 37204 (June 28, 2005)). Generally speaking, effects range from beneficial to harmful for programs that use local fish for hatchery broodstock and from neutral or negligible to harmful when a program does not use local fish for broodstock. When hatchery programs use fish originating from a different population, or from a different ESU, NMFS is particularly interested in how effective the program will be at isolating hatchery fish and avoiding interactions that potentially disadvantage fish from natural populations. The range in effects are refined and narrowed after available scientific information and the circumstances and conditions that are unique to individual hatchery programs are considered.

There are seven factors that NMFS considers when analyzing the effects of hatchery programs on ESA-listed species that are relevant to this consultation: (1) broodstock collection; (2) interactions on the spawning grounds from hatchery returns and from returns of naturally spawning hatchery fish; (3) interactions in juvenile rearing and migration areas from hatchery releases and from the progeny of naturally spawning hatchery fish; (4) research, monitoring, and evaluation (RM&E); (5) masking (i.e., when hatchery fish are not identifiable from other fish and thus undermine or confuse the status of a population); (6) construction[1], operation, and maintenance; and (7) fisheries. Each effect is weighed against the affected population's or populations' current extinction risk level for abundance and productivity and for spatial structure and diversity (low, moderate, high), and the role of the affected natural population(s) in the ESU's recovery (core or non-core 1).

Information used when considering the effects of an HGMP may include: (1) the number, location and timing of naturally spawning hatchery fish; (2) the estimated level of gene-flow between hatchery fish and fish from natural populations; (3) the origin of the hatchery stock; and (4) the quality and quantity of spawning and rearing habitat in the action area, including the distribution of spawning and rearing habitat by quality and best estimates for spawning and rearing habitat capacity. Additional information that should be used when performing the effects analysis, if available, includes: (1) the size of hatchery fish relative to co-occurring natural-origin fish; (2) the timing of emergence and the distribution and estimated abundance for progeny from both hatchery and natural-origin natural spawners; and (3) the abundance, size, distribution, and timing for juvenile hatchery fish in the action area.

2.1.2.1 Factors Considered When Analyzing Hatchery Effects

Broodstock collection (Factor 1)

The key aspects for this part of the analysis are the origin and number of fish used for hatchery broodstock. The analysis looks at whether broodstock are of local origin, the proportion of

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[1] Construction of FCH was consulted on via the biological opinion on removal of the Klamath dams (NMFS 2021a). Consultation of operation and maintenance is specific to the FCH coho salmon program.

natural-origin fish used for broodstock, if the program selects for ESA-listed natural-origin or hatchery-origin fish, and if the program "backfills" with fish from outside the local or immediate area. Also important is the number of fish needed for broodstock.

NMFS analyzes the incidental effects on ESA-listed fish from samples collected from the entire run to collect hatchery broodstock. Some programs collect their broodstock from fish voluntarily entering into the hatchery itself, typically into a ladder and holding pond, while others sort through a sample of the entire run, usually at a weir, ladder, or sampling facility. Generally speaking, hatchery programs that access large numbers of the run to obtain hatchery broodstock result in more fish that are handled or delayed during migration and can import a greater threat to listed species. The information NMFS uses for this analysis includes a description of the facilities, practices, and protocols for collecting broodstock, the environmental conditions under which broodstock can be handled, and the encounter rate for ESA-listed fish.

Interactions on the spawning grounds from hatchery returns and from the returns of naturally spawning hatchery fish (Factor 2)

NMFS also analyzes the effects of hatchery returns and the progeny of naturally spawning hatchery fish on the spawning grounds. There are two aspects to this part of the analysis: genetic effects and ecological effects or competitive interactions on the spawning grounds between fish from a natural population and hatchery fish. At this time, based on the weight of available scientific information, NMFS believes that artificial breeding and rearing tends to result in some degree of genetic change and fitness reduction in hatchery fish and in the progeny of naturally spawning hatchery fish relative to desired levels of diversity and productivity for natural populations. When hatchery fish interbreed with fish from natural populations they often pose a threat to natural population rebuilding and recovery. The risk may be outweighed under circumstances where demographic or short-term extinction risk to the population is greater than risks to population diversity and productivity. However, the extent and duration of genetic change and fitness loss and the short and long-term implications and consequences for different species, for species with multiple life-history types, and for species subjected to different hatchery practices and protocols, remains unclear and should be the subject of further scientific investigation. As a result, NMFS believes hatchery intervention, following best management practices, is typically a legitimate and useful tool to help avert, at least in the short-term, salmon and steelhead extinction, but otherwise managers should seek to limit interactions between hatchery and natural-origin fish and implement hatchery practices that harmonize conservation with the implementation of treaty Indian fishing rights and other applicable laws and policies.

Genetic change and fitness reduction resulting from hatchery selection depends on: 1) the difference in selection pressures; 2) the exposure or amount of time the fish spends in the hatchery environment; and 3) the duration of hatchery program operation (i.e., the number of generations that fish are propagated by the program). On an individual level, exposure time in large part equates to fish culture, both the environment experienced by the fish in the hatchery and natural selection pressures, independent of the hatchery environment. On a population basis, exposure is determined by gene-flow proportions of natural-origin fish being used as hatchery broodstock and hatchery-origin fish spawning in the wild (Lynch and O'Hely 2001; Ford 2002), and then by the number of years the exposure takes place. In assessing risk or determining impact, both the effects to the individual and the population are considered.

Interactions of hatchery origin and natural origin fish in rearing areas (Factor 3)

Another factor that NMFS analyzes is the potential for competition, predation, and premature emigration when the progeny of naturally spawning hatchery fish and hatchery releases use juvenile rearing areas. Generally speaking, competition and a corresponding reduction in productivity and survival may result from direct interactions when hatchery-origin fish interfere with the accessibility to limited resources by natural-origin fish, or through indirect means, when the utilization of a limited resource by hatchery fish reduces the amount available for natural-origin fish (McMichael et al. 1997; Kostow et al. 2003; Kostow and Zhou 2006). Naturally produced fish may be competitively displaced by hatchery fish early in life, especially when hatchery fish are more numerous, of equal or greater size, when hatchery fish take up residency before naturally produced fry emerge from redds, and when hatchery releases become non-migrants and residualize. Hatchery fish might alter naturally produced salmon behavioral patterns and habitat use, making them more susceptible to predators (Steward and Bjornn 1990). Hatchery-origin fish may also alter naturally produced salmonid migratory responses or movement patterns, leading to a decrease in foraging success (Steward and Bjornn 1990). Actual impacts on naturally produced fish would thus depend on the degree of dietary overlap, food availability, size-related differences in prey selection, foraging tactics, and differences in microhabitat use (Steward and Bjornn 1990).

Research, monitoring, and evaluation (RM&E)(Factor 4)

NMFS also reviews a proposed hatchery action for its RM&E component. Generally speaking, the review process assesses the benefits and risks of implementing the proposed RM&E, including the effects on ESA-listed species and on designated critical habitat. The following five aspects that NMFS takes into account when it assesses hatchery RM&E are: (1) the status of the affected species and effects of the proposed RM&E on the species and on designated critical habitat; (2) critical uncertainties over effects of the proposed action on the species; (3) performance monitoring and determining the effectiveness of the hatchery program at achieving its goals and objectives; (4) identifying and quantifying collateral effects; and (5) tracking compliance of the hatchery program with the terms and conditions for implementing the program. After assessing the proposed hatchery RM&E and before it makes any recommendations to the action agencies, NMFS considers the benefit or usefulness of new or additional information, whether the desired information is available from another source, and the effects on ESA-listed species.

Masking (Factor 5)

Hatchery actions also must be assessed for masking effects. The effects of masking occur when hatchery fish are not discernable from wild or naturally produced fish and thus undermine or confuse the status of a population. For example, management decisions may be more conservative than necessary because of uncertainty over their effects on protected species. Both adult and juvenile hatchery fish can have masking effects. Masking has major implications for evaluating proposed actions under sections 4(d), 7, and 10 of the ESA and for conserving listed species in general. When presented with a proposed hatchery action, NMFS analyzes the nature and level of uncertainties caused by masking and whether and to what extent listed salmon and steelhead are at increased risk. The analysis also considers the role of the affected salmon and steelhead population(s) in recovery and whether unidentifiable hatchery fish compromise important RM&E.

Construction, operation, and maintenance activities (Factor 6)

Construction, operation, and maintenance activities ongoing at hatchery facilities can alter fish behavior and injure or kill eggs, juveniles and adults. These activities can also adversely affect designated critical habitat. The analyses identify effects on VSP attributes from changes in water quantity and quality, riparian habitat, channel morphology and habitat complexity, in-stream substrates, and from the location and protocols for operating diversion structures and weirs, and conducting maintenance activities. For diversion structures and fish passage facilities, a key consideration is whether they are constructed and operated consistent with NMFS criteria. Potential adverse effects related to operation of fish weirs upon listed species include delays in migration, rejection or fallback, physical injury, handling, and increased vulnerability to predation. Hatchery facilities often host multiple hatchery programs for distinct periods of time. Where possible, NMFS attempts to assign facility effects on the specific program or programs under review.

Fisheries (Factor 7)

There are two aspects of fisheries that NMFS considers. One is when listed species are incidentally taken in fisheries targeting other fish, and the other is when fisheries are used as a tool to prevent hatchery fish from spawning naturally, which is not anticipated as part of the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that is likely to be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" for the jeopardy analysis. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the function of the PBFs that are essential for the conservation of the species.

2.2.1 Species Description and General Life History

The SONCC ESU of coho salmon is listed as threatened and is described as naturally spawned coho salmon originating from coastal streams and rivers between Cape Blanco, Oregon, and Punta Gorda, California (70 FR 37160 (June 28, 2005); 64 FR 24049 (May 5, 1999)). Also, the SONCC ESU includes coho salmon from the following artificial propagation programs: The Cole Rivers Hatchery Program; the Trinity River Hatchery (TRH) Program; and the IGH Program (50 CFR 223.102(e)). SONCC coho salmon have a generally simple three-year life history. The adults typically migrate from the ocean and into bays and estuaries towards their freshwater spawning grounds in late summer and fall, and spawn by mid-winter. Adults die after spawning. The eggs are buried in nests, called redds, in the rivers and streams where the adults spawn. The eggs incubate in the gravel until fish hatch and emerge from the gravel the following spring as fry. Individual fish produced during the same year are considered from the same "year class" or cohort. Fish typically rear in freshwater for about 15 months before migrating to the ocean. The juveniles go through a physiological change during the transition from fresh to salt water called smoltification. Coho salmon typically rear in the ocean for two growing seasons, returning to their natal streams as three-year old fish to renew the cycle.

2.2.2 Status of SONCC Coho Salmon and their Critical Habitat

As described in more detail in the Analytical Approach section above, NMFS assesses four population viability parameters to help us understand the status of each species and their ability to survive and recover. These population viability parameters are: abundance, population productivity, spatial structure, and diversity (McElhany et al. 2000). While there is insufficient information to evaluate these population viability parameters in a thorough quantitative sense, NMFS has used existing information, including the Recovery Plan for SONCC coho salmon (NMFS 2014b) and the most recent status review for SONCC coho salmon (Williams et al. 2016a) to determine the general condition of each population and factors responsible for the current status of the ESU. We use these population viability parameters as surrogates for reproduction, numbers, and distribution; the criteria found within the regulatory definition of "jeopardize the continued existence of" (50 CFR 402.02). This opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the PBFs that help to form that conservation value.

2.2.2.1 Status of SONCC Coho Salmon

SONCC Coho Salmon Abundance and Productivity: Although long-term data on coho salmon abundance are scarce, the available evidence from short-term research and monitoring efforts indicate that spawner abundance has declined since the previous status review (Williams et al.

2011) for populations in this ESU (Williams et al. 2016a). In fact, most of the 30 independent populations in the ESU are at high risk of extinction because they are below or likely below their depensation threshold, which can be thought of as the minimum number of adults needed for survival of a population. No populations are at low risk of extinction and all core populations are thousands short of the numbers needed for recovery (Williams et al. 2016a).

SONCC Coho Salmon Spatial Structure and Diversity: The distribution of SONCC coho salmon within the ESU is reduced and fragmented, as evidenced by an increasing number of previously occupied streams from which SONCC coho salmon are now absent (NMFS 2001b; Good et al. 2005; Williams et al. 2011; Williams et al. 2016a). Extant populations can still be found in all major river basins within the ESU (70 FR 37160 (June 28, 2005)). However, extirpations, loss of brood years, and sharp declines in abundance (in some cases to zero) of SONCC coho salmon in several streams throughout the ESU indicate that the SONCC coho salmon's spatial structure is more fragmented at the population-level than at the ESU scale. The genetic and life history diversity of populations of SONCC coho salmon is likely very low. The SONCC coho salmon ESU is currently considered likely to become endangered within the foreseeable future in all or a significant portion of its range, and there is heightened risk to the persistence of the ESU as VSP parameters continue to decline and no improvements have been noted since the previous status review in 2011 (Williams et al. 2016a).

2.2.2.2 Status of SONCC Critical Habitat

Critical habitat for SONCC coho salmon is designated to include all river reaches accessible to listed coho salmon between Cape Blanco, Oregon, and Punta Gorda, California. Critical habitat consists of the water, substrate, and adjacent riparian zone of estuarine and riverine reaches (including off-channel habitats) in hydrologic units and counties identified in Table 6 of 50 CFR Part 226. Accessible reaches are those within the historical range of the ESU that can still be occupied by any life stage of coho salmon. Inaccessible reaches are those above specific dams identified in Table 6 of 50 CFR Part 226 or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years) (50 CFR 226.210(b)). Tribal lands are specifically excluded from critical habitat for this ESU (50 CFR Part 226, Table 6, note 2). The condition of SONCC coho salmon critical habitat, specifically its ability to provide for their conservation, has been degraded from conditions known to support viable salmonid populations. NMFS has determined that currently depressed population conditions are, in part, the result of the following human induced factors affecting critical habitat: overfishing, artificial propagation, logging, agriculture, mining, urbanization, stream channelization, dams, wetland loss, and water withdrawals (including unscreened diversions for irrigation). Impacts of concern include altered stream bank and channel morphology, elevated water temperature, lost spawning and rearing habitat, habitat fragmentation, impaired gravel and wood recruitment from upstream sources, degraded water quality, lost riparian vegetation, and increased erosion into streams from upland areas (Weitkamp et al. 1995; 70 FR 37160 (June 28, 2005); 64 FR 24049 (May 5, 1999)). Diversion and storage of river and stream flow has dramatically altered the natural hydrologic cycle in many of the streams within the ESU. Altered flow regimes can delay or preclude migration, dewater aquatic habitat, and strand fish in disconnected pools, while unscreened diversions can entrain juvenile fish.

2.2.2.2.1 Factors Related to the Decline of Species and Degradation of Critical Habitat

The factors that caused declines include hatchery practices, ocean conditions, habitat loss due to dam building, degradation of freshwater habitats due to a variety of agricultural and forestry practices, water diversions, urbanization, over-fishing, mining, climate change, and severe flood events exacerbated by land use practices (Good et al. 2005; Williams et al. 2016b). Sedimentation and loss of spawning gravels associated with poor forestry practices and road building are particularly chronic problems that can reduce the productivity of salmonid populations. Late 1980s and early 1990s droughts and unfavorable ocean conditions were identified as further likely causes of decreased abundance of SONCC coho salmon (Good et al. 2005). From 2014 through 2016, the drought in California reduced stream flows and increased temperatures, further exacerbating stress and disease. Drought conditions returned to the Klamath Basin in 2020 (Reclamation 2020), and the state of Oregon declared a state of drought emergency in the upper Klamath River Basin in early 2021 due to unusually low snow pack and lack of precipitation (Oregon 2021). Reduced flows can cause increases in water temperature, resulting in increased heat stress to fish and thermal barriers to migration.

One factor affecting the range wide status and aquatic habitat at large is climate change. The best available information suggests that the earth's climate is warming, and that this could significantly impact ocean and freshwater habitat conditions, and thus the survival of species subject to this consultation. Recent evidence suggests that climate and weather is expected to become more extreme, with an increased frequency of drought and flooding (IPCC 2019). Climate change effects on stream temperatures within Northern California are already apparent. For example, in the Klamath River, Bartholow (2005) observed a 0.5ºC per decade increase in water temperature since the early 1960's and model simulations predict a further increase of 1-2 ºC over the next 50 years (Perry et al. 2011). Heavier winter rainstorms from warming may lead to increased flooding and high-flow events that result in scouring of riverbeds, smothering redds, and increasing suspended sediment in systems. In the summer, decreased stream flows and increased water temperature can reduce salmon habitat and impede migration (Southern Resident Orca Task Force 2019).

In coastal and estuarine ecosystems, the threats from climate change largely come in the form of sea level rise and the loss of coastal wetlands. Sea levels will likely rise exponentially over the next 100 years, with possibly a 43-84 cm rise by the end of the 21st century (IPCC 2019). This rise in sea level will alter the habitat in estuaries and either provide an increased opportunity for feeding and growth or in some cases will lead to the loss of estuarine habitat and a decreased potential for estuarine rearing. Marine ecosystems face an entirely unique set of stressors related to global climate change, all of which may have deleterious impacts on growth and survival while at sea. In general, the effects of changing climate on marine ecosystems are not well understood given the high degree of complexity and the overlapping climatic shifts that are already in place (e.g., El Niño, La Niña, and Pacific Decadal Oscillation) and will interact with global climate changes in unknown and unpredictable ways. Overall, climate change is believed to represent a growing threat, and will challenge the resilience of SONCC coho salmon.

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02).

For this proposed action, the action area is the FCH facility, the Klamath River, and Klamath tributaries including the Trinity River, upstream to the anticipated extent of coho salmon habitat. Post dam removal, coho salmon, including potentially HOR individuals from FCH, are expected to re-populate their historic range that includes tributary and mainstem habitat upstream of IGD, inclusive of Spencer Creek in Klamath County Oregon (Hamilton et al. 2005; ODFW 2021b). The Klamath basin tributaries, including Bogus Creek, the Shasta River, Scott River, Salmon River, and Trinity River are included in the action area because IGH adult coho salmon have historically occasionally strayed into these locations, albeit at a very low rate for tributaries downstream of the Shasta River, and because juveniles from these locations could interact with FCH coho salmon smolts in the Klamath River mainstem and estuary. Therefore, for the purposes of this biological opinion, the action area includes the range of the Lower Klamath River, Middle Klamath River, Upper Klamath River, Shasta River, Scott River, Salmon River, Lower Trinity River, South Fork Trinity River, and Upper Trinity River populations (Figure 4, Figure 5).

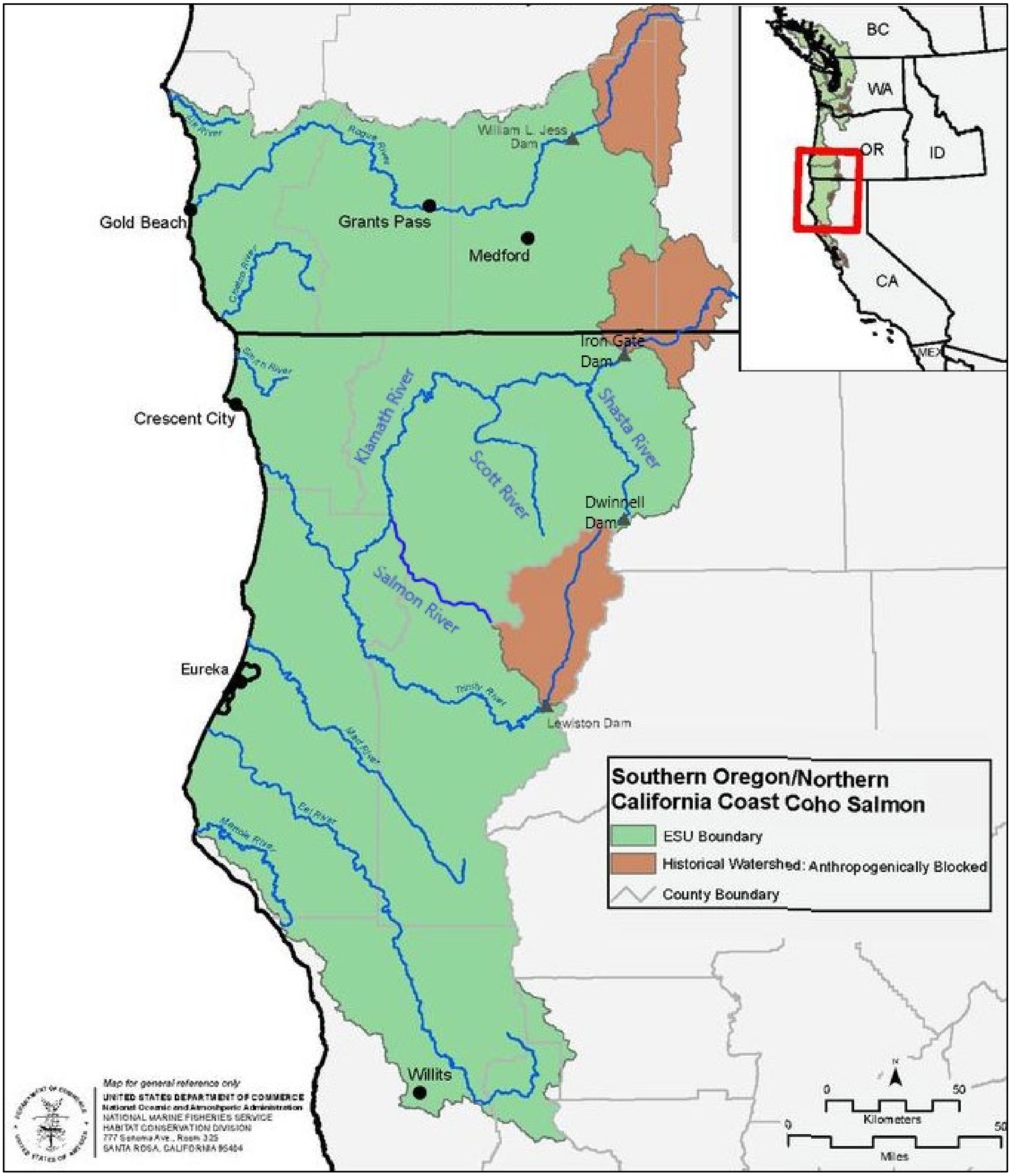

Figure 4. Map showing the SONCC coho ESU boundary and major current barriers including IGD on the Klamath River, and Lewiston Dam on the Trinity River. Areas contained within the action area include the entire mainstem Klamath River including historical habitat above IGD, the Shasta River, Scott River, Salmon River, and Trinity River.

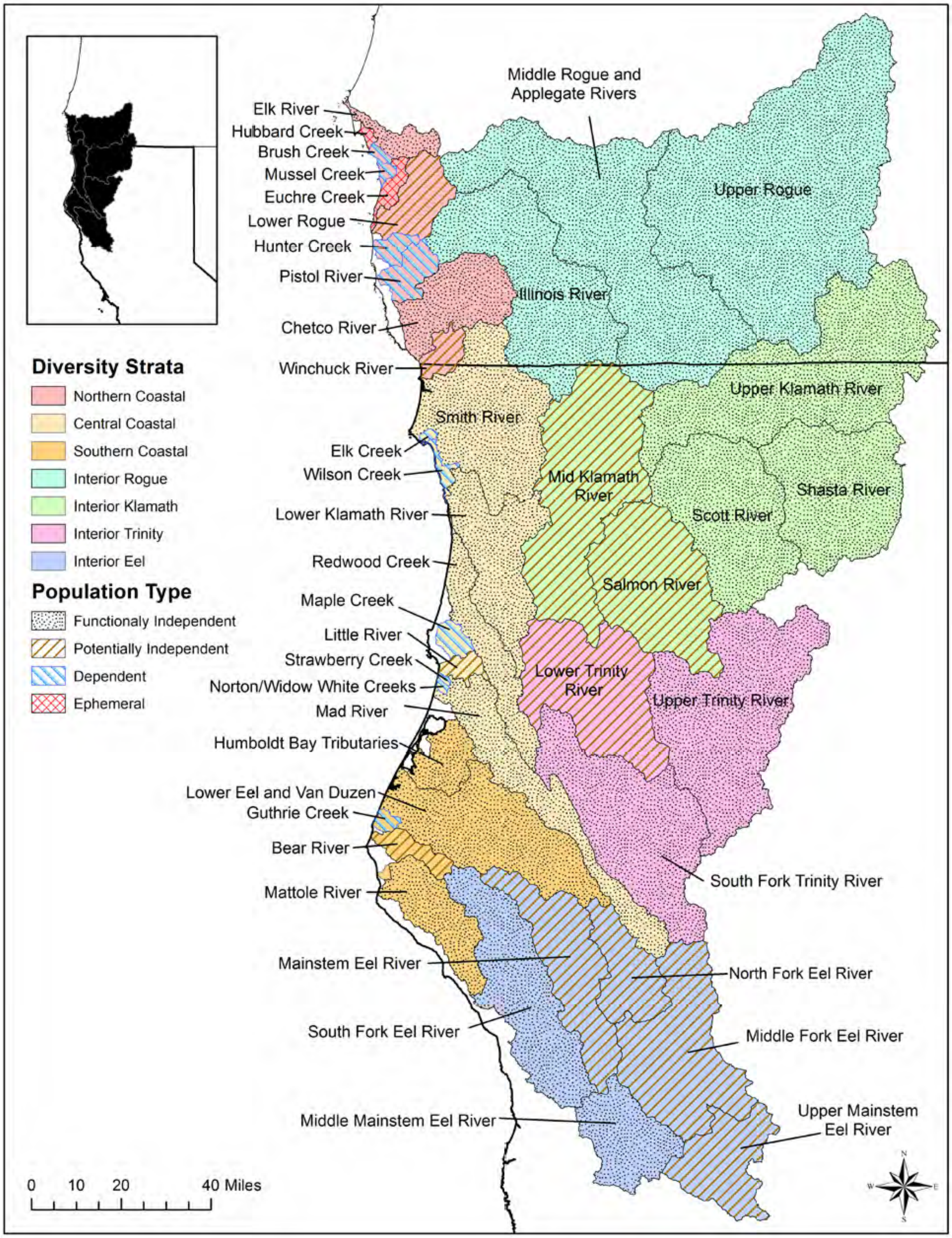

Figure 5. Populations and diversity strata of the SONCC coho salmon ESU. Populations with ranges that overlap with the action area are: Lower Klamath River, Middle Klamath River, Upper Klamath River, Shasta River, Scott River, Salmon River, Lower Trinity River, South Fork Trinity River, and Upper Trinity River populations.

2.4 Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

2.4.1 SONCC Coho Salmon

While the *Status of SONCC coho salmon* section (Section 2.2.2.1) discussed the viability of the SONCC coho salmon ESU as a whole, this section will focus on the condition of SONCC coho salmon and their critical habitat in the action area, and factors affecting their condition within the action area. Because this Environmental Baseline section refers to the condition of the species and habitat without the consequences of the proposed action, the primary focus of this section will be on the habitat within their current range (i.e., the Klamath Basin downstream of IGD). However, because the proposed action is anticipated to provide access to historic habitat above IGD to as far upstream as Spencer Creek (Hamilton et al. 2005), the current conditions of some habitat factors above IGD are also discussed in this Section.

Coho salmon were once numerous and widespread within the Klamath River Basin (Snyder 1931). Today, due to migration barriers (Figure 4), habitat degradation, and other factors, the populations that remain occupy a fraction of their historical area, in limited habitat within the tributary watersheds (e.g., Bogus Creek, Shasta River, Scott River, Salmon River, Trinity River, and miscellaneous smaller tributaries) and the mainstem Klamath River just downstream of IGD (NRC 2004; NMFS 2014b). Since 1962, the upper limit to anadromous migration on the Klamath River has been the IGD. Dwinnell Dam on the Shasta River, a major tributary to the Klamath River downstream of IGD, was completed in 1928 and blocked access to portions of the upper Shasta River. The Lewiston water diversion dam on the Trinity River, completed in 1963, has prevented access of coho salmon to their historical spawning grounds upstream of the dam (Reclamation and CDFW 2017). In recent years, the highest recorded escapement of adult coho salmon in the Klamath Basin has been to either the Trinity River or Scott River sub-basins. The extent and quality of coho salmon habitat in each sub-basin is discussed in greater detail below.

Coho salmon potentially affected by the proposed action currently occupy temperate coastal regions and arid inland areas stretching an approximated 193 river miles from IGD downstream to the estuary, in addition to tributaries that join along that length of the Klamath River. Coho salmon potentially affected by the proposed action belong to three (i.e., the Interior Klamath, the Central Coastal, and the Interior Trinity) of the seven diversity strata that comprise the SONCC coho salmon ESU. All five populations of the Interior Klamath Diversity Stratum, one population of the Central Coastal Diversity Stratum, and all three populations in the Interior Trinity Diversity Stratum, would be affected by the proposed action (Section 1.3)(Figure 5).

2.4.1.1 Status of Habitat in the Action Area

The action area is a patchwork of areas that are or are not designated critical habitat (64 FR 24049 (May 5, 1999)). For example, the habitat above IGD that is expected to be re-populated by coho salmon following removal of the Klamath dams is not designated as critical habitat. The tributaries downstream of IGD (e.g., Shasta, Scott, Salmon, and Trinity rivers), are mostly designated as critical habitat. Because some of the coho salmon migrating through or otherwise utilizing the action area that may be affected by the proposed action will then utilize the habitat in those tributaries, the status of the habitat conditions in those tributaries is relevant to our analysis of the effects of the proposed action. The status of the habitat conditions in those areas is summarized in this section. The threats and stressors that impact designated critical habitat and habitat that SONCC coho salmon utilize that is not designated as critical habitat are similar, so they are only described once in this section. However, for the purposes of the analysis of effects to SONCC coho salmon critical habitat, we identify in this section which habitat is designated as critical habitat, and which habitat is not.

Critical habitat for SONCC coho salmon in the Klamath River Basin that overlaps with the action area consists of the water, substrate, and adjacent riparian zone from the IGD (RM 193.1) to the Klamath River mouth at the Pacific Ocean, excluding the Yurok Reservation, Karuk Reservation, and Resighini Rancheria (64 FR 24049 (May 5, 1999)), which includes the Klamath River downstream of the confluence with the Trinity River. Again, the area upstream of IGD (RM 193.1) that is expected to be re-populated by coho salmon following removal of the Klamath dams, which is believed to be as far upstream as Spencer Creek (confluence at RM 233.4) (Hamilton et al. 2005), is not designated as critical habitat. In addition, the tributaries to the Klamath River downstream of IGD, including the Shasta, Scott, Salmon, and Trinity (excluding the Hoopa Valley Reservation) rivers are designated critical habitat.

2.4.1.1.1 Water Quality Conditions

Much of the Klamath Basin is currently listed as water-quality impaired under section 303(d) of the Clean Water Act (Table 10). Water temperatures within both mainstem and tributary reaches are often stressful to juvenile and adult coho salmon during late spring, summer, and early fall months. In addition, increased nutrient loading and organic enrichment with associated depletion of dissolved oxygen (DO) are recognized to be stressors for coho salmon in much of the Klamath Basin (NMFS 2014b).

Table 10: Water bodies listed as water-quality impaired under section 303(d) of the Clean Water Act and stressors for locations that contain SONCC coho salmon populations that may be affected by the proposed action (adapted from DOI and CDFG 2012; FERC 2021a).

Water Body	Water Temperature	Sedimentation	Organic Enrichment/Low Dissolved Oxygen	Nutrients
Klamath River: Spencer Creek mouth to Oregon-California State Line (not designated critical habitat)	x		x	
Klamath River: Oregon-California State line to IGD (not designated critical habitat)	x		x	x
Klamath River: IGD to Scott River mouth* (critical habitat)	x		x	x
Klamath River: Scott River mouth to Trinity River mouth** (critical habitat)	x		x	x
Klamath River: Trinity River mouth to Pacific Ocean (not designated critical habitat)	x	x	x	x
Shasta River (critical habitat)	x		x	
Scott River (critical habitat)	x	x		
Salmon River (critical habitat)	x			
Trinity River (critical habitat where not overlapping with Hoopa Valley Reservation)		x		

x – Indicates water bodies (row) listed as water quality impaired for a specific stressor (column).
*Selected minor tributaries that are impaired for sediment and sedimentation include Beaver, Cow, Deer, Hungry, and West Fork Beaver creeks (USEPA 2010).
**Minor tributaries that are impaired for sediment and sedimentation include China, Fort Golf, Grider, Portuguese, Thompson, and Walker creeks (USEPA 2010).

2.4.1.1.2 Disease

Since the late 1990s, fish disease research and monitoring has been conducted extensively in the Klamath River Basin. Disease effects are likely to negatively impact all of the VSP parameters of the Klamath and Trinity coho salmon populations because both adults and juveniles can be affected. In terms of critical habitat, disease impacts adult and juvenile migration corridors, and juvenile spring and summer rearing areas. Several documents provide extensive overviews of aquatic diseases that affect salmonids in the Klamath River, including:

- USFWS and NMFS (2013) biological opinion for Klamath Project Operations,
- NMFS (2019) biological opinion for Klamath Project Operations,
- NMFS (2021a) biological opinion for the Surrender and Decommissioning of the Lower Klamath Hydroelectric Project,
- the Synthesis of the Effects to Fish Species of Two Management Scenarios for the Secretarial Determination on Removal of the Lower Four Dams on the Klamath River (Hamilton et al. 2011),
- the Klamath Facilities Removal Environmental Impact Statement/Environmental Impact Report (DOI and CDFG 2012),
- the Final Environmental Impact Report for the Lower Klamath Project License Surrender (CSWRCB 2020),
- a series of USFWS Technical Memoranda (USFWS 2016a; USFWS 2016b; USFWS 2016c; USFWS 2016d).

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; (2) the bacterial pathogens *R. salmoniranrum* (bacterial kidney disease), *Flavobacterium columnare* (columnaris), and *Aeromonas hydrophila*; (3) external protozoan parasites *Ichthyophthirius* (Ich), *Ichthyobodo,* and *Trichodina*; and (4) the myxozoan parasites *Ceratonova shasta* (causes ceratomyxosis) and *Parvicapsula minibicornis*. Other pathogens are likely present in the Klamath River, but are rarely detected. Ich and columnaris have occasionally had a substantial impact on adult salmon downstream of IGD, particularly when habitat conditions include exceptionally low flows, high water temperatures, and high densities of fish (such as adult salmon migrating upstream in the fall and holding at high densities in pools). In 2002, these habitat factors were present, and a disease outbreak occurred, with more than 33,000 adult salmon and non-listed steelhead losses, including an estimated 334 coho salmon (Guillen 2003). Most of the fish affected by the 2002 fish die-off were non-listed fall-run Chinook salmon in the lower 36 miles of the Klamath River (Belchik et al. 2004). Although losses of adult salmonids can be substantial when events such as the 2002 fish die-off occur, the combination of factors that leads to adult infection by Ich and columnaris disease may not be as frequent as the annual exposure of juvenile salmonids to *C. shasta* and *P. minibicornis*, as many juveniles must migrate each spring downstream past established populations of the invertebrate worm intermediate host.

The life cycles of both *P. minibicornis* and *C. shasta* involve an invertebrate host 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 worm, *Manayunkia occidentalis sp,* identified previously as *Manayunkia speciosa* Leidy, 1859. (Atkinson et al. 2020). Once the annelids 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, and remain viable (able to infect salmon) from three to seven days at temperatures ranging from 11 to 18ºC (Foott et al. 2006). When temperatures are outside of 11 to 18ºC, actinospores are viable for a shorter time. USFWS (2016c) states that myxospores released from adult salmon carcasses contribute the bulk of myxospores to the system; mostly from carcasses upstream of the confluence with the Shasta River.

The annelid host for *C. shasta* is present in a variety of habitat types, including runs, pools, riffles, and edge-water; as well as sand, gravel, boulders, bedrock, and aquatic vegetation; and is frequently present with *Cladophora* (a type of algae) (Bartholomew and Foott 2010). The altered river channel downstream of IGD has resulted in an atypically stable river bed, which provides favorable habitat for the annelid worm. The reach of the Klamath River from the Shasta River to Seiad/Indian Creek is known to be a highly infectious zone with high actinospores, especially from April through August (Beeman et al. 2008), although within and between years the size of the infectious zone and the magnitude of parasite densities may vary geographically (True et al. 2016b; Voss et al. 2018; Voss et al. 2019; Voss et al. 2020; Voss et al. 2023). The highest rates of infection occur in the Klamath River within approximately 50 miles downstream of IGD (Stocking and Bartholomew 2007; Bartholomew and Foott 2010).

Annual prevalence of the myxozoan parasite *C. shasta* has been documented in emigrating juvenile salmon populations during spring and early summer in the Klamath River. *C. shasta* in out-migrating juvenile salmonids has been well studied (True et al. 2016a; True et al. 2016b; True et al. 2017; Voss et al. 2018; Som et al. 2019; Voss et al. 2019; Robinson et al. 2020; Voss et al. 2020; Voss et al. 2022; Voss et al. 2023), and the processes that influence *C. shasta* impacts on Klamath River salmon are increasingly understood (Robinson et al. 2020). Robinson et al. (2020)'s results suggested that hatchery origin smolts may exacerbate the impacts of the disease as evidenced by an associative relationship between the prevalence of infection in outmigrating hatchery fish with the densities of water-borne *C. shasta* spores in subsequent seasons.

2.4.1.1.3 Hatcheries

Two hatchery programs release anadromous salmonids in the Klamath Basin: IGH on the Klamath River, and TRH on the Trinity River. The coho salmon propagated at IGH and TRH are part of the ESA listed SONCC coho salmon ESU (50 CFR 223.102(e)). TRH produces coho salmon, Chinook salmon, and steelhead that could be impacted by the proposed action. In addition, the fish that are produced at TRH could adversely affect coho salmon in the action area through competition in the lower Klamath River. Therefore, production at TRH is included in this section (Table 11).

Table 11. Iron Gate and Trinity River hatcheries current production goals.

Hatchery	Species	Number released	Life Stage	Released Target Date	Adult Run timing
IGH	Chinook Salmon	5,100,000	smolts	May-June	Mid-September to early November
IGH	Chinook Salmon	900,000	yearlings	mid-October through November	Mid-September to early November
IGH	coho salmon	75,000	yearlings	March-May	October to January
IGH	Steelhead*	200,000	smolts		November to March
TRH	Chinook Salmon	3,000,000	smolts	May-June	Mid-September to early November
TRH	Chinook Salmon	1,300,000	yearlings	November	Mid-September to early November
TRH	Steelhead	448,000	smolts	April	November to March
TRH	coho salmon	300,000	Yearlings	March	October to January

*No steelhead have been produced at IGH since 2012 due to low adult returns.

Based on mitigation goals established when IGH was constructed in 1962, the IGH historically released approximately six million Chinook salmon, 75,000 coho salmon and 200,000 steelhead annually (Table 11). Of the six million Chinook salmon that is the goal for production at IGH, about 5.1 million are smolts that are typically release from mid-May through early June and about 900,000 are yearlings that are typically released from mid-October through November. Production of Chinook salmon and coho salmon has been maintained but production targets are not always reached, especially for Chinook salmon in recent years. Due to insufficient returns of Chinook Salmon, hatchery egg production was 7,044,080 eggs (69%) short of the target of 10,200,000 eggs in 2019 (Giudice and Knechtle 2020), and 7,164,606 eggs (70%) short of the same target in 2020 (Giudice and Knechtle 2021b). Adult returns of coho salmon to IGH were sufficient to reach egg production goals in 2017 through 2021, but produced less than half of the egg production target in 2015 and 2016 (Giudice and Knechtle 2021b; Giudice and Knechtle 2022b). The production of steelhead at IGH tapered off and then ceased in 2012, due to low adult returns.

The target 75,000 coho salmon are typically released from IGH as yearlings after March 15th each spring. Prior to 2001, all of the Chinook salmon smolts were released after June 1 of each year. However, beginning in 2001, CDFW began implementing an early release strategy in response to recommendations provided by the Joint Hatchery Review Committee (CDFG and NMFS 2001). The Joint Hatchery Review Committee stated that the current smolt release times (June 1 to June 15) often coincide with a reduction in the flow of water released by Reclamation into the Klamath River, and that this reduction in flows also coincides with a deterioration of water quality and reduces the rearing and migration habitat available for both natural and hatchery reared fish. In response to these concerns the CDFW proposed an Early Release Strategy and Cooperative Monitoring Program in April of 2001 (CDFG 2001). The goals of implementing the early release strategy are to:

1. Improve the survival of hatchery released fall Chinook salmon smolts from IGH to the commercial, tribal, and sport fisheries.

2. Reduce the potential for competition between hatchery and natural salmonid populations for habitats in the Klamath River, particularly for limited cold water refugia habitat downstream of IGD.

Similar to production targets and associated release numbers, release timing is also variable each year. The timing of release for Chinook salmon at IGH is dependent on fish growth and environmental conditions. In 2021, due to inhospitable in-river conditions in the Klamath River, no IGH Chinook salmon were released during the typical smolt release timing, and instead were held at TRH during the summer before being returned to IGH to be released during the typical yearling timing in the fall (CDFW 2021b). In 2022, 2.8 million unmarked and untagged IGH HOR Chinook salmon were released early to avoid releasing fish into inhospitable in-river conditions, and one million IGH HOR Chinook salmon were also again held at TRH and then returned to IGH to be released during the typical yearling timing in the fall (CDFW 2022).

As discussed in the Background Section (Section 1.1), an HGMP for coho salmon was developed for IGH as part of the CDFW's application for an ESA section 10(a)(1)(A) permit for the IGH coho salmon program (CDFW and PacifiCorp 2014). The IGH HGMP is intended to guide hatchery practices toward the conservation and recovery of SONCC coho salmon; specifically, through protecting and conserving the genetic resources of the upper Klamath River coho salmon population. In addition, the HGMP is also intended to reduce the immediate threat of extirpation for both the upper Klamath River and Shasta River populations by encouraging release of adult coho salmon from the hatchery that are not required or suitable for use in the hatchery genetic spawning matrix. The exact effects on wild juvenile coho salmon in the Klamath River from the annual release of up to 6,000,000 hatchery-reared Chinook salmon smolts and 75,000 yearling coho salmon from IGH are not known precisely. The release of a relatively large number of hatchery origin juvenile Chinook salmon has the potential to affect wild coho salmon juveniles via competitive interactions, increased predation, and exposure to disease, but habitat partitioning between the two species likely limits these effects.

2.4.1.1.4 Harvest

Coho salmon have been harvested in the past in both coho- and Chinook-directed ocean fisheries off the coasts of California and Oregon. However, stringent management measures, which began to be introduced in the late 1980s, reduced coho salmon harvest substantially. The prohibition of coho salmon retention in commercial and sport fisheries in all California waters began in 1994 (NMFS 2014b). With the exception of some tribal harvest by the Yurok and Hoopa Valley for subsistence and ceremonial purposes, the retention of coho salmon is prohibited in all California river fisheries. Tribal fishing for coho salmon within the Yurok tribe's reservation on the lower Klamath River has been monitored since 1992. The median Yurok harvest from the entire area from 1994 to 2012 was 345 coho salmon, which approximates an average annual maximum harvest of 3.1 percent of the total run (NMFS 2014b). The annual Yurok Tribe Fall Harvest Management Plan (e.g., Yurok Tribe 2021) continues to implement weekly coho protection fishing closures intended to protect coho salmon from harvest. The majority of coho salmon captured by Hoopa Valley tribal fisheries are TRH origin fish (Orcutt 2015). With regards to ocean fisheries, in 1995, ocean recreational fishing for coho salmon was closed from Cape Falcon in Oregon to the United States/Mexico border, and remains closed. In order to comply with the SONCC coho salmon ESU conservation objective, projected incidental mortality rates on Rogue/Klamath River hatchery coho salmon stocks are calculated during the preseason planning process using the coho salmon Fishery Regulation Assessment Model (Kope 2005). Specifically, the Pacific Fishery Management Council applies a SONCC coho salmon ESU consultation standard requirement of no greater than a 13.0 percent marine exploitation rate on Rogue/Klamath hatchery coho salmon, which applies to incidental mortality in the Chinook salmon ocean fisheries from Cape Falcon in Canada to the United States/Mexico border, and the observed exploitation rate is typically substantially less than 13.0 percent each year (PFMC 2018; PFMC 2023).. For example, the preliminary postseason estimate for marine exploitation of California origin coho salmon in 2020 was 2.1% (PFMC 2023). In summary, major steps have been taken to limit effects of harvest on SONCC coho salmon, but there is still some small impact of incidental mortality associated with various Chinook salmon fisheries, and by subsistence and ceremonial tribal fisheries.

2.4.1.1.5 Predation

Predation of adult and juvenile coho salmon is likely to occur from a number of sources including piscivorous fish, avian predators, pinnipeds, and other mammals. However, the effect of predation on coho salmon in the Klamath Basin is not well understood. Pinniped predation on adult salmon can significantly affect escapement numbers within the Klamath River Basin. Hillemeier (1999) assessed pinniped predation rates within the Klamath River estuary during August, September, and October 1997, and estimated that a total of 223 adult coho salmon were consumed by seals and sea-lions during the entire study period. Increased rates of predation of juvenile coho salmon from piscivorous fish (e.g., steelhead) may result from the concentrated hatchery releases from IGH (Nickelson 2003). While the extent of predation is not well understood, some level of predation is known to be occurring, and the associated mortality and lost production is likely having some adverse effect on coho salmon in the Klamath Basin (NMFS 2014b), including in the action area.

2.4.1.1.6 Restoration Activities

There are various restoration and recovery actions underway in the Klamath Basin aimed at removing barriers to salmonid habitat and improving habitat and water quality conditions for anadromous salmonids. While habitat generally remains degraded across the ESU, restorative actions have effectively improved the conservation value of critical habitat throughout the range of the SONCC coho salmon, including portions of the Klamath Basin. Recent projects have included techniques to create important slow water and off channel habitat that is limited across the range of the ESU, and studies have shown positive effects of these restorative techniques to coho salmon growth and survival (Cooperman et al. 2006; Ebersole et al. 2006; Witmore 2014; Yokel et al. 2018). The magnitude of restoration efforts that have occurred in the Klamath Basin is difficult to summarize in terms of metrics like stream miles restored or pieces of Large Woody Debris (LWD) installed because restoration projects and practitioners have variable restoration approaches and goals. The complexity of the restoration and associated monitoring landscape in the Klamath Basin is summarized in the ESSA (2017) Klamath Basin Integrated Fisheries Restoration and Monitoring (IFRMP) Synthesis Report, and further described in the ESSA and Klamath Basin Working Groups (2023) Klamath Basin IFRMP. In 2002, NMFS began ESA recovery planning for the SONCC and Oregon Coast coho salmon ESU through a scientific technical team created and chaired by the Northwest and Southwest Regional Fishery Science Centers, referred to as the Oregon and Northern California Coast coho salmon technical recovery team. In 2014, NMFS issued a final recovery plan for the SONCC coho salmon ESU (NMFS 2014b). Planned and implemented actions intended to help recover SONCC coho salmon, as guided by the recovery plan, include:

- Reclamation has provided $500,000 per year since 2013 for the Klamath Coho Habitat Restoration Program administered by National Fish and Wildlife Foundation (NFWF). The grant program funds restoration activities to improve habitat, water quality, water quantity, and fish passage, as well as research projects for coho salmon recovery. Restoration activities can occur on the mainstem Klamath River and its tributaries, with most restoration being conducted in the Shasta, Scott, and Mid Klamath tributaries. Restoration projects are typically implemented by state, tribal, local, or private non-governmental organizations. Since 2016, the Reclamation Klamath Basin Coho Habitat Restoration Program has awarded approximately $2.5 million to 21 projects. These projects have leveraged over $2.8 million in matching funds and in-kind contributions. The grant program is for projects that address limiting factors to be part of Reclamation's Program, projects for SONCC coho salmon in the Klamath Basin (NMFS 2019). Additionally, Reclamation provided a total of $1.7 million for FY2022 and anticipates awarding an additional $500k in FY2023 and $500k in FY2024.
- Covered activities under the PacifiCorp Klamath Hydroelectric Project Interim Operations HCP for Coho Salmon (PacifiCorp 2012) and associated incidental take permit under ESA section 10(a)(1)(B) include activities that are necessary to operate and maintain the Klamath hydroelectric facilities prior to the potential removal of four mainstem hydroelectric facilities. NMFS issued the incidental take permit in 2012 for a term of ten years. In 2020, PacifiCorp requested a one year extension to the Klamath HCP and associated Incidental Take Permit (PacifiCorp 2012; PacifiCorp 2020b), which NMFS (2021d) found to be consistent with applicable laws and regulations. As part of PacifiCorp's HCP (PacifiCorp 2012), PacifiCorp provides $500,000 per year to a "Coho Enhancement Fund", which is also administered by the NFWF, to pay for coho recovery actions in the Klamath River during the interim period prior to potential dam removal. Detailed information on habitat conservation plan's covered activities can be found in

Chapter 2 of the PacifiCorp HCP (PacifiCorp 2012). As of December 31, 2020, the PacifiCorp Coho Enhancement Fund has awarded approximately $5.7 million to 57 projects (PacifiCorp 2021b).

The PacifiCorp HCP has seven goals and objectives, which were developed with technical assistance from NMFS technical staff, based on the conservation needs of the SONCC coho salmon, as follows (PacifiCorp 2012):

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

- Congress authorized $1 million annually from 1986 through 2006 to implement the Klamath River Basin Conservation Area Restoration Program. The Klamath River Basin Fisheries Task Force was established by the Klamath River Basin Fishery Resources Restoration Act of 1986 (Klamath Act) to provide recommendations to the Secretary of the Interior on the formulation, establishment, and implementation of a 20-year program to restore anadromous fish populations in the Klamath River Basin to optimal levels.

- Multiple local watershed groups exist in the action area, including: TNC and Caltrout (who are active in the Shasta River sub-basin and other locations in the Klamath Basin), Scott River Watershed Council (Scott sub-basin), Siskiyou Resource Conservation District (Scott sub-basin), Scott Valley Water Trust (Scott sub-basin), Salmon River Restoration Council (Salmon sub-basin), Karuk Tribe and Mid-Klamath Watershed Council (mid-Klamath sub-basin), and the Yurok Tribe (lower-Klamath sub-basin). These groups have all received funds from the Reclamation and PacifiCorp funded grant programs described in previous bullets. Some key restoration actions that have been implemented in these sub-basins include (PacifiCorp 2020a; PacifiCorp 2021a):

  - Construction of off-channel ponds and side channels to provide winter velocity refugia for juvenile salmonids. These projects typically include connection to ground water so the habitat can also function as cold water refugia throughout the summer as well.

  - Construction of beaver dam analogue structures (BDAs) to improve floodplain connectivity and instream complexity. The BDAs increase ground water storage, sort sediment, and provide both winter and summer refugia for juvenile salmonids.

- Placement of large wood jams in tributaries to improve floodplain connectivity, provide winter, and summer refugia for juvenile salmonids.
- Remediation of mine tailings and reconstruction of stream reaches to improve sinuosity and floodplain connection.
- Implementation of off-channel stock watering systems to improve water quality and quantity as well as riparian vegetation condition.

- NMFS administers several grant programs to further restoration efforts in the Klamath River Basin. Since 2000, NMFS has issued grants to the States of California and Oregon, and Klamath River Basin tribes (Yurok, Karuk, Hoopa Valley and Klamath) through the Pacific Coast Salmon Restoration Fund (PCSRF) for the purposes of restoring coastal salmonid habitat. California integrates the PCSRF funds with their salmon restoration funds and issues grants for habitat restoration, watershed planning, salmon enhancement, research and monitoring, and outreach and education. In addition, the NOAA Restoration Center has provided more than $4.5 million from 2001 through 2022 on fish passage, LWD, water conservation and floodplain reconnection projects in the Klamath Basin (Pagliuco 2023).
- The Fish and Wildlife Service has three ecological services offices in the Basin. The Service's Partners for Fish and Wildlife Program delivers conservation on private lands and tribes. Fish and Wildlife Service programs also invest in habitat restoration, science, and monitoring activities throughout the Basin. In FY 21, the Service invested over $11M to advance the restoration of Klamath Basin native fish species in the Upper Basin and anadromous salmon, steelhead, and lamprey in the Lower Basin. The Service used these funds to invest in improving conditions for salmon and suckers, and water quality. The Service was also able to provide tribal grants totaling approximately $2M to assist them in developing more internal capacity to undertake tribal fisheries priorities. The Service, along with Tribes and other Stakeholders also provide funding and resources to study and restore the Trinity River through the Trinity River Restoration Program for native aquatic species (Matt Baun, USFWS, personal communication[2]).

2.4.1.1.7 Land Use/Management Activities

2.4.1.1.7.1 Wildfire

Two linked factors that have affected coho salmon in the action area are the occurrence and subsequent suppression of wildfires. A number of significant fires were seen in the Klamath Basin during and after the recent drought. The Klamathon fire in 2018 impacted 38,000 acres

[2] Email from Matt Baun (USFWS) to Bob Pagliuco (NOAA Restoration Center), October 29, 2021.

around Iron Gate Reservoir, including the Camp Creek area and the river reach downstream of the dam. Since 2008, many large wildfires (i.e., wildfires greater than 10,000 acres) occurred downstream of the hydroelectric dams, including the Siskiyou Complex in 2008, Fort Complex in 2012, Beaver and Happy Camp Complex in 2014, Bear in 2015, Gap in 2016, Prescott and Abney in 2017, Klamathon and Natchez in 2018, Slater/Devil in 2020, and the McCash and Lava fires in 2021 (CalFire 2021; FERC 2021a). Negative impacts to anadromous fish from wildfires can result from altered hydrologic function, increased sediment loading and turbidity, decreased habitat resulting from water drafting (i.e., water being removed from streams for firefighting and dust abatement), water quality impacts from the misapplication of fire retardants, and other factors. NMFS has consulted with the United States Forest Service (USFS) on projects to reduce impacts of wildfires in key coho salmon tributaries (NMFS 2016a). Wildfire effects to coho salmon habitat have been minimized through application of federal protective guidance including NMFS' (2001c) Water Drafting Specifications to avoid dewatering, fish impingement and entrainment impacts, and USFS' Interagency Wildland Fire Chemicals Policy and Guidance described in USFS' Implementation Guide for Aerial Application of Fire Retardant (USFS 2019). Despite application of this guidance, wildfires have and will continue to impact coho salmon in the action area. The magnitude and extent of future wildfire impacts may increase due to a recent period of protracted drought in the Klamath Basin.

2.4.1.1.7.2 Timber Harvest

Timber harvesting in the action area has resulted in long-lasting effects to fish habitat conditions. As described in NMFS' SONCC coho salmon recovery plan (NMFS 2014b), harvest of streamside trees during the early and middle 1900s has left a legacy of reduced large woody debris recruitment. Lack of large wood recruitment has contributed to elevated stream temperatures due to decreased incidence of pool habitats and altered hydrodynamics, particularly along the Klamath mainstem and along the lower reaches of the Scott River. Sedimentation from modern-day harvest units, harvest-related landslides and an extensive road network continues to impact habitat, although at much reduced levels in comparison to early logging. Ground disturbance, compaction, and vegetation removal during timber harvest have modified drainage patterns and surface runoff, resulting in increased peak storm flows that have, in turn, increased stream channel simplification and channel aggradation. Simplification of stream channels and sediment aggradation result in loss or destruction of salmonid holding and rearing habitat, as pool complexes and side channel habitats become degraded to the point of no longer providing refugia for juveniles.

In order to combat the severe alteration of salmon habitat caused by historical forest practices, several forest practices and management plans are being implemented in the Klamath Basin. The Northwest Forest Plan (NFP) is an integrated, comprehensive design for ecosystem management, intergovernmental and public collaboration, and rural community economic assistance for federal forests in western Oregon, Washington, and northern California. Since adoption of the NFP in 1994, timber harvest and road building on USFS lands in the Klamath Basin have decreased dramatically and road decommissioning has increased. It is expected that implementation of the NFP in its revised form will help to recover aquatic habitat conditions adversely affected by legacy timber practices. The Klamath National Forest is also committed to treat legacy sediment sources, through a conditional waiver issued by the North Coast Regional

Water Quality Control Board, under Section 404 of the Clean Water Act. These sediment sources include road-stream crossings, the largest, chronic producers of sediment capable of mobilization downstream to SONCC ESU coho salmon critical habitat.

Along the lower Klamath River, Green Diamond Resource Company owns and manages approximately 265 square miles of commercial timber lands downstream of the Klamath-Trinity River confluence. The company has completed an HCP for aquatic species, including SONCC ESU coho salmon (GDRC 2006), and NMFS issued an ESA section 10(a)(1)(B) incidental take permit on June 12, 2007 (NMFS 2007). The 50-year HCP commits Green Diamond to reducing sediment mobilization from approximately half of its high- and moderate-priority road segments for treatment. These sediment-reduction treatments are to be property-wide, and are to occur during the first 15 years of implementation. The HCP also places restrictions on timber harvest on unstable slopes and in fish-bearing watercourses. The HCP is, therefore, expected to reduce impacts of Green Diamond's timber operations on aquatic species habitat over time.

2.4.1.1.7.3 Agriculture

Crop cultivation and livestock grazing in the upper Klamath River Basin began in the mid-1850s. Since then, valleys have been cleared of brush and trees to provide more farm land. Besides irrigation associated with Reclamation's Klamath Project, other non-Project irrigators operate within the Klamath River Basin. Irrigated agriculture both above (e.g., Williamson, Sprague, and Wood rivers) and surrounding UKL consists of approximately 180,000 acres. Excluding Reclamation's Project, estimated average consumptive use in the upper Klamath River Basin is approximately 350,000 acre feet per year (NRC 2004).

Two diversion systems transfer water from the Klamath River to the Rogue River Basin: Fourmile Creek and Jenny Creek. Water operators annually divert an average of 24,000 acre-feet of water from the Klamath River basin at Jenny Creek into the Rogue River Basin (Reclamation 2013). An additional 6,600 acre feet is diverted annually from Fourmile Creek into the Rogue River Basin; however, 2,200 acre feet of the Fourmile diversion is lost through canal leakage and assumed to stay in the Klamath Basin (RRVID 2018). Thus, roughly 28,400 acre feet of water is diverted annually from the Klamath River to the Rogue River Basin via those diversion systems (NMFS 2012a). In addition, the Trinity River Division of Reclamation's Central Valley Project provides impounded water from the Trinity River to California's Central Valley via the Clear Creek Tunnel. The Trinity River Division diverts an annual average of approximately 50% of Trinity Reservoir inflow to the Central Valley for agricultural use.

The consumptive use of water described above is expected to negatively impact one or more of the VSP criteria for the interior Klamath populations because it reduces summer and fall discharge of tributaries that the populations use (Van Kirk and Naman 2008); and low flows in the summer have been cited as limiting coho salmon survival in the Klamath Basin (CDFG 2002; NRC 2004). Specifically, the spatial structure, population abundance, and productivity can be impacted by agricultural activities. Altered flows likely interfere with environmental cues that initiate distribution of juvenile coho salmon in the river, alter seaward migration timing, and potentially impact other important ecological functions, leaving juveniles exposed to a range of poor-quality habitat, and prolonged exposure to stressful over wintering and summer rearing conditions.

2.4.1.1.7.4 Mining

Mining activities within the Klamath River Basin began prior to 1900. The negative impacts of stream sedimentation on fish abundance were observed as early as the 1930s. Mining operations adversely affected spawning gravels, decreased survival of fish eggs and juveniles, decreased benthic invertebrate abundance, increased adverse effects to water quality, and impacted stream banks and channels. Gravel mining also has removed coarse sediment which can significantly alter physical habitat characteristics and fluvial mechanisms, such as causing increased river depth, bank erosion, and head-cutting (Freedman et al. 2013). Since the 1970s, however, large-scale commercial mining operations have been eliminated in the basin due to stricter environmental regulations, and in 2009 California suspended all instream mining using suction dredges (NMFS and USFWS 2013). The use of vacuum or suction dredge equipment, otherwise known as suction dredging, remains prohibited and unlawful throughout California (https://wildlife.ca.gov/Licensing/Suction-Dredge-Permits, visited on December 1, 2021; see generally California Fish and Game Code 5653, 5653.1, 12000, subdivision (a)).

2.4.1.1.8 Habitat Conditions in the Klamath Basin above IGD (IGD to Spencer Creek)

Although the current upstream terminus of anadromous habitat in the Klamath Basin is IGD, because coho salmon are expected to re-populate their historic habitat above IGD, which is believed to be at least as far upstream as Spencer Creek (Hamilton et al. 2005), the current habitat conditions in this reach are discussed here. Critical habitat for SONCC coho salmon is not designated upstream of IGD. While coho salmon are not currently present in this reach, habitat characteristics in this reach have been evaluated and compared to coho salmon habitat needs (Ramos 2020). In addition, the habitat in this reach does support a population of potadromous rainbow/redband trout (*Oncorhynchus mykiss*), and evaluation of the rainbow trout habitat usage in this reach may inform potential usage by anadromous species when anadromous species again have access to this reach (Hamilton et al. 2011). The majority of spawning habitat for rainbow/redband trout in this reach is in Spencer and Shovel creeks; however, various life stages of rainbow/redband trout utilize other tributaries and sections of the reach, including cold water refugia at Big Springs and Fall Creek (Hamilton et al. 2011).

Ramos (2020) conducted habitat surveys and specifically analyzed the repopulation potential for coho salmon in the largest tributaries to the Klamath River between IGD and Spencer Creek. Ramos (2020) used temperature and other physical features of six tributaries (i.e., Scotch, Camp, Jenny, Fall, Shovel, and Spencer creeks) to assess their capacity to support juvenile coho salmon following dam removal, and found that the six newly accessible tributary streams will provide greater than 33 km of newly accessible habitat, and maintained significant juvenile coho salmon summer rearing capacity, redd capacity, and intrinsic potential for adult coho salmon spawner escapement (Table 12). Ramos (2020) concluded that there was prolific cold-water temperatures throughout Scotch, Camp, Fall, Shovel, and portions of Spencer creeks, and that newly accessible habitat in the study tributaries will provide substantial rearing and spawning habitat for coho salmon after dam removal. Building on the work done by Ramos (2020), the NOAA Fisheries Restoration Center initiated habitat surveys in additional smaller tributaries in this reach, including areas of the Ramos (2020) tributaries that were previously inaccessible. These habitat surveys identified additional habitat features, including spawning gravel in Spencer Creek and Camp Creek, a complex of unnamed coldwater springs flowing into Copco Lake, and cold water refugial rearing areas (e.g., several springs on Shovel Creek, East Branch and West Branch Long Prairie Creek, and Frain Creek) that could be utilized by coho salmon (NMFS 2021b).

Table 12. Overall summary of results of habitat surveys in tributaries upstream of IGD to Spencer Creek. Adapted from Table 8 in Ramos (2020).

Stream	Scotch Creek	Camp Creek	Jenny Creek	Fall Creek	Shovel Creek	Spencer Creek
MWMT* (°C)	16.6 – 17.1	17.1	20.8 – 22.2	15.6 – 16.2	13.2 – 15.4	16.7 – 23.7
MWAT* (°C)	15.1 – 16.6	14.6	19.8 – 20.7	13.8 – 14.0	12.1 – 13.7	15.2 – 19.2
Accessible Habitat (km)	1.0	2.2	3.3	1.6	4.7	20.5
HLFM* Juvenile Coho Salmon Summer Rearing Capacity	2,600	--	18,100	4,700	13,300	66,300
HLFM* Redd Capacity	205	--	51	92	23	17,993
HLFM* Egg Capacity	512,500	--	127,500	230,00	57,500	44,982,500
IP* (km)	1.7	1.6	1.3	0.9	2.8	13.1
IP* Coho Salmon Spawner Escapement Target	67	65	52	37	111	526

*MWMT = maximum weekly maximum temperature. MWAT = maximum weekly average temperature. HLFM = habitat limiting factors model. IP = Intrinsic Potential.

2.4.1.1.9 Habitat Conditions downstream of IGD

As described above, critical habitat for SONCC coho salmon in the Klamath River Basin that overlaps with the action area consists of the water, substrate, and adjacent riparian zone from the IGD (RM 193.1) to the Klamath River mouth at the Pacific Ocean, excluding the Yurok Reservation, Karuk Reservation, and Resighini Rancheria, which includes the Klamath River downstream of the confluence with the Trinity River. In addition, the tributaries to the Klamath River downstream of IGD, including the Shasta, Scott, Salmon, and Trinity (excluding the Hoopa Valley Reservation) rivers are also designated critical habitat. The following sub-sections describe habitat conditions in reaches downstream of IGD, including juvenile migratory, adult migratory, juvenile rearing, and spawning habitat conditions. In some cases, conditions outside of the action area are described where they have effects on the abundance and distribution of SONCC coho salmon in the action area.

2.4.1.1.9.1 Juvenile Migratory Habitat Conditions

Juvenile migratory habitat must support both smolt emigration to the ocean and the seasonal redistribution of juvenile fish. This habitat must have adequate water quality, water temperature, water velocity, and passage conditions to support migration. It's important that migratory habitat is available year round since juvenile coho salmon spend at least one year rearing in freshwater and have been shown to move upstream, downstream, in the mainstem, and into non natal tributaries when redistributing to find suitable habitat (Adams 2013; Witmore 2014). Emigrating smolts are usually present within the mainstem Klamath River between February and the beginning of July, with April and May representing the peak migration months (Pinnix et al. 2007; Daniels et al. 2011)(Figure 6). Emigration rate tends to increase as fish move downstream (Stutzer et al. 2006).

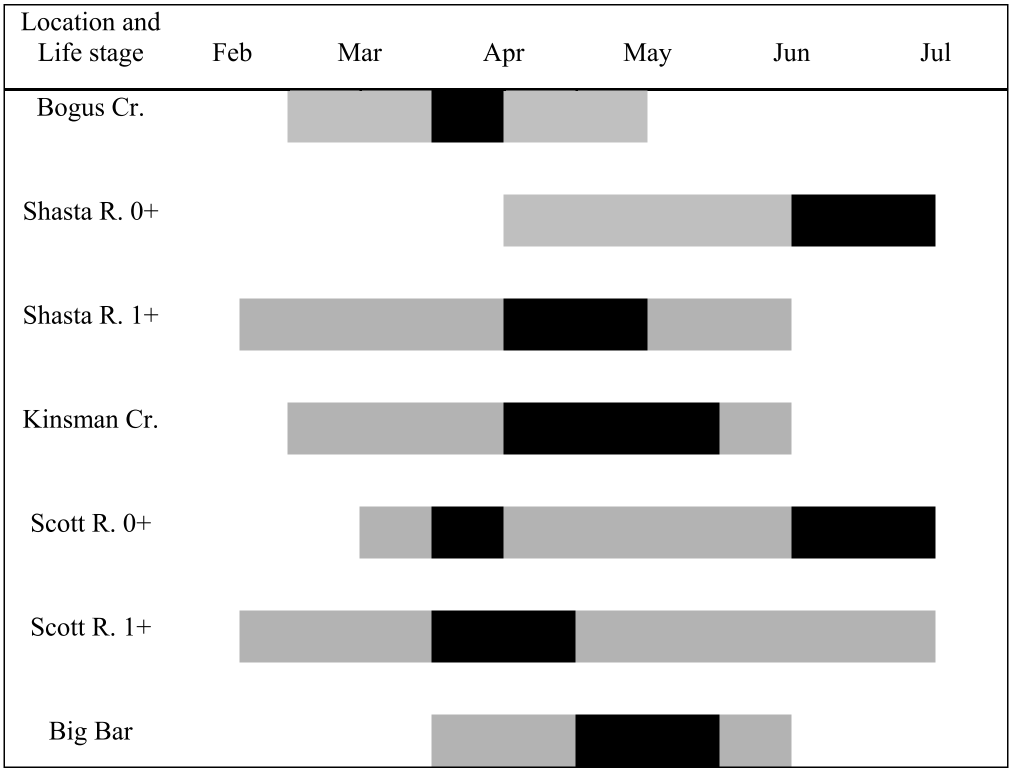

Figure 6. General emigration timing for coho salmon smolt within the Klamath River and tributaries. Black areas represent peak migration periods, those shaded gray indicate non-peak periods. 0+ refers to young-of-year while 1+ refers to smolts.

Juvenile migratory habitat conditions by sub-reach are described as follows:

2.4.1.1.9.1.1 Middle Klamath River Reach (Trinity River Confluence to IGD)

Downstream of IGD, some juvenile migration corridors are degraded because of diversion dams, low flow conditions, poorly functioning road/stream crossings in tributaries, disease effects, and high-water temperatures and low water velocities that slow and hinder emigration or upstream and downstream redistribution in both tributaries and the mainstem portion of this reach. The unnatural and steep decline of the hydrograph in the spring, due to anthropogenic factors including water diversions and timing of water releases, observed in both the mainstem and tributaries, likely slows the emigration of coho salmon smolts, speeds the proliferation of fish diseases in the mainstem, and increases water temperatures more quickly than would occur otherwise. Disease effects, particularly in areas of the mainstem such as the Trees of Heaven site (RM ~174), have been found to have had a substantial impact on the survival of migrating juvenile coho salmon in this stretch of river (NMFS 2014b). Low flows in the mainstem during the spring can slow the emigration of smolt coho salmon, which can in turn lead to longer exposure times for disease, and greater risks due to predation.

2.4.1.1.9.1.2 Shasta River population

Smolt emigration in the Shasta River coincides with the drop-in flows from irrigation water withdrawal, typically in mid-April. Because there are significant water diversions and impoundments in the Shasta River, the unnatural and steep decline of the hydrograph following the start of the irrigation season in April decreases the quantity of rearing habitat and causes water temperatures to increase more quickly than would occur otherwise. These changes can displace young-of-year coho salmon, forcing them to redistribute in search of suitable rearing habitat and thereby increasing their risk of mortality (Gorman 2016). Similarly, the reduction in water quality and quantity likely has a negative impact to emigrating coho salmon smolts, increasing their risk of mortality. Recent drought conditions in the Shasta River basin are an additional factor that can negatively impact emigrating coho salmon smolts. As a response to these drought conditions, the SWRCB has instituted diversion curtailments in the Shasta River Basin (https://www.waterboards.ca.gov/drought/scott_shasta_rivers/, visited on December 3, 2021).

2.4.1.1.9.1.3 Scott River

Some anthropogenic features in the Scott River can impact the timing of juvenile migration. A number of physical fish barriers exist in the Scott River watershed. For instance, Big Mill Creek, a tributary to the East Fork Scott River, has a complete fish passage barrier caused by down cutting at a road culvert outfall. Additionally, historical mining has left miles of tailings piles along the mainstem and some tributaries of the Scott River. A seven-mile reach of Scott River goes subsurface every summer due to this channel modification in combination with low flows, limiting juvenile redistribution. For many years, the City of Etna's municipal water diversion dam on Etna Creek effectively blocked fish passage into upper Etna Creek; however, this dam was retrofitted with a volitional fishway in 2010. In addition, valley-wide agricultural surface water withdrawals and diversions, and groundwater extraction have all combined to cause premature surface flow disconnection in the summer and delayed re-connection in the fall along the mainstem Scott River. These conditions can consistently result in restrictions or exclusions to suitable rearing habitat, contribute to elevated water temperatures, and contribute to conditions that force juvenile fish to move, become stranded, and increase mortality risks (NMFS 2014b). Recent drought conditions in the Scott River basin are an additional factor that can negatively impact emigrating coho salmon smolts. As a response to these drought conditions, the SWRCB has instituted diversion curtailments in the Scott River Basin (https://www.waterboards.ca.gov/drought/scott_shasta_rivers/, visited on December 3, 2021).

2.4.1.1.9.1.4 Salmon River

Juvenile migration corridors exhibit high water temperatures that may hinder juvenile redistribution during the summer. Seasonal low flow barriers were previously a concern for juvenile migration, but those barriers were largely addressed and barriers are now a low level stressor for the Salmon River (NMFS 2014b).

2.4.1.1.9.1.5 Trinity River

The Trinity River Division of the Central Valley Project has caused loss of hydraulic function, habitat loss, and habitat simplification in the mainstem Trinity River. The juvenile stage of the Upper Trinity River population unit of SONCC coho salmon is the most limited life stage and suitable quality summer and winter rearing habitat is lacking for the population. Water withdrawals from important tributaries like Weaver and Rush creeks reduce baseflows in the summer and fall months, contributing to low flows and high-water temperatures that can impact juvenile migration. In the summer, flow regimes and the lack of LWD and off-channel habitat leads to poor hydrologic function, disconnection and diminishment of thermal refugia, and poor water quality in tributaries and the mainstem during dry years. These issues are being addressed through restoration efforts but will continue to persist as limiting factors for the population (NMFS 2014b).

2.4.1.1.9.1.6 Lower Klamath River Reach (Klamath River mouth to Trinity River Confluence)

The mainstem lower Klamath River provides migratory and rearing habitat for juvenile coho salmon for all Klamath River coho salmon populations (NMFS 2014b). Water temperatures are typically suitable for juvenile salmonids in the Klamath River downstream of the Trinity River, and flow is also generally suitable to preclude the formation of barriers and support juvenile migration year-round.

2.4.1.1.9.2 Adult Migratory Habitat 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. Adult coho salmon typically begin entering the lower Klamath River in late September (but as early as late August in some years), with peak migration occurring in mid-October (Ackerman et al. 2006). Adults may remain in the rivers until spawning is completed as late as February.

Adult migratory habitat conditions by sub-basin are described as follows:

2.4.1.1.9.2.1 Middle Klamath River Reach (Trinity River Confluence to IGD)

The current physical and hydrologic conditions of the adult migration corridor in the mainstem Middle Klamath River reach are likely functioning in a suitable manner. Water quality is sufficient for upstream adult migration, and with implementation of flows analyzed in the NMFS (2019) biological opinion and subsequent IOP, flow volume is above the threshold at which physical barriers to migration are likely to form.

2.4.1.1.9.2.2 Shasta River

Migration timing of adult coho salmon entering the Shasta River typically begins in about the middle of October. The run typically begins to decrease quickly after the second week of December. Flow levels throughout the Shasta River typically increase after October 1st when most of the irrigation diversions upstream are turned off at the end of the season. Therefore, in most years, physical and hydrologic conditions in the lower Shasta River have improved by mid-October providing suitable conditions for adult coho salmon migratory access to spawning habitats in the upper Shasta River near Big Springs Creek.

2.4.1.1.9.2.3 Scott River

In the Scott River, upstream migration of adult coho salmon may begin in the last two weeks of October and may last into the first week of February. However, the majority of coho salmon migrate upstream during November with numbers decreasing in December and January. The irrigation season ends on October 15 under the Scott River Decree; however, stock water is still diverted through the winter. In addition to the surface water diversions, there are a substantial number of larger alfalfa farms in the lower portions of the Scott Valley and along Moffett Creek that rely on groundwater pumping to meet their irrigation demands. These withdrawals lower the groundwater table below the elevation of the existing river channel, adversely affecting the abundance of interconnected groundwater to stream and river channels along the valley floor (Harter and Hines 2008; Hathaway 2012; S.S. Papadopulos & Associates Inc. 2012). As a result, surface flow connectivity in the fall is delayed until fall precipitation events and tributary flow contributions restore groundwater elevations up to a level equal to or greater than the elevations of the river channel. The delay in the establishment of adequate surfaces flows results in a corresponding delay in creating suitable flow conditions for adult salmon to migrate upstream through the lower Scott River canyon where several naturally occurring migration obstacles are present. This altered flow regime can result in substantial delay for migrating adult Chinook salmon and early migrations of coho salmon.

2.4.1.1.9.2.4 Salmon River

The current physical and hydrologic conditions of the adult migration corridor in the Salmon River reach are likely properly functioning in a manner that supports its conservation role of the adult migration corridor. Water quality is suitable for upstream adult migration, and flow volume is above the threshold at which physical barriers are likely to form (NMFS 2014b).

2.4.1.1.9.2.5 Trinity River

The Trinity River supports three populations of SONCC coho salmon that must migrate through the Lower Klamath River: the Upper Trinity River, Lower Trinity River, and Lower Klamath River Population Units (NMFS 2014b). The Upper-Trinity Population unit is unique within the Trinity River system as these coho salmon are currently the longest migrating adult coho salmon in the diversity stratum. While coho salmon likely used to migrate as far as Hayfork Creek on the South Fork Trinity River, habitat degradation and water utilization on that river has restricted the spatial structure of the population unit. The run timing of the Upper Trinity River population unit is earlier (September and October) than those fish in the Lower Trinity Population unit (November through January).

2.4.1.1.9.2.6 Lower Klamath River Reach (Klamath River mouth to Trinity River Confluence)

Implementation of the flows analyzed in the NMFS (2019) biological opinion and subsequent IOP has likely alleviated many of the adult migration issues observed in the past and improved critical habitat in the Lower Klamath reach. The implemented flows include fall and winter flow variability, which has alleviated instream conditions brought about by low flows that likely resulted in impairments to upstream adult migration in the past.

2.4.1.1.9.3 Juvenile Rearing Habitat Conditions

Juvenile coho salmon rear in freshwater for a full year and can be found in the mainstem and tributaries. Although their rearing needs and locations may change on a seasonal basis, an interconnected system is critical so that they can access different resources provided in different water bodies. For example, Witmore (2014) and Brewitt and Danner (2014) documented juvenile salmonids rearing in tributaries of the Klamath River while simultaneously relying on mainstem food sources. These individuals displayed a diurnal movement pattern that highlights the importance of tributary/mainstem connection even during times when the mainstem appears to be inhospitable.

Juvenile rearing habitat conditions by sub-basin are described as follows:

2.4.1.1.9.3.1 Middle Klamath River Reach (Trinity River Confluence to IGD)

Juvenile summer rearing areas have been compromised by low flow conditions, high water temperatures, insufficient dissolved oxygen levels, excessive nutrient loads, habitat loss, disease effects, pH fluctuations, non-recruitment of large woody debris, and loss of geomorphological processes that create habitat complexity. Water released from IGD during summer months is already at a temperature stressful to juvenile coho salmon, and solar warming can increase temperatures even higher (up to 26 ºC) as flows travel downstream (NRC 2004). The period of time when fry and juvenile rearing, as well as smolt migration, is possible along the mainstem has been shortened by these conditions and is, therefore, a temporal limitation. In the summer, the diversion and impoundment of water continues to lead to poor hydrologic function, disconnection and diminishment of thermal refugia, and poor water quality in tributaries and the mainstem. Most tributaries with summer rearing potential are highly impacted by agriculture and past timber harvest. Very few remaining areas exist downstream of IGD with the potential and opportunity for summer rearing. Overwinter rearing habitat may be a limiting factor for juvenile coho salmon in the Middle Klamath River. Human activities such as mining and agriculture have significantly altered the mainstem and tributaries into a more simplified channel with limited access to the floodplain. Additionally, much of the Middle Klamath River reach parallels Highway 96, leaving little room for floodplain complexity. As a result, slow velocity water, such as side channels, off channel ponds, and alcoves, have been eliminated, decreasing the ability for juvenile coho salmon to persist during high velocity flows in the winter (NMFS 2014b). As mentioned above, many of the tributaries in this reach are small and may go subsurface near their confluence with the mainstem Klamath River. Yet these intermittent tributaries sometimes remain important rearing habitat for coho salmon, when and where sufficient instream flows, water temperature, and habitat conditions are suitable to sustain them. Coho salmon have adapted life history strategies (spatial and temporal) to use intermittent streams. For example, adult coho salmon will often stage within the mainstem Klamath River at the mouth of natal streams until hydrologic conditions allow them to migrate into tributaries, where they are able to find more suitable spawning conditions, and juveniles can find adequate rearing conditions and cover. In summer when the downstream sections of these tributaries may go dry, the shaded, forested sections upstream provide cold water and high-quality summer rearing habitat for juvenile coho salmon.

Unlike many of the other tributary streams within the Middle Klamath River reach, Bogus Creek and its largest tributary Cold Creek, contain several cold water springs that provide favorable conditions for rearing coho salmon during the summer (Hampton 2010). These springs are located upstream of a waterfall (RM 3.48) that prevented anadromous fish access to these locations historically. In 1965, a fish ladder was constructed over this migration barrier and adult salmon and steelhead have had access to another six miles of habitat upstream of the barrier since that time. There are several habitat and water conservation projects that have been completed recently or are currently underway to further improve rearing habitat conditions for juvenile coho salmon in the reach upstream of the ladder. These projects include installation of cattle exclusion fencing, riparian plantings, piping of irrigation ditches, construction of tailwater capture systems, and direct infusion of cold spring water to the channel. The mouth of Bogus Creek is located adjacent to IGH and hatchery origin coho salmon are known to stray and spawn in Bogus Creek. The CDFW has been monitoring emigration of smolt from Bogus Creek since 2015. Results of this effort indicate that age 1+ coho salmon emigrate from late February through May, and fry coho salmon have been observed from April through mid-June (Knechtle and Giudice 2018; Knechtle and Giudice 2021a; Knechtle and Giudice 2022b).

Over approximately the last 10 years, there has been a large effort to improve over winter habitat for juvenile coho salmon in the Middle Klamath River reach. In particular, the Mid Klamath Watershed Council and Karuk Tribe have been constructing off channel pond features in key locations to provide slow velocity water. Over a dozen ponds have been constructed in locations such as Seiad Creek, Horse Creek, Tom Martin Creek, West Grider Creek, and O'Neil Creek. Monitoring efforts have shown that both natal and non-natal juvenile coho salmon are using these sites in large numbers (Witmore 2014).

There are approximately 79 miles of potentially suitable juvenile rearing habitat spread throughout the mainstem Klamath River and tributaries in the Middle Klamath region (NMFS 2014b). However, juvenile summer rearing areas in this stretch of river are degraded relative to the historical state. High water temperatures, exacerbated by water diversions and seasonal low flows, restrict juvenile rearing in the mainstem Klamath River and lessen the quality of tributary rearing habitat (NMFS 2014b). Nevertheless, a few tributaries within the Middle Klamath River Population (e.g., Boise, Red Cap and Indian creeks) support populations of coho salmon, and offer critical cool water refugia within their lower reaches when mainstem temperatures and water quality approach uninhabitable levels. Other important tributaries for juvenile rearing include Sandy Bar, Stanshaw, China, Little Horse, Pearch, and Boise creeks (NMFS 2014b). However, these cool water tributary reaches can become inaccessible to juveniles when low flows and sediment accretion create passage barriers; therefore, summer rearing habitat can be limited.

2.4.1.1.9.3.2 Shasta River

Historically, instream river conditions, fostered by unique cold spring complexes, created abundant summer rearing and off channel overwintering habitat that were favorable for production of coho salmon in the Shasta River basin. However, a reduction in the frequency of large flood flows along with the elimination of sediment transport processes downstream of Dwinnell Dam have resulted in coarsening of the bed and reduction in habitat diversity immediately downstream of the dam. The loss of woody debris, pools, side channels, springs, and accessible wetlands from land use conversions have also contributed to reduced summer and winter rearing capacity for juvenile coho salmon (NMFS 2014b).

Juvenile rearing is currently confined to the mainstem Shasta River from RM 17 to RM 23, Big Springs Creek, Lower Parks Creek, Shasta River Canyon, Yreka Creek, and the upper Little Shasta River. Stream temperatures for summer rearing are poor throughout much of the mainstem Shasta River from its mouth upstream to near the confluence of Big Springs Creek. The onset of the irrigation season in the Shasta River watershed has a dramatic impact on discharge when large numbers of irrigators begin taking water simultaneously. This results in a rapid decrease in flows below the diversions, stranding coho salmon as channel margin and side channel habitat disappears and in some extreme cases channels can become entirely de-watered, Low stream flows can decrease rearing habitat availability for juvenile coho salmon. Further alterations to stream channel function from agricultural practices includes a reduction in the number of beaver ponds, which provide important habitat attractive to rearing coho salmon (NMFS 2014b).

Historically, the most vital habitat in the Shasta River basin were its cold springs, which created cold water refugia for juvenile coho salmon, decreased overall water temperatures, and allowed for successful summer rearing of individuals in natal and non-natal creeks and mainstem areas. These areas have been significantly adversely affected by water withdrawals, agricultural activities, and riparian vegetation removal. These land use changes have compromised juvenile rearing areas by creating low flow conditions, high water temperatures, insufficient dissolved oxygen levels, and excessive nutrient loads. However, habitat restoration in the Big Springs complex and on The Nature Conservancy’s Nelson Ranch have improved juvenile rearing conditions in those areas.

Streamflow in the Upper Shasta River is primarily controlled through releases from Dwinnell Reservoir, which is owned and operated by the Montague Water Conservation District (MWCD). There are several ways in which MWCD can release water to the Upper Shasta River downstream of Dwinnell Dam. These include releases of irrigation water to meet rights of prior water right holders downstream, short term voluntary release of water and participation in water lease agreements to improve instream conditions for salmonids, and release of environmental water as agreed to under their Conservation and Habitat Enhancement and Restoration Program

(CHERP) which was developed coincident with a Settlement Agreement with the Klamath River Keeper and Karuk Tribe. Under the CHERP, once water conservation projects have been completed to their main canal, MWCD will increase instream environmental releases by an average of 4,400 acre-feet below Dwinnell Dam as a conservation measure to improve conditions for coho salmon.

In addition to CHERP, a substantial Safe Harbor Agreement (SHA) was recently completed in the Shasta River (NMFS 2020). Under the SHA, 11 landowners on 14 properties associated with water and land use in the upper Shasta River basin agree to complete a suite of beneficial management activities such as LWD installations, or water conservation and forbearance agreements, that are intended to improve habitat in the Shasta basin. LWD is depleted in the Shasta River due to anthropogenic land use changes, including grazing and agricultural practices. Additionally, water diversions have likely lowered the water table throughout the basin, thereby limiting growth of riparian vegetation and channel forming wood. The lack of large wood in the Shasta River creates a deficit of shade and shelter, and decreases habitat complexity and pool volumes, all necessary components for over-summering juvenile survival. The Shasta SHA is expected to provide a net conservation benefit in the upper Shasta River basin, including improving juvenile rearing conditions for coho salmon.

2.4.1.1.9.3.3 Scott River

Numerous water diversions, dams and interconnected groundwater extraction for agricultural purposes, and the diking and leveeing of the mainstem Scott River have reduced summer and winter rearing habitat in the Scott River basin, limiting juvenile survival. Although rearing habitat still exists in some tributaries, access to some of these areas is hindered by dams and diversions, the existence of alluvial sills, and the formation of thermal barriers at the confluence of tributaries. Where passage is possible, there are thermal refugial pools and tributaries where the water temperature is several degrees cooler than the surrounding temperature, providing a limited amount of rearing habitat in the basin.

Currently, valley-wide agricultural water withdrawals and diversions, groundwater extraction, and drought have all combined to cause premature surface flow disconnection along the mainstem Scott River. In addition, summer discharge has continued to decrease significantly over time, further exacerbating detrimental effects on coho salmon in the basin. These conditions restrict or exclude available rearing habitat, elevate water temperature, decrease fitness and survival of over-summering juveniles, and sometimes result in juvenile fish strandings and death.

Woody debris is scarce throughout the mainstem Scott River and its tributaries. Mainstem habitat has been straightened, leveed, and armored. Anthropogenic impacts have resulted in a lack of channel complexity from channel straightening and reduced amounts of woody material (Cramer Fish Sciences 2010). The present-day mainstem Scott River bears minor resemblance to its more complex historic form although meandering channel planforms are still present (Cramer Fish Sciences 2010). Over the last several years the Scott River Watershed Council has been working collaboratively with NMFS and CDFW to improve habitat conditions for rearing coho salmon, improve wetland habitat, improve floodplain connectivity, and help maintain surface water and groundwater connectivity through development of BDAs at strategic locations in major tributary streams and in the mainstem Scott River. Fry and juvenile coho salmon have been documented using these restoration sites throughout the year. The Scott River Watershed Council in collaboration with NMFS has shown through their long term monitoring efforts that the fish in these BDA sites have displayed high rates of growth and high rates of over-winter survival (Yokel et al. 2018). Development of more of these types of projects, if combined with improved water conservation and management practices, is anticipated to improve conditions for rearing coho salmon in the future.

2.4.1.1.9.3.4 Salmon River

According to available juvenile fish survey information beginning in 2002, juvenile coho salmon have been found rearing in most of the available suitable tributary habitat. These streams are tributaries to the South Fork Salmon (Knownothing and Methodist Creek), at least nine tributaries to the North Fork Salmon, and in mainstem Salmon River tributaries, including Nordheimer and Butler Creeks (Hotaling and Brucker 2010). The lower reaches of these tributaries provide substantially cooler summer habitat than mainstem river habitat. During juvenile coho salmon presence/absence surveys conducted from 2015-2017 a total of 89 juvenile coho salmon were observed (0 in 2015, 53 in 2016, 36 in 2017), primarily within the South Fork or its tributaries. In 2018, 54 juvenile coho salmon were observed at the mouth of and within Methodist Creek, a tributary to the South Fork (SRRC 2019, unpublished data). There is some indication that juvenile coho salmon move up from the mainstem Klamath River into the cooler Salmon River tributaries during summer months when stressed by mainstem water temperatures. Some juveniles found in surveys are thought to reflect non-natal as well as natal rearing (NMFS 2014b).

2.4.1.1.9.3.5 Trinity River

Tributaries known to support coho salmon rearing in the Lower Trinity include Mill Creek, Horse Linto Creek, Tish Tang Creek, and Sharber-Peckham Creek. The presence of juvenile coho salmon has also been confirmed in Manzanita Creek, Big French Creek, East Fork New River, Cedar, Supply, Campbell, and Hostler creeks, as well as in Willow Creek as far upstream as the Boise Creek confluence. Lack of floodplain and channel structure impacts have a major impact on the productivity of the Lower Trinity River population. Rearing opportunities and capacity are low due to disconnection of the floodplain, a lack of LWD inputs, poor riparian conditions, and sediment accretion. Low-lying areas of streams such as Supply, Mill, and Willow creeks have been channelized, diked, and disconnected from the floodplain. Many tributaries in low-gradient areas of the Lower Trinity experience similar habitat characteristics due to development of the floodplain, sedimentation and changes in flow. Loss of flow variability and reduced rearing habitat during the fall and winter months as a result of truncated flow release is expected to reduce the ability of the habitat in the Upper Trinity River to support winter rearing of juvenile coho salmon. The mainstem also lacks side channel, backwater, and wetland habitat where juvenile coho salmon could find habitat in the winter. A lack of floodplain and channel structure impacts winter rearing because high flow events can displace juveniles from streams and there exists very little low-velocity rearing habitat. Lack of complex habitat also impacts summer rearing due to the loss of predatory refugia, low-flow refugia, and foraging habitat. In some portions of this population unit cannabis farming impacts summer rearing areas for juveniles, due to runoff and pollution, as well as contributing to poor water quality and quantity.

2.4.1.1.9.3.6 Lower Klamath River Reach (Klamath River mouth to Trinity River Confluence)

In addition to providing connectivity to tributary watersheds for spawning and rearing, the mainstem Lower Klamath River provides rearing habitat for juvenile coho salmon for all Klamath River coho salmon populations. Juvenile coho salmon have been found in many tributary streams in this reach, including Salt, High Prairie, Hunter, Hoppaw, Saugep, Waukell, Terwer, McGarvey, Tarup, Omagaar, Blue, Ah Pah, Bear, Surpur, Little Surpur, Pularvasar, One Mile, Tectah, Johnsons, Pecwan, Mettah, Roaches, Cappell, Richardson, and Tully creeks. In general, coho salmon were only observed in the lower reaches of most tributaries, and in some cases the Yurok Tribe noted that their presence appeared to be non-natal rearing. Faukner et al. (2019) studied the role of the Klamath River mainstem corridor in the life history and performance of juvenile coho salmon in this reach between 2011 and 2017. Their report focuses on sampling conducted in four Lower Klamath River tributaries (Waukell, McGarvey, Panther, and Salt Creeks). Annual spring outmigration estimates for age-1+ coho salmon in Waukell Creek were generally higher than those observed at the other tributaries. Constructed off-channel features in Terwer and McGarvey Creeks were utilized by both natal and non-natal juvenile coho salmon. Non-natal use was higher in the lower portion of McGarvey Creek where most recent stream restoration has occurred. Although the majority of non-natal juvenile coho salmon utilized the lower portion of McGarvey Creek individuals consistently traveled at least 1.4 miles upstream. Fall emigrants from upstream locations that overwinter in Lower Klamath River tributaries contribute substantially to total coho salmon smolt production for the Klamath River population (Faukner et al. 2019). A detailed analysis of survival and emigration rates of both natal fish in two reaches of McGarvey Creek and non-natal fish from Mid Klamath tributaries suggest that a high proportion of the 2017 spring outmigration estimate were most likely non-natal (Antonetti et al. 2017).

2.4.1.1.9.4 Spawning Habitat Conditions

Coho salmon are typically tributary spawners, but low numbers of adult coho salmon annually spawn in the Middle Klamath River mainstem. However, upstream dams block the transport of sediment into this reach of river, and the lack of clean and loose gravel diminishes the quality of salmonid spawning habitat downstream of the dams. This condition is especially critical directly downstream of IGD (FERC 2007). However, water temperatures and water velocities are generally sufficient in this reach for successful adult coho salmon spawning. Downstream of IGD, channel conditions reflect the interruption of sediment flux from upstream by reservoir capture and the eventual re-supply of sediment from tributaries entering the mainstem Klamath River (PacifiCorp 2004).

Spawning habitat conditions by sub-basin are described as follows:

2.4.1.1.9.4.1 Middle Klamath River Reach (Trinity River Confluence to IGD)

The quality and amount of spawning habitat in the Middle Klamath River reach is naturally limited due to the geomorphology and the prevalence of bedrock in this stretch of river. Coho salmon are typically tributary and headwater stream spawners, so it's unclear if there was historically very much mainstem spawning in this reach. In addition to the tributaries discussed below, key Middle Klamath River reach spawning tributaries to which adult coho salmon return annually to spawn include Red Cap Creek, Camp Creek, Seiad Creek and Horse Creek in the lower portion of the reach, Beaver Creek in the middle portion of the reach, and Bogus Creek located in the upper portion of the reach.

2.4.1.1.9.4.2 Shasta River

The Shasta River in particular, with its cold flows and high productivity was once especially productive for anadromous fishes. The current distribution of spawners is limited to the mainstem Shasta River from RM 17 to RM 23, Big Springs Creek, lower Parks Creek, and the Shasta River Canyon. The reduction of LWD recruitment, channel margin degradation, and excessive sediment has limited the development of complex stream habitat necessary to sustain spawning habitat in the Shasta Valley. Persistent low flow conditions through the end of the irrigation season (October 1) can also constrain the timing and distribution of spawning adult coho salmon. Unlike the majority of the Shasta Valley, the irrigation season in Parks Creek doesn't end until November 1, and there are also several stock water diversions that continue to divert throughout the fall and winter season. Therefore, persistent low flow conditions, particularly in dry years can limit the extent of spawning, and may in some years prevent coho salmon from spawning in Parks Creek.

Coho salmon spawning has been observed in the Shasta River Canyon, lower Yreka Creek, throughout the Big Springs Complex area, and in Lower Parks Creek. In some reaches, particularly in the lower canyon and the reach below the Dwinnell Dam, limited recruitment of coarse gravels is likely contributing to a decline in abundance of spawning gravels (Ricker 1997). The causes of the decline in gravels include gravel trapping by Dwinnell Dam and other diversions, bank-stabilization efforts, and historical gravel mining in the channel. In a 1994 study of Shasta River gravel quality, Jong (1997) found that small sediment particles and fines (<4.75mm) were present in quantities associated with excessive salmon and steelhead egg mortality. Jong (1997) also concluded that gravel quality had deteriorated since 1980 when the California Department of Water Resources performed similar work in the Shasta basin. Greenhorn Dam blocks the movement of gravel down Yreka Creek, and alters the Yreka Creek hydrograph.

2.4.1.1.9.4.3 Scott River

Gravel transport in the Scott River basin is relatively unimpeded; however, significant water diversions can reduce the volume and power of the mainstem and tributaries such that bedload mobilization is reduced. Pebble count data and survey data indicate that suitable gravels sizes are found in conjunction with slopes also suitable for spawning (Cramer Fish Sciences 2010). These observations suggest that the amount of coarse sediment and its rate of delivery are not limiting spawning habitat availability in the Scott River Watershed.

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

2.4.1.1.9.4.4 Salmon River

Known coho salmon spawning has been observed in the Nordheimer Creek, Logan Gulch, Brazil Flat, and Forks of Salmon areas along the mainstem Salmon River, in the Knownothing and Methodist Creek reaches of the South Fork Salmon River, and in the lower North Fork Salmon River (NMFS 2014b). Twelve percent of the 1,414 miles of stream within the Salmon River watershed are able to support anadromous salmonids, due to the mountainous topography and associated hydrology of the landscape (Elder et al. 2002). For this reason, coho salmon in the Salmon River population are naturally restricted in their distribution (NMFS 2014b).

2.4.1.1.9.4.5 Trinity River

The Trinity River supports three populations of coho salmon: The Lower Trinity River, Upper Trinity River, and South Fork Trinity River populations. Good spawning habitat exists in a few tributaries in the Lower Trinity River. The Burnt Ranch and New River subareas have some of the best-known spawning habitat in the population area. Tributaries known to support coho salmon spawning and/or rearing include Mill Creek, Horse Linto Creek, Tish Tang Creek, and Sharber-Peckham Creek. Spawning also occurs in each of the other two Trinity River coho populations (NMFS 2014b).

2.4.1.1.9.4.6 Lower Klamath River Reach (Klamath River mouth to Trinity River Confluence)

Because of the high incidence of non-natal rearing, juvenile survey data cannot be used to determine the distribution of spawning in this reach. Spawner distribution data provide more accurate information regarding natal population distribution. Spawning coho salmon have been found in Blue, Hunter, Waukell, McGarvey, Terwer, Ah Pah, Tectah, and Pine creeks. Blue Creek is the largest and most resilient watershed and correspondingly supports the largest anadromous fish populations in the sub-basin (Antonetti and Partee 2013). Habitat surveys in other creeks have shown only marginal habitat suitability for coho salmon spawning, primarily due to the high embeddedness of spawning gravels, and lack of channel structure (e.g., fluvial stored wood) required to facilitate necessary gravel sorting and retention dynamics (NMFS 2014b).

2.4.1.2 Factors Affecting Habitat in the Klamath Basin, Including the Action Area

2.4.1.2.1 Climate Change

Climate change has some general long-term implications for the Klamath Basin, including warming of air and water temperatures, changes in precipitation (i.e., amount of rain versus snow, and frequency of rain-on- snow events), the amount of snowpack, water quantity (e.g., more frequent, high-intensity storms, and lower summer flows), and overall seasonal streamflow patterns (NRC 2004; Halofsky et al. 2018). In the Klamath Basin, climate change effects will vary widely on the SONCC coho salmon populations. The hydrologic characteristics of the Klamath River mainstem and its major tributaries are dominated by seasonal snowmelt runoff (NRC 2004). 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 Basin, particularly those at lower elevations (<6000 ft.). The overall warming trend that has been ubiquitous throughout the western United States (Groisman et al. 2004), particularly in winter temperatures over the last 50 years (Feng and Hu 2007; Barnett et al. 2008), has caused a decrease in the proportion of precipitation falling as snow (Feng and Hu 2007). Basins below approximately 5900-8200 feet in elevation appear to be the most impacted by reductions in snowpack (Knowles and Cayan 2004; Regonda et al. 2005; Mote 2006). Over the last 50 years, some of the largest declines in snowpack over the Western U.S. have been in the Cascade Mountains and Northern California (Mote et al. 2005; Mote 2006). Regonda et al. (2005) analyzed western states data from 1950 through 1999, including data from the Cascade Mountains of southern Oregon, and found a decline in snow water equivalent of greater than 6 inches during March, April, and May in the southern Oregon Cascades for the 50-year period evaluated. A decline of 6 inches equals an approximate 20 percent reduction in snow water equivalent. Declines in snowpack are expected to continue in the Klamath Basin. Mote et al. (2018) found that there have been declines in the snow water equivalent in the mountains of northern California of 40 to 80 percent from 1955-2016.

Most recent winter temperatures have been as warm or warmer than at any time during the last 80 to 100 years (Mayer 2008). Air temperatures over the region have increased by about 1.8º to 3.6º F (1° to 2º C) over the past 50 years and water temperatures in the Klamath River and some tributaries have also been increasing (Bartholow 2005; Flint and Flint 2012). Reclamation (2011) reports that the mean annual temperature in Jackson and Klamath Counties, Oregon, and Siskiyou County, California, increased by slightly less than 1 °C between 1970 and 2010. During the same period, total precipitation for the same counties decreased by approximately 2 inches.

Projections of the effects of climate change in the Klamath Basin suggest temperature will increase in comparison to the 1961 through 2000 time period (Barr et al. 2010; Reclamation 2011). Projections are based on ensemble forecasts from several global climate models and carbon emissions scenarios. Anticipated temperature increases during the 2020s compared to the 1990s range from 0.9 to 1.4° F (0.5 to 0.8° C)(Reclamation 2011). During the 2035 and 2045 period, temperature increases are expected to range from 2.0 to 3.6° F (1.1 to 2.0° C), with greater increases in the summer months and lesser increases in winter (Barr et al. 2010).

Effects of climate change on precipitation are more difficult to project and models used for the Klamath Basin suggest decreases and increases. During the 2020s, Reclamation (Reclamation 2011) projects an annual increase in precipitation of approximately 3 percent compared to the 1990s. Reclamation (2011) also suggests that an increase in evapotranspiration will likely offset the increase in precipitation. In the winter months, December through February precipitation is expected to increase by up to 10 percent while June through August precipitation is expected to decrease between 15 and 23 percent (Barr et al. 2010).

Reclamation (2011) projects that snow water equivalent during the 2020s will decrease throughout most of the Klamath Basin, often dramatically, from values in the 1990s. Projections suggest that snow water equivalent will decrease 20 to 50 percent in the high plateau areas of the upper basin, including the Williamson River drainage. Snow water equivalent is expected to decrease by 50 to 100 percent in the Sprague River basin and in the vicinity of Klamath Falls. In the lower Klamath Basin, Reclamation projects decreases in snow water equivalent between 20 and 100 percent. The exception to the declines is the southern Oregon Cascade Mountains, where snow water equivalent is projected to be stable or increase up to 10 percent (Reclamation 2011).

Bartholow (2005) found that the Klamath River is increasing in water temperature by 0.5°C per decade, which may be related to warming trends in the region and/or alterations of the hydrologic regime resulting from the dams, logging, and water use in Klamath River tributary basins. Particularly, changes in the timing of peak spring discharge, and decreases in water quantity in the spring and summer may affect salmonids of the Klamath River. Most life history traits (e.g., adult run timing, juvenile migration timing) in Pacific salmon have a genetic basis (Quinn et al. 2000) that has evolved in response to watershed characteristics (e.g., hydrograph) as reflected in the timing of their key life-history features (Taylor 1991). In their natural state, anadromous salmonids become adapted to the specific conditions of their natal river like water temperature and hydrologic regime (NRC 2004). Therefore, the ability of coho salmon individuals and populations to adapt to the extent and speed of changes in water temperatures and hydrologic regimes will determine the extent of climate change related impacts to these fish.

Reclamation (2011) and Woodson et al. (2011) suggest that projected climate change will have the following potential effects for the basin:

- Warmer conditions might result in increased fishery stress, reduced salmon habitat, increased water demands for instream ecosystems and increased likelihood of invasive species infestations (Reclamation 2011).
- Water demands for endangered species and other fish and wildlife could increase due to increased air and water temperatures and runoff timing changes (Reclamation 2011).

- Shorter wet seasons projected by most models will likely alter fish migration and timing and possibly decrease the availability of side channel and floodplain habitats (Woodson et al. 2011).
- Groundwater fed springs will decrease and may not flow year around (Woodson et al. 2011).
- Disease incidence on fishes will increase (Woodson et al. 2011).
- Dissolved oxygen levels will fluctuate more widely, and algae blooms will be earlier, longer, and more intense (Woodson et al. 2011).

In addition to having multiple hydrologic effects, climate change may affect biological resources in the Klamath Basin. Climate change could exacerbate existing poor habitat conditions for fish by further degrading water quality. Climate change may at best complicate recovery of coho salmon, or at worst hinder their persistence (Beechie et al. 2006; Van Kirk and Naman 2008). By negatively affecting freshwater habitat for Pacific salmonids (Mote 2003; Battin et al. 2007), climate change is expected to negatively impact one or more of the VSP criteria for the interior Klamath populations. Climate change can reduce coho salmon spatial structure by reducing the amount of available freshwater habitat. Diversity could also be impacted if one specific life history strategy is disproportionately affected by climate change. Population abundance may also be reduced if fewer juveniles survive to adulthood. Climate change affects critical habitat by decreasing water quantity and quality, and reducing the amount of space available for summer juvenile rearing.

In terms of future climate change effects on coho salmon in the Klamath Basin, NMFS believes that within the period of effects of the proposed action, climate changes will have noticeable additional effects on coho salmon or its critical habitats beyond what has been occurring. Specific projections during the period of effects of the proposed action that are expected to affect coho salmon and their habitat include changes in seasonality of runoff, decreased snow water equivalent, decreased snowpack, and warmer air and water temperatures (Reclamation 2011). These predicted changes are part of our analysis in Section 2.7 *Integration and Synthesis.*

2.4.1.3 Status of Coho Salmon Populations in the Klamath Basin that utilize the Action Area

As described in the Analytical Approach (Section 2.1), in addition to coho salmon populations that occur (in their freshwater life history stages) wholly within the action area, coho salmon that originate in locations that are adjacent to the action area (see Section 2.3) may be impacted by the proposed action while utilizing habitat in the action area. Therefore, the status and life history characteristics of those populations are relevant to our analysis of the effects of the proposed action. The condition of coho salmon populations that utilize the action area during all or some portion of their freshwater life history stages is summarized in this section.

2.4.1.3.1 Periodicity

The biological requirements of SONCC ESU coho salmon in the Klamath Basin, including in the action area, vary depending on the life history stage present at any given time (Spence et al.

1996; Moyle 2002). Generally, during salmonid spawning migrations, adult salmon prefer clean water with cool temperatures and access to thermal refugia, dissolved oxygen near 100 percent saturation, low turbidity, adequate flows and depths to allow passage over barriers to reach spawning sites, and sufficient holding and resting sites. Anadromous fish select spawning areas based on species-specific requirements of flow, water quality, substrate size, and groundwater upwelling (Sandercock 1991). Embryo survival and fry emergence depend on substrate conditions (e.g., gravel size, porosity, permeability, and dissolved oxygen concentrations), substrate stability during high flows, and, for most species, water temperatures of 14 ºC or less (Quinn 2005). Figure 7 depicts the seasonal periodicities of coho salmon that utilize the action area.

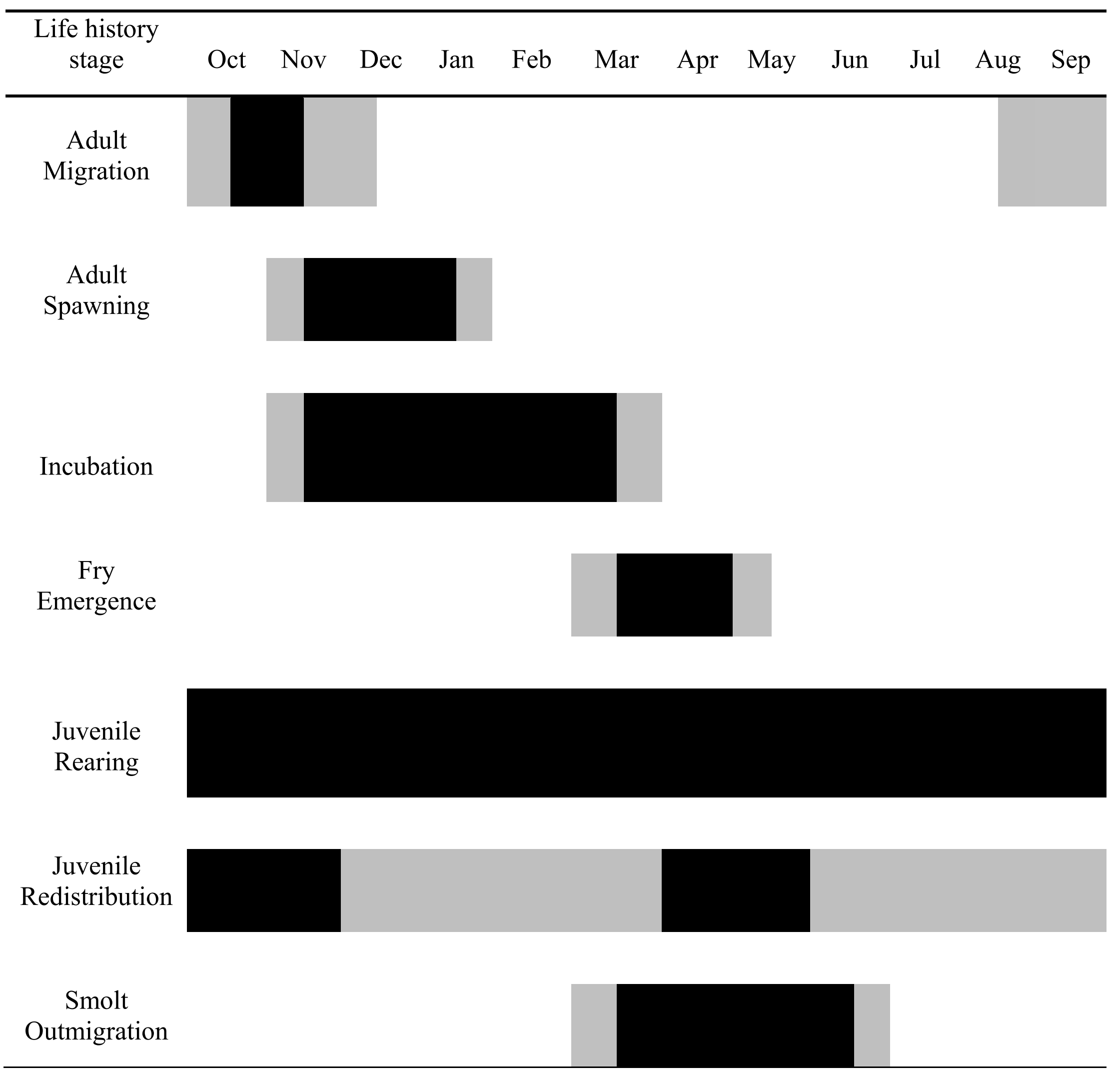

Figure 7. Life stage periodicities for coho salmon within the Klamath River Basin. Black areas represent peak use periods. Shaded gray indicates non-peak periods (Leidy and Leidy 1984; NRC 2004; Justice 2007; Carter and Kirk 2008).

2.4.1.3.2 Abundance and Distribution

Robust abundance estimates are not available for all populations of coho salmon that utilize the action area. However, population estimates of adult coho salmon in the basin that are available are all reduced from historic numbers and are all estimated to be below the viability threshold each year since 2009 (Table 13; NMFS (2014b), updated through 2021). The most robust abundance estimates of natural populations in the Klamath Basin come from the Shasta River, Scott River, and Bogus Creek, at which CDFW maintains video weirs (Table 13)(Kier et al. 2020; Giudice and Knechtle 2021a; Knechtle and Giudice 2021a; Knechtle and Giudice 2021b; Giudice and Knechtle 2022a; Knechtle and Giudice 2022a; Knechtle and Giudice 2022b). Abundance estimates in most other locations are derived from spawner surveys. The Trinity River has had the largest runs of SONCC coho salmon in the Klamath Basin in most recent years, but the Scott River also maintains a strong run, which has occasionally been larger than the Trinity River in recent years (Table 13). Abundance and seasonal distribution characteristics are summarized for each sub-basin population in the following sections (Section 2.4.1.3.2.1 to Section 2.4.1.3.2.7).

Table 13: Estimated spawning coho salmon escapement for populations potentially affected by the action.

Population	Origin	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Iron Gate Hatchery [a]	Hatchery	485	586	644	1,268	384	72	86	122	200	116	242	1,150
Upper Klamath River [b]	Natural	<350	<300	<300	<300	<300	<300	<300	<300	<300	<300	<300	<300
Bogus Creek [c]	Natural	154	142	185	446	97	14	85	48	47	67	187	343
Middle Klamath River [d]	Natural	< 1,500	< 1,500	< 1,500	< 1,500	< 1,500	< 1,500	< 1,500	< 1,500	< 1,500	< 1,500	< 1,500	< 1,500
Shasta River [e]	Natural	44	62	114	163	46	45	48	41	39	50	37	53
Scott River [f]	Natural	927	355	201	2,752	485	212	226	382	739	346	1,766	852
Salmon River [g]	Natural	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Trinity River [h]	Natural	3,522	10,186	10,422	15,275	9,629	1,282	798	235	744	424	1,028	2,348
Trinity River Hatchery [h]	Hatchery	4,425	4,810	8,236	6,631	3,908	3,337	527	420	742	649	2,334	2,346
Lower Klamath River [i]	Natural	< 1,500	< 1,500	< 1,500	< 1,500	< 1,500	< 1,500	< 1,500	< 1,500	< 1,500	< 1,500	< 1,500	< 1,500

a (Giudice and Knechtle 2022b)
b Estimates based on Bogus Creek counts, which are shown in the row below (Knechtle and Giudice 2022b) plus an estimated small numbers of mainstem and tributary spawners (Corum 2011; MKWC 2022).
c (Knechtle and Giudice 2022b)
d Projected using the highest estimates (i.e., 2004) from Ackerman et al. (2006)(see discussion below).
e (Giudice and Knechtle 2022a)
f (Knechtle and Giudice 2022a)
g Continues from Ackerman et al. (2006) estimates for the Salmon River.
h (Kier et al. 2022)
i Regular monitoring of coho salmon escapement does not occur annually for this population. Projected using the estimates from Ackerman et al. (2006). The majority of spawning occurs in Blue Creek (Gale et al. 1998; Gale 2009; Antonetti and Partee 2012; Antonetti and Partee 2013).

After emergence from spawning gravels within the mainstem Klamath River, or as they move from their natal streams into the river, coho salmon fry distribute themselves upstream and downstream while seeking favorable rearing habitat (Sandercock 1991). Further redistribution occurs following the first fall rain freshets as fish seek stream areas conducive to surviving high winter flows (Ackerman et al. 2006). The Yurok Tribal Fisheries Program and the Karuk Tribal Fisheries Program have been monitoring juvenile coho salmon movement in the Klamath River using passive integrated transponder (PIT) tags. Some coho salmon parr, tagged by the Karuk Tribal Fisheries Program, have been recaptured in ponds and sloughs over 90 river miles away in the lower 6-7 miles of Klamath River (Soto et al. 2016). Juvenile coho salmon (parr and smolts) have been observed residing within the mainstem Klamath River between IGD and Seiad Valley throughout the summer and early fall in thermal refugia during periods of high ambient water temperatures (>22 ºC). Mainstem refugia areas are often located near tributary confluences, where water temperatures are 2 to 6°C lower than the surrounding river environment (NRC 2004; Sutton 2007; Antonetti et al. 2017; Faukner et al. 2019).

In summary, abundance and seasonal distribution of coho salmon by sub-basin is as follows:

2.4.1.3.2.1 Upper Klamath River Population

The Upper Klamath River Population currently occupies approximately 64 miles of mainstem habitat and numerous tributaries to the Klamath River, extending upstream of Portuguese Creek to IGD. Juvenile coho salmon may migrate through the action area during summer and fall redistribution periods when seeking non-natal refugial habitats. Smolts outmigrate during the spring and adult coho salmon immigrate during the fall and winter, utilizing the mainstem reaches within the action area. Tributaries that flow into the action area (*i.e.*, Horse Creek and Seiad Creek) provide sources of cold water where juvenile coho salmon can be found over summering and low velocity reaches and off channel habitat features that provide low velocity refugia during the winter rearing period.

Coho salmon within the Upper Klamath River population spawn and rear primarily within several of the larger tributaries between Portuguese Creek and IGD, including Horse and Seiad creeks. Coho salmon presence was confirmed in six surveyed tributary streams including Horse, Seiad, Grider, West Grider, Walker, and O'Neil creeks (Garwood 2012). In surveys from 2014 to 2017, KNF fisheries staff routinely observed 100s of young-of-year juvenile coho salmon in lower Horse and Seiad creeks (NMFS 2014b).

Escapement of adult coho salmon entering Bogus Creek has been monitored by the CDFW annually since about 2004. Over that period the number of adult coho salmon estimated to have entered Bogus Creek has ranged between 7 fish (2009) and 446 fish (2013), averaging 152 fish annually (Knechtle and Giudice 2022b). The proportion of hatchery coho salmon present in the run over that period has ranged between 0.09 (2019) and 0.91 (2021), averaging 0.48 (Knechtle and Giudice 2022b). Between 2014 and 2019 the total number of adult coho salmon observed has been less than 100 fish, down substantially from the average run size between 2004 and 2013, but the 2020 return was 187 fish (Knechtle and Giudice 2018). Due to the low numbers of the Upper Klamath River population, IGH coho salmon strays are currently an important component of the adult returns for these populations because of their role in increasing the likelihood that wild/natural coho salmon find a mate and successfully reproduce (NMFS 2014b).

2.4.1.3.2.2 Middle Klamath River Population

Little data on adult coho salmon are available for this stretch of river. Adult spawning surveys and snorkel surveys have been conducted by the USFS and Karuk Tribe, but data from those efforts are insufficient to draw definitive conclusions on run sizes (Ackerman et al. 2006). Ackerman et al. (2006) relied on professional judgment of local biologists to determine what run sizes would be in high, moderate, and low return years to these tributaries; therefore, the run size approximations are professional judgment-based estimates. NMFS (2014b) does identify that the Middle Klamath River population is at moderate risk of extinction. Most of the juveniles observed in the Middle Klamath have been in the lower parts of the tributaries, which suggests many of these fish are non-natal rearing in these refugial areas. Adults and juveniles appear to be well distributed throughout the Middle Klamath; however, use of some spawning and rearing areas are restricted by water quality, flow, and sediment issues. Although the Middle Klamath River population's spatial distribution appears to be good, many of the Middle Klamath tributaries are used for non-natal rearing, and too little is known to infer its extinction risk based on spatial structure.

2.4.1.3.2.3 Shasta River

Adult coho salmon returns to the Shasta River have generally been in decline over the last decade. Since 2007 the number of adult coho salmon observed entering the Shasta River has ranged from a high of 249 fish in 2007 to a low of only 9 fish in 2009 (Giudice and Knechtle 2022a). From 2014 through 2021 the number of adult coho salmon have been 53 or less fish annually (Giudice and Knechtle 2022a)(Table 13). To reduce the risk of local extirpation, all IGH surplus adult coho salmon have been released back to the Klamath River since 2010. Some of these surplus adults have been observed entering the Shasta River which is about 14 river miles downstream from IGH. Since that time the percentage of hatchery origin coho salmon observed in the Shasta River spawning population has ranged from about 25 percent to 80 percent. Due to the low numbers of the Shasta River population, IGH/FCH origin fish play an important role in increasing the likelihood that wild/natural coho salmon find a mate and successfully reproduce. The proportion of hatchery origin adults in the spawning population for most recent years (2015 to 2019, and 2021) was unknown because sampling efforts were unable to recover any adult carcasses during this time, but the proportion of hatchery spawners in the Shasta River in 2020 was 43 percent.

The current distribution of coho salmon spawners is concentrated in the mainstem Shasta River from RM 32 to about RM 36, Big Springs Creek, lower Parks Creek, and in the Shasta River Canyon (RM 0 to RM 7). Juvenile rearing is also occurring in these same areas (NMFS 2014b).

2.4.1.3.2.4 Scott River

Abundance estimates on the Scott River are relatively robust due to the presence of a video fish counting weir, which has been utilized since 2007 (Knechtle and Giudice 2022a)(Table 13). Spawning activity and redds have been observed in the East Fork Scott River, South Fork Scott River, Sugar, French, Miners, Etna, Kidder, Patterson, Shackleford, Mill, Canyon, Kelsey, Tompkins, and Scott Bar Mill creeks. Fish surveys of the Scott River and its tributaries have been occurring since 2001. These surveys have documented that many of the tributaries do not consistently sustain juvenile coho salmon, indicating that the spatial structure of this population is restricted by available rearing habitat. Many of these tributaries likely have intermittent fish occupation due to low flow barriers for juvenile and adult migration periods as described in the sections above. Juvenile fish have been found rearing in the mainstem Scott River, East Fork Scott River, South Fork Scott River, Shackleford Creek and its tributary Mill Creek, Etna Creek, French Creek and its tributary Miners Creek, Sugar Creek, Patterson Creek, Kidder Creek, Canyon Creek, Kelsey Creek, Tompkins Creek, and Mill Creek (NMFS 2014b).

2.4.1.3.2.5 Salmon River

Since 2002, the Salmon River Restoration Council along with CDFW, the Karuk Tribe, the USFS and the USFWS have conducted spawning and juvenile surveys throughout the watershed. Juvenile coho salmon have been found rearing in most of the available tributary habitat with moderate or high intrinsic potential values (NMFS 2014b). Juvenile presence/absence and abundance data from a variety of surveys indicate that many of the tributaries throughout the watershed are used for spawning, including tributaries to the lower Salmon River, Wooley Creek, and the North and South Fork Salmon (NMFS 2014b). Annual adult coho salmon abundance observed in the Salmon River has varied between 0 and 14 spawning adults since 2002 (Hotaling and Brucker 2010). Between 2002 and 2007 only 18 adults and 12 redds (average of 4 spawners per year) were found in the roughly 15 miles of surveyed habitat. Known coho salmon spawning has been observed in the Nordheimer Creek, Logan Gulch, Brazil Flat, and Forks of Salmon areas along the mainstem Salmon River, in the Knownothing and Methodist Creek reaches of the South Fork Salmon River, and in the lower North Fork Salmon River (Hotaling and Brucker 2010), with the most recent recorded observation being two individuals building a redd in 2017 (Meneks 2018), and a single individual in 2018 (Amy Fingerle 2019, unpublished data). Without any new information to show coho salmon spawner abundance increased, NMFS continues to estimate the total Salmon River spawner abundance as less than 50 individuals. An adult population of 50 or less would represent a population with limited spatial structure.

2.4.1.3.2.6 Trinity River

Information regarding population size of individual SONCC coho salmon population units in the Trinity Basin is limited because systematic monitoring on the coho salmon populations in the area is limited. Because adult coho salmon from all three population units of the Interior-Trinity Diversity Stratum pass through the Willow Creek weir on the lower Trinity, it is not known which population of coho salmon is captured at the weir. As such, the weir provides an aggregate population estimate for all unmarked coho salmon upstream of the weir. The mean natural area spawners for the five year period of 2017 to 2021 was 956 fish, which was substantially lower than the average for the five year period of 2012 to 2016, which was 7,481 fish (Kier et al. 2022). The natural area coho salmon spawner estimate for the 2021 spawning season was 2,348 fish (Kier et al. 2022). Coho salmon continue to be present in many of the tributary streams in this population unit, but low adult returns in recent years have left some habitat unoccupied. Although there may be robust numbers of spawners occasionally in some years, the overall number of naturally produced coho salmon in the Upper Trinity River watershed is low compared to historic conditions, and hatchery fish dominate the run. The Upper Trinity River Population unit has the greatest degree of temporal and spatial exposure to hatchery fish of any of the population units in the action area. SONCC coho salmon in this population unit are exposed to both genetic interactions through breeding with TRH coho salmon, as well as ecological interactions (predation, competition and disease transfer) with hatchery coho salmon, Chinook salmon, and steelhead.

2.4.1.3.2.7 Lower Klamath River

Coho salmon have a wide distribution throughout the Lower Klamath, but almost always low abundances, based on the results of juvenile surveys, spawner surveys, and outmigrant trapping. Moderate densities of coho salmon are found in Blue, McGarvey and Ah Pah creeks. The majority of spawner observations have been made in Blue Creek (Gale 2009; Antonetti and Partee 2012; Antonetti and Partee 2013). Adult coho salmon population abundance, estimated by Ackerman et al. (2006) ranged from 14 to approximately 1,500 spawners between 2002 and 2006 (NMFS 2014b).

2.4.1.4 Relevant Federal Actions in the Klamath Basin that Have Undergone ESA Section 7 Consultation

NMFS has performed a number of other ESA Section 7 consultations on Federal actions in the action area. NMFS has performed numerous informal consultations in the action area for activities such as: bridge replacement and widening, road rehabilitation, fire management, and approval of Total Maximum Daily Loads (TMDLs) under the Clean Water Act. For all of these, NMFS concurred with the federal action agency that their proposed action was not likely to adversely affect listed species under NMFS' jurisdiction. Some key formal consultations, where adverse effects to listed species were likely, that NMFS has performed for Federal actions in the Klamath Basin include:

- Consultation with FERC on the effects of the Klamath dam removal project (i.e. Surrender and Decommissioning of the Lower Klamath Hydroelectric Project) on ESA listed species, including construction of FCH, and the effects of the non-ESA listed Chinook Salmon program at IGH/FCH (NMFS 2021a), as described in the Background Section (Section 1.1), resulting in a non-jeopardy biological opinion. The proposed action was expected to result in adverse effects to SONCC coho salmon critical habitat and individuals, however beneficial effects of the proposed action were expected to be long-term and significantly enhance the long-term status of SONCC coho salmon critical habitat and individuals.

- Consultation with NMFS relating to issuance of ESA Section 10(a)(1)(A) Permit 15755 to CDFW for enhancement and scientific purposes for implementation of an HGMP for the coho salmon program at the Iron Gate Hatchery, as described in the Background Section (Section 1.1), resulting in a non-jeopardy biological opinion. The proposed action was expected to result in adverse effects to SONCC coho salmon critical habitat and individuals, including direct take associated with hatchery activities (NMFS 2014c).
- NMFS has completed multiple consultations over the past approximately 20 years with Reclamation on their Klamath Project operations Early consultations (NMFS 2001a; NMFS 2002) concluded that the Reclamation action, as proposed, was likely to jeopardize the continued existence of SONCC coho salmon and destroy or adversely modify critical habitat for the SONCC coho salmon, which was avoided by implementation of reasonable and prudent alternatives. Subsequent biological opinions (USFWS and NMFS 2013; NMFS 2019) concluded that the proposed action would not jeopardize listed species or adversely modify their critical habitat.
- Consultation with NMFS on the issuance of an ESA Section 10(a)(1)(B) Permit associated with an HCP for SONCC coho salmon (PacifiCorp 2012). Additional Relevant ESA Consultations and Permits, resulting in a non-jeopardy biological opinion. Under the HCP, PacifiCorp is responsible for implementing several extensive conservation measures, as described in the HCP. The proposed action was expected to result in adverse effects to SONCC coho salmon critical habitat and individuals, including incidental take effect mostly in the form of harm, because effects from continued PacifiCorp operations and maintenance activities, despite minimization and mitigation measures implemented via the HCP, would impair habitat and normal behavior patterns of SONCC coho salmon (NMFS 2012b).

For most of these consultations, and for other formal consultations in the action area, NMFS concluded that the proposed federal action would not be likely to jeopardize the continued existence of listed species or destroy or adversely modify their critical habitat. However, NMFS did conclude the proposed action for Reclamation's Klamath Project operations would be likely to jeopardize the continued existence of listed species and destroy or adversely modify their critical habitat in 2001 and 2002, and Reclamation implemented reasonable and prudent alternatives to avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat.

2.5 Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action (see 50 CFR 402.02). A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered the factors set forth in 50 CFR 402.17(a) and (b).

As described in the Analytical Approach section (Section 2.1), NMFS analyzes the effects of the proposed action on both species and their habitat using an exposure-response-risk approach. In addition, NMFS uses the VSP framework and a methodology for analyzing hatchery effects. NMFS also analyzes the anticipated beneficial effects to listed resources.

2.5.1 Effects of the Action on SONCC Coho Salmon

2.5.1.1 Removal of Adult Coho Salmon for Broodstock (Factor 1)

The removal of adults from a naturally-spawning population has the potential to reduce the effective size of the natural-origin spawning population (sometimes called "mining"), cause selection effects, and remove nutrients from upstream reaches (Spence et al. 1996). Removal of adult spawners from a population can contribute to decreased productivity and abundance levels, which can lead to a population not being viable (Reisenbichler and Rubin 1999). In addition to problems with productivity, populations may experience decreased fitness from small population sizes. Larger populations tend to have a larger set of unique characteristics that increase the fitness of the population in the local environment (Houde et al. 2010). In populations with low abundance, environmental influences on different individuals within the population may be correlated more strongly, causing larger fluctuations in total population abundance (McElhany et al. 2000). Under the proposed action, broodstock would only be removed from locations inhabited by Upper Klamath River population (i.e. Bogus Creek, the IGH auxiliary fish ladder, or Fall Creek). The average abundance of the Upper Klamath River populations is below the depensation threshold, and the population is currently considered to be at a high risk of extinction (NMFS 2014b; Williams et al. 2016a).

Removal of adult coho salmon from the spawning grounds will cause a decrease in the natural spawning population and may expose remaining natural spawners to adverse effects from small population size. As discussed earlier, a population's extinction risk depends on both deterministic (e.g., natural selection, harvesting) and stochastic (e.g., environmental, demographic and genetic) processes. Decreased population size can influence the level of genetic diversity in small populations (Frankham 1995). Small population size may lead to a loss of genetic variation through genetic drift, while periodic population bottlenecks will accelerate the erosion of genetic diversity. Small population size may also result in disproportionately faster rates by which genetic diversity is lost via genetic drift (McElhany et al. 2000; Frankham 2005). Random genetic drift, inbreeding and the resulting accumulation of deleterious mutations are all known to lead to loss of genetic variation (Frankham 2005).

Inbreeding depression due to reduced population size can contribute significantly to extinction risk in the wild (Frankham 2005). Inbreeding depression is caused by the mating of closely related individuals (e.g., sibs, half-sibs, cousins). The smaller the population, the more likely spawners will be related. Related individuals are likely to contain similar genetic material, and the resulting offspring may then have reduced survival because they are less variable genetically or have double doses of deleterious mutations. The lowered fitness of fish due to inbreeding depression accentuates the genetic risk problem, helping to push a small population toward extinction (Reed 2005). The Upper Klamath River and Shasta River populations are likely to continue to be exposed to adverse effects similar to those described above, for the term of the permit.

Adverse effects to the Upper Klamath River population from removal of individuals for broodstock are outweighed by demographic benefits provided by the increased fitness of the Program. In the short-term, the hatchery program will serve an important function by reducing extinction risk of the Upper Klamath River population, and by providing fish that could disperse to newly accessible habitat made available from dam removal. In addition, the hatchery population reflects the characteristics of the natural population to the extent possible by including NOR fish as broodstock, especially when collecting fish randomly in proportion to run-timing. The program will continue to use NOR coho salmon for hatchery broodstock for the term of the permit.

2.5.1.2 Fish Handling, Transport and Tagging (Factors 1 and 4)

Fish handling activities include crowding, netting, transport in holding tanks from fish trapping facilities to holding ponds adjacent to the hatchery building or release locations, and handling and examination of fish to determine sex, maturity, and collect biological data necessary to describe population and genetic characteristics of the run. The primary contributing factors to stress and mortality from handling include: (1) excessive doses of anesthetic; (2) differences in water quality between the original habitat and the holding tank in which the fish are held; (3) dissolved oxygen levels; (4) length of time that fish are held out of water; and (5) physical trauma from inadequate handling procedures (Kelsch and Neill 1990). Adverse effects from handling may include: increased stress, decreased condition, increase in energy expenditure, decreased reproductive and spawning success, increased exposure to disease, decreased fitness, delayed or failed spawning, changes in metabolic rates, and mortality (Wedemeyer 1976; Sharpe et al. 1998). All life stages of coho salmon that are captured and handled will be exposed to these potential adverse effects.

Individual handling procedures integral to many hatchery programs may be stressful and these procedures can produce a negative physiological effect (Sharpe et al. 1998). The stress of relocation and handling can cause injury or mortality in juvenile and adult salmonids (Habera et al. 1996; Nielsen 1998; Habera et al. 1999; Nordwall 1999). Suboptimum conditions, while not immediately lethal, may stress coho salmon, resulting in delayed mortality or failure to spawn (Rottman et al. 1991). Research has shown that the metabolic consequences of the handling procedures are more protracted than the initial (cortisol) response and that the fish handled for a longer period of time had a greater stress response (Sharpe et al. 1998).

Hatchery fish are unavoidably subjected to a variety of handling and transport-related stressors as part of normal operations. Such acute disturbances cause detectable physiological changes that can be useful indicators of the degree of stress experienced by fish in aquaculture (Maule et al. 1988; Iwama et al. 1995; Wendelaar Bonga 1997; Sharpe et al. 1998). Responses by fish to handling or crowding may include a series of biochemical and physiological changes in an attempt to compensate for the challenge imposed upon it and, thereby, cope with the stress (Sharpe et al. 1998; Cogliati et al. 2019). One well-established primary indicator of stress is an alteration of circulating levels of the steroid hormone cortisol (Barton 2002). Exposure to continuous stress can cause rapid increases in plasma cortisol concentrations (Barton 2002). Increased cortisol levels have also been shown to cause decreases in the defense system of salmonids, and may make them more susceptible to disease (Barton 2002; Cogliati et al. 2019).

Occasionally, some adult coho salmon that are transported from the Bogus Creek, the auxiliary fish ladder at IGH, or from other location on Fall Creek may unintentionally die. The unintentional mortality of NOR adult coho salmon is expected to be no more than 23 adult coho salmon per year.

Although small numbers of fish that are handled can experience long term effects from handling events, the overall effects of the handling are generally short lived. A study by Pickering (1989) examined the response of brown trout to a single, short (approximately 2 minutes) incidence of handling stress for a period of 1 month post-stress. Significant changes were found in feeding behavior, in the levels of plasma cortisol, glucose and lactate, in the concentration of circulating lymphocytes and in the degree of epidermal mucification. However, no changes were detected in the growth rate and coefficient of condition, in the levels of plasma thyroxine, in the concentrations of circulating erythrocytes, neutrophils and thrombocytes or in the thickness of the epidermis (Pickering 1989). Fish that were handled displayed normal conditions within two weeks of testing. Results from testing of glucose levels indicate that although the metabolic consequences of handling procedures are more protracted than initial (cortisol) responses and that fish may exhibit a relatively greater response to a more protracted treatment, adverse effects were short lived (Barton 2002).

Coho salmon that are handled and tagged for M&E activities may be exposed to short term adverse effects. Potential adverse effects from tagging include those discussed above, and may result in mortality. In a study of retention and tagging mortality in adult sockeye salmon, tagging induced mortality averaged around 0.02 percent and did not change between tagged groups and untagged groups (Ramstad and Woody 2003). Data indicate that tagging of adult salmon does not have an adverse effect on swimming ability, endurance, or feeding (Hockersmith et al. 2000). However, Knudsen et al. (2009) did find a significant effect of PIT-tagging on hatchery origin juvenile spring-run Chinook salmon survival and growth, and caution that PIT tag effects should be considered when conducting studies using PIT tags.

Adverse effects from tagging will be minimized by utilizing the most effective and non-invasive tagging techniques. Although tagging may not increase the potential for mortality or harm to captured coho salmon, captured individuals will be exposed to adverse effects from other collection and handling activities. Handling and tagging procedures will be implemented in a manner to minimize handling to the greatest practicable extent, and individuals will be allowed to fully recover before release. Minimizing handling time will minimize the potential for adverse effects to coho salmon of all life stages.

Handling, transportation and tagging will occur annually during broodstock collection activities. Up to 4,017 adult coho salmon may be handled annually. Sourcing broodstock from the adult trap at the Bogus Creek Fish Counting Facility or the auxiliary ladder at IGH would be necessary if returns of adult coho salmon to FCH fail to meet broodstock goals. The adult trap and auxiliary ladder would be operated with primary purpose of collecting broodstock to meet the minimum number of broodstock necessary to fulfill mitigation, broodstock composition, and spawning matrix objectives.

Outmigrant traps are generally used to obtain information on natural population abundance and productivity. The trapping, capturing, or collecting and handling of juvenile fish using traps is likely to cause some stress on listed fish (Music et al. 2010). Debris buildup in traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis. In addition, predation of salmonid fry in the trap can range from less than 1 percent to more than 10 percent in any given year (Duffy et al. 2011). However, fish typically recover rapidly from handling procedures. The primary factors that contribute to stress and mortality from handling are excessive doses of anesthetic, differences in water temperature, dissolved oxygen conditions, the amount of time that fish are held out of water, and physical trauma.

The potential for unexpected injuries or mortalities among listed fish is reduced in a number of ways. Outmigrant traps are checked at least daily to ensure it is functioning properly. Debris is removed as needed. Appropriate anesthetics will be used to calm fish subjected to collection of biological data. Captured fish must be allowed to fully recover before being released back into the stream and will be released only in slow water areas. All of these protocols and are used to make sure the mortality rates stay at one percent or lower. Up to 575 juvenile and smolt coho salmon may be handled and/or tagged at the Bogus Creek downstream trap annually. An additional 50,000 coho salmon fry may be captured and immediately released downstream of the trap. Based on years of sampling at hundreds of locations under hundreds of scientific research authorizations, NMFS would expect the mortality rates for fish captured at rotary screw type traps to be one percent or less (NMFS 2023).

2.5.1.3 Hatchery Disease Outbreaks (Factors 2, 3)

Disease outbreaks in hatcheries are common and can result in the mortality of large numbers of juvenile and smolt fish. Disease outbreaks have the potential to expose hatchery reared and natural origin fish to diseases when HOR fish are released into the natural environment. Exposure to diseases can have adverse effects including decreased fitness, decreased spawning success, and decreased survival. The potential for disease outbreaks in IGH facilities will be minimized through the implementation of BMPs related to cleaning and monitoring and maintenance of hatchery rearing facilities (CDFW 2023a). CDFW certifies the health and disease status of coho salmon prior to release.

Hatchery workers avert most disease outbreaks by reducing fish density in rearing ponds, as necessary. Fish disease prevention procedures will continue to be implemented under the HGMP (CDFW 2023a). CDFW employs experienced fish culturists; most have spent their entire careers rearing salmonids at CDFW facilities. These professionals maintain healthy rearing conditions and proper growth rates and are able to recognize adverse conditions including disease that may negatively influence production. In the rare event of a disease outbreak during incubation, individual stacks and trays will be isolated to stop the spread of the disease. Similarly, raceway production can also be isolated. At the first sign of problems in Salmon survival or health a CDFW pathologist will be contacted. Samples of fish are sent to pathology for diagnosis and direction regarding treatment or the pathologist may make an on-site visit and diagnosis. The potential for loss of coho salmon from disease outbreaks are reduced, and there is no record of any occurrences of these types of failure in the recent history of the hatchery (CDFW 2023a). Under the HGMP, these BMPs will continue to be implemented and will minimize the potential for disease outbreaks in the hatchery.

Disease has not been an issue for coho salmon at IGH, and is not expected to be an issue at FCH (CDFW 2023a). As under the current hatchery program, there are not expected to be disease effects on NOR salmon from the direct release of juvenile coho. However, because hatchery coho are susceptible to infection by the myxosporean parasite *Ceratonova shasta* (*C. shasta*), returning adult HOR coho that spawn naturally may increase the prevalence of this organism and increase disease load in the basin. However, the likelihood of this is reduced by monitoring the infectiousness of the river and modifying hatchery releases if necessary.

2.5.1.4 Ecological Interactions (Factors 1, 2, 3)

Ecological effects refer to effects from competition between individuals for spawning sites, predation, changes in disease dynamics, redd superimposition, contributions to marine-derived nutrients, and the removal of fine sediments from spawning gravels. Ecological effects on the spawning grounds may be beneficial or adverse. To the extent that hatcheries contribute added fish to the ecosystem, there can be beneficial effects. When anadromous salmonids return to spawn, hatchery-origin and natural-origin alike, they transport marine-derived nutrients stored in their bodies to freshwater and terrestrial ecosystems. Their carcasses provide a direct food source for juvenile salmonids and other fish, aquatic invertebrates, and terrestrial animals, and their decomposition supplies nutrients that may increase primary and secondary production (Kline et al. 1990; Helfield and Naiman 2001; Johnson 2006; Merz and Moyle 2006). However, many studies have shown that hatchery releases interacting with wild fish can lead to decreased productivity of natural-origin salmonids (Araki et al. 2007; Araki et al. 2008; Araki et al. 2009; Kostow 2009; Christie et al. 2014; Davison and Satterthwaite 2017). For example, in a review of 51 estimates from six studies on four salmon species, Christie et al. (2014) found that early-generation hatchery fish averaged only half the reproductive success of their wild-origin counterparts when spawning in the wild, and that all species showed reduced fitness due to hatchery rearing.

2.5.1.4.1 Competition, Predation and Disease

Results conducted during implementation of the previous HGMP using the PCDRISK-1 model indicate that IGH coho salmon induced mortality on naturally produced coho salmon from predation, competition and disease in the Klamath River is likely at levels of less than 5 percent (CDFW 2023a). The PCDRISK-1 model output provides an index for comparing the ecological effect of annual hatchery releases on wild populations in terms of predation, competition, and disease (Pearsons et al. 2012). With the implementation of the 2014 IGH coho salmon HGMP (CDFW 2014) the PCDRISK-1 Model was run annually to evaluate predation and competition effects to NOR coho salmon based on hatchery release numbers and environmental conditions. Modeling results show that the overall risk index has been 5% or less since 2015, and 0.5% or less since 2018. However, disease dynamics in the Klamath basin are such that model was not a good indicator of disease risk, so disease risk was not calculated via the PCDRISK-1 Model beginning in 2018. Given the reduced predictive ability of the PCDRISK-1 Model with the disease component removed, and the very low modeled risk index for competition and predation in recent years, it was determined that use of the model will not be continued for this HGMP.

Under the HGMP, CDFW will volitionally release up to 82,500 coho salmon smolts annually. The average number of smolts released annually under the previous HGMP was less than that (Table 3). Prior to implementation of the previous HGMP, much larger HOR releases of coho salmon smolts were not uncommon. Even at low abundance, NOR and HOR juvenile and smolt coho salmon may overlap temporally and spatially during spring emigration to the estuary. Adhering to current production goals will help minimize the potential for increases in predation by HOR coho salmon. Under the HGMP, smolt development indices will be monitored and used to inform release timing of coho salmon from the hatchery to ensure that released fish are physiologically ready to emigrate downstream quickly to the estuary and ocean, thus reducing the likelihood that released coho salmon will linger and rear in the river downstream of the hatchery where they could intermingle with rearing natural origin coho salmon. Given the small number of coho salmon smolts released and the short duration of temporal and spatial overlap, predation rates from HOR coho salmon are likely low in the Klamath Basin. Minimizing ecological interactions likely minimizes the potential for adverse effects from competition, predation, and displacement by decreasing the occurrences where the two groups interact. In a review of 270 references on ecological effects of hatchery salmonids on natural salmonids, Flagg et al. (2000) found that in situations of low wild salmonid density, introduction of HOR salmonids may not have a significant negative impact on NOR coho salmon.

The potential for exposure to predation, competition or displacement from interactions with HOR smolt coho salmon decreases downstream, as habitat and prey availability increase. Given the relatively small quantity of both IGH HOR and NOR juvenile and smolt coho salmon in the Klamath River, density dependent mechanisms are likely reduced and the relationship between the growth and survival of the two groups of fish is likely density independent. However, as natural population levels begin to recover, adverse ecological effects related to predation, competition and displacement would likely increase.

Naman and Sharpe (2012) found that spatial and temporal overlap is one of the most influential factors when determining the extent of predation and other ecological interactions. Beeman et al. (2012) documented emigration timing of HOR and NOR smolt coho salmon in the Klamath basin during two different years (2006 and 2009) and found that migration timing and passage rates between HOR and NOR coho salmon differed in the upper Klamath River upstream of the confluence of the Shasta River. In 2006, NOR coho salmon traveled through this reach faster than HOR coho salmon. Whereas, in 2009, HOR fish traveled through this upper reach more quickly than NOR fish. Survival rates were similar between both groups (HOR and NOR) in 2006 and 2009. Several factors may have influenced movement through this upstream reach, including latent handling and tagging effects, source of experimental fish used, discharge, photoperiod, and water temperature. Travel times of HOR fish and NOR fish were similar through all downstream reaches, indicating that once active migration began, HOR and NOR fish traveled at similar rates (Beeman et al. 2012). These data indicate that HOR and NOR smolts will likely overlap temporally and spatially to varying degrees during downstream emigration.

2.5.1.4.2 Straying

High amounts of straying have been documented in Bogus Creek and the Shasta River since 2010 when CDFW started the practice of returning all adult coho salmon in excess of IGH broodstock needs back to the river to spawn naturally. This practice was initiated in consultation with NMFS to help reduce risks to extinction and preserve remaining genetic characteristics in the Upper Klamath River population. IGH HOR coho salmon have made up from 2 to 80% of the spawners in the Shasta River from 2007 to 2021 (Giudice and Knechtle 2022a). IGH HOR coho salmon have made up from 9 to 91 % of the spawners in Bogus Creek from 2004 to 2021 (Knechtle and Giudice 2022b). In contrast, few, if any, IGH HOR coho salmon spawn in the Scott River each year (Knechtle and Giudice 2022b), Trinity River, or in Upper Klamath River Population Unit streams other than Bogus Creek (PacifiCorp 2021b). FCH HOR coho salmon are not expected to stray into tributaries of the lower Klamath Population Unit. Stray rates in Klamath River tributaries besides the Shasta River and Bogus Creek are much lower, and likely well below the 5 percent standard proposed by Williams et al. (2008) to maintain low extinction risk.

Straying has the potential to reduce the reproductive success of the natural population (Chilcote 2003; McLean et al. 2004) and negatively affect the diversity of the interior Klamath populations via outbreeding depression (Reisenbichler and Rubin 1999; HSRG 2004). Hatchery fish strays spawning in the wild have the potential to reduce the fitness, diversity, productivity, and survival rates of natural populations. Straying rates >5% are assumed to pose significant risks to natural-origin fish (HSRG 2012). However, given the low overall abundance of coho salmon in the Upper Klamath River and Shasta River populations, some volitional straying of hatchery-origin fish, even at rates >5% may still benefit the populations, and aid in the reintroduction of coho Salmon into newly accessible habitat upstream of IGD following removal of the dams, and thereby benefit the resiliency of the Upper Klamath River population unit as a whole.

In addition, adverse effects to the Shasta River and Upper Klamath River populations may be minimized by the lack of genetic divergence between IGH coho salmon and NOR coho salmon in these populations. Data suggest that the Shasta River and Upper Klamath River populations are similar genetically, and that the Shasta River Population does not represent a reservoir of unique genetic information, but instead are similar to the Upper Klamath River population (e.g., Bogus Creek, IGH or upper mainstem Klamath River)(Garza 2014; Gilbert-Horvath et al. 2016). Genetic analyses indicate a dominance of temporal structuring among populations in the extreme upper end of the Klamath River basin (upstream of the Scott River), likely influenced by hatchery management practices (Garza 2014; Gilbert-Horvath et al. 2016). The primary purpose of the Program is to protect the genetic resources of the Upper Klamath Population Unit and reduce extinction risks. Given the urgency to reduce extinction risks, CDFW, in collaboration with NMFS' Southwest Fisheries Science Center, began implementing the spawning matrix for all hatchery crosses in 2010 and also began releasing all excess adult coho salmon not used in the spawning matrix back to the Klamath River to spawn naturally. Therefore, although adverse effects from straying in these populations may continue, those effects were determined to be secondary to the greater threat of extinction and preservation of remaining genetic material as identified in the HGMP.

2.5.1.5 Spawning Surveys (Factor 4)

During the spawning ground surveys, coho salmon would be observed in-water (e.g., by snorkel surveys or from the banks). Direct observation is the least disruptive method for determining a species' presence/absence and estimating their relative numbers. Its effects are also generally the shortest-lived and least harmful of the monitoring activities because a cautious observer can effectively obtain data while only slightly disrupting the fishes' behavior. Fry and juveniles frightened by the turbulence and sound created by observers are likely to seek temporary refuge in deeper water, or behind/ under rocks or vegetation. In extreme cases, some individuals may leave a particular pool or habitat type and then return when observers leave the area.

Redds may be visually inspected, but would not be walked on. While conducting the surveys individuals are likely to disturb adult coho salmon attempting to spawn or while guarding their nests. However, this disturbance would be temporary and adults are expected to resume their spawning behavior after surveyors leave the reach. Spawning ground surveys may disturb up to 50 live NOR and 50 live HOR adult coho salmon and up to 5,900 NOR and HOR adult salmon carcasses may be biologically sampled in tributary streams included in the M&E program annually. These numbers represent the maximum number of coho salmon carcasses that could be handled at times of high abundance. Adverse effects associated with these activities described above will continue for the term of the HGMP.

2.5.1.6 Masking (Factor 5)

The effects of masking occur when hatchery fish are not discernable from wild or naturally produced fish and thus undermine or confuse the status of a population. Since all (100%) HOR coho salmon smolts are externally marked with a left maxillary clip prior to their release, HOR coho salmon are easily distinguished from NOR coho salmon. Therefore, NMFS believes that adverse effects from masking are negligible.

2.5.1.7 FCH Propagation Facilities (Factor 6)

Hatchery operations have an inherent element of risk during each stage of coho salmon culture due to the potential for disrupted water supply, poor water quality, disease outbreaks, handling and transport. The potential for flow reductions, flooding and poor culture practices may all cause hatchery facility failure or the catastrophic loss of listed species under propagation. The potential for adverse effects to coho salmon from the failure of FCH facilities is unlikely due to the implementation of BMPs and established prevention measures that ensure continuing operation of FCH facilities during emergency and unforeseen circumstances.

The hatchery utilizes 10 cfs of primarily spring-water from Fall Creek. The temperature of the water ranges from approximately 43°F to 54.5 °F that has been found ideal for the culture of salmonids. The predominantly spring-fed nature of the water supply is relatively resilient to the climate changes that have impacted the basin. In addition, the hatchery managers train all staff members to respond to any unforeseen emergency and avert stochastic fish loss. A hatchery employee is always on duty or on standby in housing for quick response, as necessary. Water to the hatchery is gravity fed and therefore does not rely on a source of power and mechanical pumps to maintain flow to culture facilities. The hatchery is equipped with a backup power generator and alarms that alert staff to both power and water issues at the facility. This reduces the chance of raceways dewatering and killing fish. The raceways are connected to Fall Creek so that fish can be released in case of an operational emergency that may result in mortality. The City of Yreka and PacifiCorp will continue to coordinate maintenance and operation of water diversion structures to prevent dewatering of the stream channel or disruption of the water supply for the hatchery. The hatchery is located outside of the Klamath River flood zone near Fall Creek. Flow into Fall Creek is mitigated by an upstream diversion from Spring Creek via PacifiCorp's Fall Creek powerhouse and controlled by two small dams just upstream of the hatchery. Therefore, there is very low risk of flooding occurring at the hatchery site.

Given these protective measures, and the location of the hatchery away from areas that have the potential to flood, NMFS concludes that the potential for adverse effects from the failure of hatchery facilities is negligible, and that suitable safety measures are in place to minimize adverse effects.

2.5.1.8 FCH Water Intake and Outflow (Factor 6)

The potential for adverse effects on coho salmon from the intake of water for FCH facilities is anticipated to be discountable given the location of intake structures. A system of fish exclusion barriers, consisting of concrete velocity aprons on the downstream side of the dams that are used to create head for the FCH water intake will be used to prevent fish from accessing water diversion intakes. Therefore, the impingement or entrainment of listed species due to water diversion for FCH, or the adjacent City of Yreka water supply diversion, is not possible.

Water quality effluent leaving the hatchery is monitored monthly for a variety of physiological water quality parameters including dissolved oxygen, biochemical oxygen demand (BOD), pH, and turbidity. All hatchery facilities will operate under the "Upland Fin-Fish Hatching and Rearing" NPDES general permit which conducts effluent monitoring and reporting and operates within the limitations established in its permit. his program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. The NCRWQCB water quality standards establish limits on effluent discharge including prohibiting direct effluent discharge from the hatchery to the Klamath River with any detectable level of chemical with exception of carbon dioxide. The NCRWQCB requires monthly effluent sampling and quarterly and annual reporting to document permit compliance.

Based on the above discussion, including the location of intake areas above anadromy, expected compliance with NCRWQCB water quality standards and the applicable NPDES permit, and the potential for producing cold water refugia, NMFS concludes that the potential for adverse effects to coho salmon from IGH water intake is discountable and adverse effects from IGH outflow are insignificant.

2.5.1.9 Fisheries (Factor 7)

Directed fisheries for coho salmon have been prohibited off of the California coast since 1995 and in-river recreational fisheries since 1998 (CDFG 2004). Klamath Basin tribes (Yurok, Hoopa, and Karuk) harvest a relatively small number of coho salmon for subsistence and ceremonial purposes. Coho salmon harvested by Native American tribes is primarily incidental to larger Chinook salmon subsistence and commercial fisheries in the Klamath and Trinity rivers. Although no retention of coho salmon is allowed in California, some HOR coho salmon may be taken in Oregon fisheries, or incidentally killed in ocean fisheries in California that target Chinook salmon. In summary, major steps have been taken to limit effects of harvest on SONCC coho salmon, but there is still some small impact of incidental mortality associated with various Chinook salmon fisheries, and by subsistence and ceremonial tribal fisheries.

Implementation of the HGMP is anticipated to improve the viability of SONCC coho salmon in the Upper Klamath River population by reducing the threat of demographic extinction, improving genetic fitness and survival, and providing individuals that may migrate into previously inaccessible habitat above IGD, all while maintaining current mitigation release numbers (75,000 smolts). All of these measures, when complimented by habitat restoration actions including Klamath dam removal, are anticipated to increase the abundance of coho salmon in the Upper Klamath River population over time. Therefore, implementation of the HGMP is anticipated to benefit Tribal subsistence fisheries in the future.

2.5.1.10 Integrated Hatchery Program

Although transitioning from IGH to FCH, the Program will continue to be operated as an integrated hatchery program as described by the HSRG (2004). Operation of the Program is expected to continue the progress made in culture practices and outcomes with the implementation of the 2014 HGMP. The IGH Program has been successful at increasing survival rates by life stage which results in a decrease in the number of coho salmon adults taken for broodstock. The IGH Program has also increased proportionate natural influence (PNI) of the population from 0.19 (pre-2014) to 0.50. The higher the PNI value the more the natural environment drives the local adaptation (i.e., fitness) of the population which is expected to result in increased survival and productivity over time. At a PNI value of 0.5, the natural and hatchery environment is equally driving local adaptation of the hatchery stock. In this way, the Bogus Creek and Fall Creek populations serve to let the natural environment drive the adaptation of both the natural and hatchery components of the Upper Klamath Population Unit. Beneficial effects from integrated hatchery programs include: (1) increasing abundance with minimization of genetic divergence of hatchery broodstock; (2) minimizing domestication; (3) increasing the percentage of NOR genes passed on, which will improve the fitness of individuals; and (4) reducing other genetic risks that hatchery-origin coho salmon may pose to the naturally spawning population (CHSRG 2012). In this way, the HGMP is expected to improve the viability of the Upper Klamath River Population by increasing abundance and productivity.

2.5.1.11 Implementation of Genetic Spawning Matrix

Under the HGMP, a real time genetic spawning matrix will continue to be implemented, with the goal of decreasing adverse effects of hatchery spawning practices by improving genetic diversity of the Upper Klamath River population. Under this program, real-time genetics analysis of all spawners will be used to develop a spawner list based on relatedness. The spawning matrix protocol began in 2010, and has been successful at preventing the breeding of highly related pairs. Although genetic changes are inevitable in cultured populations, the degree of change, or risk, can be reduced by adopting specific management strategies. The results of this analysis allows geneticists to minimize inbreeding effects and to allow for gene flow between brood years. This will in turn increase the fitness and survival of the Upper Klamath River population.

2.5.1.12 Use of Local Origin Broodstock

Using local broodstock, instead of out-of-basin transfers, will minimize adverse effects from broodstock removal. Under the HGMP, the coho salmon program at FCH will not use any non-Klamath basin coho salmon for broodstock purposes (CDFW 2023a). Using local origin broodstock will improve the fitness and viability of the Upper Klamath River population. Araki et al. (2008) found that the use of non-local origin coho salmon contributed to a significantly lower relative fitness of offspring from hatchery coho salmon. Data shows that programs using local broodstock provided small beneficial effects to the population as a whole, while programs that used non-local broodstock can create fish with lower reproductive success in the wild when compared to fish produced by local-origin broodstock (Araki et al. 2008; Christie et al. 2014). Using local broodstock also works to conserve genetic resources, life history diversity, and spatial distribution of the population (Araki et al. 2008; Christie et al. 2014). The Upper Klamath River population will experience beneficial effects for the term of the HGMP, which will help improve the viability of the population and the ESU as a whole.

2.5.2 Effects of the Action on SONCC Coho Salmon ESU Critical Habitat

As discussed in the Environmental Baseline section, coho salmon critical habitat in the action area consists of the Klamath River mainstem from IGD to just upstream of the mouth of the Trinity River. In addition, the tributaries to the Klamath River downstream of IGD, including the Shasta, Scott, Salmon, and Trinity (excluding the Hoopa Valley Reservation) rivers are also designated critical habitat. Also described in the Environmental Baseline section, the area upstream of IGD, including Fall Creek, has not been designated as critical habitat as well as the reaches downstream of Trinity River that are within the boundaries of the Yurok Tribe Reservation. Below, we considered the impacts to the PBFs (e.g., water quality and food resources) and their ability to support essential habitat types which are, in summary, 1) spawning, 2) migration, and 3) rearing. Effects to critical habitat associated with construction, operation, and maintenance of FCH are not expected because Fall Creek is not designated critical habitat.

2.5.2.1 Fish Trapping for Broodstock Collection

If adult coho salmon need to be trapped at Bogus Creek for broodstock, free passage of adult coho salmon through the weir will be temporarily disrupted, and the adult migration corridor element of SONCC coho salmon critical habitat will be adversely affected. Similarly, migrating fish attracted to the IGH auxiliary fish ladder when it is being operated may be surplus broodstock that have their migration interrupted. However, the trapping at Bogus Creek will be temporary, if trapping is needed, because of the proposed minimization measures involving close monitoring of the traps and the intermittent collection of adult coho salmon to get representation from entire length of the run. Juveniles will continue to have free passage through the Bogus Creek weir and their migration corridor will not be affected by the trapping operations.

2.5.2.2 Release of Juvenile Coho Salmon

As discussed in the Effects of the Action on SONCC coho salmon section (Section 2.5.1), the release of hatchery juvenile coho salmon may cause adverse effects to NOR coho salmon through increases in predation, competition, and displacement. Juvenile summer and winter rearing areas is the principal essential habitat type of SONCC coho salmon ESU critical habitat that will be adversely affected by the Proposed Action. The proposed annual release of up to 82,500 coho salmon smolts will decrease food availability and space within juvenile rearing areas in the mainstem Klamath River. The magnitude of decreased food availability and space is likely small and will decrease downstream, as prey and habitat availability increase and hatchery coho salmon have more areas to disperse. In addition, the relatively low numbers of hatchery smolts being released (up to 82,500) and the many miles of habitat in the mainstem Klamath River are likely to result in minimal reductions in food availability and space.

2.6 Cumulative Effects

"Cumulative effects" are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation [50 CFR 402.02 and 402.17(a)]. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described earlier in the discussion of Environmental Baseline (Section 2.4).

NMFS believes that the SONCC coho salmon ESU and its critical habitat may be affected by numerous future actions by State, tribal, local, or private entities that are reasonably certain to occur within the action area, or adjacent and upslope and have adverse effects on the action area. The following discussion provides information on the expected effects of these activities on coho salmon. Many of these future activities are continuing activities that have been discussed in the Environmental Baseline section (Section 2.4.1), and the effects of these future non-Federal actions on coho salmon and their designated critical habitat are likely to be similar to those discussed in the Environmental Baseline section.

2.6.1 FCH Chinook Salmon Production

In addition to producing coho salmon smolts, the IGH produces Chinook salmon as mitigation for habitat lost above IGD. Historically, IGH also produced steelhead trout, but the steelhead program has not produced steelhead since 2012 due to a lack of adults returning to IGH to serve as broodstock. The steelhead program will not be restarted at FCH. In addition, due to limited production capacity at FCH relative to IGH, the production goal of Chinook salmon will be reduced post-dam removal. Table 14 summarizes the NMFS and CDFW change in production goals for FCH.

Table 14. Comparison of the current production goals at IGH and production goals post-dam removal at FCH.

Species / Life Stage	Current Production Goal (at IGH)	Production Goal Post-Dam Removal (at FCH)	Release Dates
Coho Yearlings	75,000	Minimum of 75,000	March 15 – May 1
Chinook Yearlings	900,000	Minimum of 250,000	Oct 15 – Nov 20
Chinook Smolts	5,100,000	Up to 3,000,000	April 1 – June 15
Steelhead	200,000	0	N/A

NMFS completed a biological opinion on dam removal that analyzes the effects of the change in hatchery operations for Chinook salmon on listed species (NMFS 2021a). The exact effects on wild juvenile coho salmon in the Klamath River from the annual release of up to 3.25 million hatchery-reared Chinook salmon smolts and 75,000 yearling coho salmon from IGH are not known precisely. The release of a relatively large number of hatchery origin juvenile Chinook salmon has the potential to affect wild coho salmon juveniles via competitive interactions, increased predation, and exposure to disease, but habitat partitioning between the two species likely limits these effects. These ecological interactions may be having an adverse effect on NOR coho salmon. However, Chinook salmon use larger tributaries and the mainstem Klamath River and are less likely to be impacted by released juveniles that rear in smaller tributaries. Chinook salmon also migrate from tributaries and the mainstem rivers within a few months further reducing habitat overlap with Program coho salmon.

2.6.2 Oregon Reintroduction Plan

The ODFW and the Klamath Tribes of Oregon have prepared a Implementation Plan for the Reintroduction of Anadromous Fishes into the Oregon Portion of the Upper Klamath Basin (Reintroduction Plan) (ODFW and Klamath Tribes 2021a). ODFW has made significant progress to secure funding and staff for purposes of implementing the Reintroduction Plan; thus, NMFS concludes that it is reasonably certain to occur. The Reintroduction Plan recommends species-specific approaches to guide the reintroduction of historically present anadromous fishes. When the dams are removed there is a high degree of confidence that coho salmon will repopulate newly available habitat. This rapid repopulation response has been observed after barrier removal on the Elwha River (Liermann et al. 2017; Duda et al. 2021), White Salmon River (Allen et al. 2016; Hatten et al. 2016), Cedar River (Burton et al. 2013; Anderson et al. 2015), Rogue River (McDermott 2016), and the Penobscot River (Izzo et al. 2016). Therefore, this plan recommends a volitional approach to reintroduction of these fishes, in which no active measures will initially be taken to assist in repopulating habitat in the Upper Klamath Basin. The Reintroduction Plan includes a recommended strategy for monitoring reestablishment of coho salmon following the removal of the four Klamath Hydroelectric dams. The strategy for monitoring will be focused on fundamental questions. Immediately following the availability of passage, monitoring will focus on determining if coho salmon are migrating into habitat immediately above the dams. As fish populations become more widely established, monitoring will be more specific and focused on management objectives, such as determining adult escapement, juvenile productivity, and spatial distribution within each subbasin. Information gained through these Reintroduction Plan monitoring activities will advance and prioritize future restoration activities that promote improvements to fitness and survival of the Upper Klamath population of coho salmon.

2.6.3 Continued Hatchery Operations Beyond Eight Years

One potential cumulative effect that we identified is related to State actions that can be expected to occur in response to the progress of the restoration of the Klamath River system following dam removal. CDFW, ODFW and the Klamath Tribes (ODFW and Klamath Tribes 2021a) have final and draft anadromous species reintroduction plans that discuss the potential for modified hatchery operations in the Klamath River to continue beyond the length of time proposed (eight years). Hatchery operations beyond eight years (or potentially cessation of hatchery operations earlier than eight years if warranted) will depend on the level of natural production that is occurring throughout the Klamath River (including newly available upstream habitat) as indicated by monitoring efforts. The response to what is observed following dam removal and commencement of restoration activities, and any potential changes in the timeline and/or extent of hatchery production that occurs will be decided in coordination with Klamath Basin fisheries managers including the hatchery technical team. We are reasonably certain that hatchery production would continue to occur at some level beyond eight years if expectations for repopulation of newly available spawning habitat and improved productivity throughout the Klamath River system are not being met.

2.6.4 Timber Management on Private Lands

Timber management, along with associated activities such as harvest, yarding, loading, log hauling, site preparation, slash burning, tree planting, thinning, and road construction occurs in the action area. Future private timber harvest levels in the action area cannot be precisely predicted; however, NMFS assumes that harvest levels on private lands within the action area in the foreseeable future will be similar to harvest levels that have occurred over the past 20 years.

Timber harvest is not regulated if the resulting timber is not sold. When timber is sold, timber harvest is regulated under the California Forest Practice Rules (CFPR). The CFPR has likely not consistently provided protection against an unknown amount or extent of unauthorized take of salmonids listed by NMFS under the ESA, such as listed SONCC ESU coho salmon. Timber harvest results in impairments in migration, shade, large woody debris, stream temperature, turbidity, and sediment levels (NMFS 2014b). These impacts will likely continue throughout the action area and for the duration of impacts resulting from the proposed action.

Reasonably foreseeable effects of timber harvest will likely continue to degrade conditions in designated SONCC coho salmon ESU critical habitat within the action area as described in the environmental baseline section of this Opinion.

2.6.5 Control of Wildland Fires on Non-Federal Lands

Climate change is increasing the frequency and severity of wildfires not only in California but also all over the world. Since 1950, the area burned by California wildfires each year has been increasing, as spring and summer temperatures have warmed and spring snowmelt has occurred earlier (CARB 2021). During the recent drought, unusually warm temperatures intensified the effects of very low precipitation and snowpack, creating conditions for extreme, high severity wildfires that spread rapidly. Of the 20 largest fires in California's history, eight have occurred in the past three years (since 2017) (CalFire 2021).

Control of wildland fires may include the removal or modification of vegetation due to the construction of firebreaks or setting of backfires to control the spread of fire. This removal of vegetation can trigger post-fire landslides as well as chronic sediment erosion that can negatively affect downstream coho salmon habitat. Also, the use of fire retardants may adversely affect salmonid habitat if used in a manner that does not sufficiently protect streams causing the potential for coho salmon to be exposed to lethal amounts of the retardant. This exposure is most likely to affect summer rearing juvenile coho salmon. State of California protective standards require 100-foot buffers reducing likelihood of fire retardants entering waterways. While we cannot predict precisely where and when wildfires will occur, we expect the rate and severity of wildland fires will increase. We expect degradation of coho salmon habitat from wildfires will occur during this action.

2.6.6 Construction, Reconstruction, Maintenance, and Use of Roads

Adjacent to the action area are thousands of miles of surface roads used to provide access to timber or private residences. Erosion from unmaintained roads increases fine sediment concentrations to waterways and can suffocate redds, degrade pool quality, and decrease pool depth (Newcombe and Jensen 1996; Suttle et al. 2004). As the road networks in the action area are already fairly well established, NMFS does not anticipate significant new miles of roads to be built in the near future. However, NMFS does anticipate that restoration efforts will continue to upgrade and or decommission existing roads to make them less inclined to road failures (landslides) and/or be a chronic source of sediment discharge to adjacent stream networks. Improvement of environmental conditions on private and state lands related to roads adjacent to the action area is expected in the future due to an increasing emphasis on watershed-scale inventory, assessment and treatment of road networks as regulatory sediment reduction requirements are implemented in the action area (e.g., TMDLs). However, funding for such efforts is limited and the thousands of miles of existing roads in total is expected to continue to adversely affect coho salmon and their habitat.

2.6.7 Mining, Rock Quarrying and Processing

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

As described in Section 2.4.1.1.7.4, Mining, in 2009 California suspended all instream mining using suction dredges (NMFS and USFWS 2013). The use of vacuum or suction dredge equipment, otherwise known as suction dredging, is currently prohibited and unlawful throughout California (https://wildlife.ca.gov/Licensing/Suction-Dredge-Permits, visited on November 29, 2021); see generally California Fish and Game Code 5653, 5653.1, 12000, subdivision (a)). Suction dredge mining in systems that support salmonids was known to cause locally significant adverse impacts on salmonids and their habitat. NMFS expects that the prohibition of suction dredging will allow for improved habitat conditions in the Klamath mainstem and larger tributaries, and will reduce the direct and indirect effects of this activity on SONCC ESU coho salmon in both the short and long term.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in assessing the risk that the proposed action poses to species and critical habitat. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

2.7.1 SONCC Coho Salmon ESU

In the environmental baseline section NMFS summarized the extinction risk of the SONCC coho salmon ESU, and summarized the factors that led to the listing of the SONCC coho salmon ESU as a threatened species under the ESA. These factors include past and ongoing human activities and climatological trends and ocean conditions identified as influential to the viability of all populations of the SONCC coho salmon ESU. Beyond the continuation of the human activities affecting the species, NMFS also expects that ocean condition cycles and climatic shifts will continue to have both positive and negative effects on the species' ability to survive and recover. Specifically, we expect climate change will contribute to lower base flows in the summer, reduced snow pack in the winter, and more frequent flood flows associated with intense rain storms and rain-on-snow events.

The extinction risk criteria established for the SONCC coho salmon ESU are intended to represent how a species, including its constituent populations, is able to respond to environmental changes and withstand adverse environmental conditions. Thus, when NMFS determines that a species or population has a high or moderate risk of extinction, NMFS also understands that future environmental changes could have significant consequences on the species' ability to achieve recovery, depending on the extent of those changes. Also, concluding that a species has a moderate or high risk of extinction does not mean that the species has little or no potential to become viable, but that the species faces moderate to high risks from internal and external processes that can drive a species to extinction. With this understanding of the current risk of extinction of the SONCC coho salmon ESU, NMFS will analyze whether the added effects of the proposed action are likely to increase the species' extinction risk, while integrating the environmental baseline, the effects of other activities caused by the proposed action, and cumulative effects.

All four VSP parameters for the SONCC coho salmon ESU's populations are indicative of a species facing moderate to high risks of extinction from myriad threats. In order for the SONCC coho salmon ESU to be viable, all seven diversity strata that comprise the species must be viable and meet certain criteria for population representation, abundance, and diversity. Current information indicates that the species is presently vulnerable to further impacts to its abundance and productivity (Good et al. 2005; Williams et al. 2016a).

Known or estimated abundance of the SONCC coho salmon populations indicates most populations have relatively low abundance and are at high risk of extinction. Species diversity has declined and is influenced, in part, by the large proportion of hatchery fish that comprise the ESU. Population growth rates appear to be declining in many areas and distribution of the species has declined. Population growth rates, abundance, diversity, and distribution have been affected by both anthropogenic activities and environmental variation in climate and ocean conditions. The species' reliance on productive ocean environments, wetter climatological conditions and a diversity of riverine habitats to bolster or buffer populations against adverse conditions may fail if those conditions occur less frequently or intensely (as is predicted) or if human activities degrade riverine habitats.

In the environmental baseline section, NMFS described the current environmental conditions that influence the survival and recovery of Klamath River coho salmon populations. Coho salmon in the mainstem Klamath River will continue to be adversely affected by the ongoing activities, such as agricultural water diversions, timber harvest, and mining. However, many of the impacts described in the Environmental Baseline are a result of the four dams that will be removed when the four mainstem Klamath dams are removed (NMFS 2021a). These impacts include blockage of fish passage, blockage of sediment transport, reduction of flow variability, decreased water quality, and creation of conditions that increase rates of disease. NMFS' (2014b) SONCC Coho Salmon Recovery Plan identifies a number of ways that dams pose a high threat to most coho salmon life stages in the ESU and specifically highlights the Klamath River Dams as adversely affecting numerous downstream populations in the Klamath Basin. Additionally, NMFS (2014b) describes optimism in the proposal to remove the four Klamath River dams, because that would allow the Upper Klamath River population to occupy the full extent and range of its historic habitat, thereby increasing spatial structure of the entire ESU.

In the Cumulative Effects section (Section 2.6), NMFS expects many of the non-Federal activities discussed in the Environmental Baseline section (Section 2.4) will continue (e.g., timber management, control of wildfire, use of roads) with effects similar to those described in the environmental baseline. However, post dam removal, NMFS expects that the Reintroduction Plan drafted by ODFW and the Klamath Tribes (2021b) will inform and guide restoration decisions such as prioritizing key projects to aid in repopulation of the Upper Klamath Basin after fish gain access to upstream reaches.

The Klamath River basin encompasses nine SONCC coho salmon populations and two diversity strata (i.e., Interior Klamath River and Central Coastal). All nine coho salmon populations in the Klamath River basin will be affected by the proposed action; however, two out of five populations in the Interior Klamath Basin diversity stratum will be affected the most (i.e., the Upper Klamath River population and associated smaller tributaries, as well as the Shasta River). The populations within this stratum have a moderate to high extinction risk. Abundance estimates indicate that all of the populations within the stratum fall below the levels needed to result in a low risk of extinction. The large proportion of hatchery coho salmon to wild coho salmon reduces diversity and productivity of the wild species. IGH and TRH Chinook salmon smolts compete with wild coho salmon for available space and resources.

2.7.1.1 Effects of the Action on SONCC Coho Salmon ESU

As described in the Effects of the Action section (Section 2.5), the proposed action may result in adverse effects. However, the proposed action is intended and designed to minimize those adverse effects in a manner that is expected to enhance the biological status of coho salmon in the Klamath Basin. Adverse effects to the Upper Klamath River population are primarily associated with removal of adult coho salmon for broodstock; the trapping, handling, and tagging of adult, juvenile, and smolt coho salmon; ecological interactions between HOR and NOR coho salmon, and potential removal of HOR adult coho from Bogus Creek to achieve a PNI value greater than 0.5. Activities included in the HGMP that will minimize adverse effects on NOR Upper Klamath River population coho salmon include: (1) improving broodstock composition, timing, and structure to simulate NOR population characteristics; (2) increasing adult holding and spawning survival; (3) utilizing mating protocols (%jacks, %males, pNOB) that minimize inbreeding and conserve existing diversity; (4) increasing natural influence (PNI) of the broodstock; (5) decreasing disease outbreaks; (6) establishing release timing, coho salmon health, size and condition of released coho salmon to produce high survival; (7) increasing smolt to adult return rates; (8) increasing natural adult abundance; (9) ensuring similar adult run-timing between the adults returning to the hatchery and adults returning to the tributaries; (10) decreasing straying of hatchery coho salmon; and (11) implementing a real-time genetic spawning matrix.

2.7.1.2 Effects to the VSP parameters

2.7.1.2.1 Abundance

The proposed action will annually remove up to 171 NOR and 221 HOR coho salmon from the Upper Klamath River for broodstock. The actual number is expected to be substantially lower than that, and will be comprised of not more than 50 percent NOR coho salmon. Adverse effects to the Upper Klamath River population will continue for the term of the permit, but will be minimized by the reduction in broodstock size as egg to smolt survival is increased and by the subsequent increase in spawner abundance on the natural spawning grounds. Allowing a larger proportion of NOR coho salmon to spawn on the natural spawning grounds will increase the fitness, condition, spawning success, and survival of the Upper Klamath River coho salmon population. This will increase abundance over the term of the permit.

Continuation of the FCH coho salmon program will have a beneficial effect on the Shasta River population by increasing spawner abundance in this population, which will help sustain this population until it can become self-sustaining. Improving the fitness and survival of HOR coho salmon may help the Shasta River population by providing higher quality HOR coho salmon that will help the productivity of the population as a whole.

FCH HOR individuals are also expected to disperse into newly accessible habitat made available from dam removal. Ramos (2020) concluded that there were prolific cold-water temperatures throughout Scotch, Camp, Fall, Shovel, and portions of Spencer creeks, and that newly accessible habitat in the study tributaries will provide substantial rearing and spawning habitat for coho salmon after dam removal. The reproduction of these fish in this newly accessible habitat is expected to increase the abundance of Upper Klamath River coho salmon population over time.

Ecological interactions between hatchery and natural origin coho salmon juveniles are likely to result in up to 5 percent mortality to the natural coho salmon population from competition, predation, and/or displacement. However, because of the relatively low abundance of hatchery smolts, behavioral differences between HOR and NOR fish, and proposed minimization measures (e.g., implementing a smolt characteristic index that promotes rapid migration and regulating the number of HOR smolts released from the hatchery each year to no more than 82,500), the actual mortality to natural coho salmon population from these effects is likely to be much less than 5 percent.

2.7.1.2.2 Productivity

Productivity of the Upper Klamath River population will improve over the term of the permit. Release of all excess adult coho salmon (HOR and NOR) that are not required for the broodstock back to the Klamath River to spawn naturally has increased the number of naturally spawning coho salmon in the Upper Klamath River and Shasta River population units and is helping reduce the threat of demographic extinction in these locations while also helping to preserve remaining genetic characteristics. As these numbers increase, depensation effects will be reduced and production of naturally produced fish will increase. Over time, as numbers increase and habitat restoration measures improve conditions, natural selective pressures on the population will allow for restoration of successful and diverse life history strategies better adapted to environmental conditions. FCH HOR individuals are also expected to disperse into newly accessible habitat made available from dam removal. Utilization of this habitat by FCH HOR individuals spawning in the wild may increase the productivity of the Upper Klamath River population.

2.7.1.2.3 Diversity

Overall, the proposed action will result in a beneficial effect on the Upper Klamath River population life history and genetic diversity. Continuing to implement a genetic spawning matrix will increase the life history and genetic diversity of the resulting HOR coho salmon population. These increases in diversity will increase the potential for the full range of genes to be expressed and passed on to future generations. Although the HGMP does not include any activities that would result in a reduction to physical habitat characteristics for any life stage of coho salmon, conservative modeling results indicate that some mortality (< 5%) of NOR coho salmon could result through ecological interactions with HOR coho salmon smolts released from IGH in the form of predation, competition, or disease. These adverse effects will be minimized under the HGMP by limiting the number of smolts and by improving the quality of smolts released. In addition, as habitat restoration and recovery efforts proceed in the future, the abundance of NOR coho salmon in the basin are anticipated to increase, further reducing the potential adverse ecological interactions. Overall, NMFS believes that diversity benefits achieved under the HGMP related to protection of existing genetic characteristics and increased abundance outweigh potential negative ecological interactions that may occur between HOR and NOR coho salmon juveniles in the spring.

2.7.1.2.4 Spatial Structure

The HGMP does not contain any activities that involve habitat modification or alteration that would cause physical changes to spatial structure. The release of excess coho salmon from FCH is anticipated to reduce depensation effects, which may improve spatial structure through increased distribution within available habitats. Both the Upper Klamath River and Shasta River populations are currently well below depensation levels. Release of excess broodstock coho salmon will improve spatial structure, help preserve remaining genetic characteristics, and will help reduce the immediate threat of extinction. Increases in the number of adult coho salmon allowed to spawn naturally under the current conditions will improve spatial structure in the Upper Klamath River and Shasta River populations. Again, FCH HOR individuals are also expected to disperse into newly accessible habitat made available from dam removal, thus improving spatial structure for the Upper Klamath River population

Operation of downstream outmigrant traps at or near Bogus Creek may result in mortality of up to 1% of juveniles capture, annually. In addition, the PCDRISK-1 model was used to quantify potential adverse ecological interactions (predation, competition, and disease) between HOR and NOR juvenile coho salmon. Modeling results show that the overall risk index has been 5% or less since 2015. Monitoring and evaluation activities identified in the HGMP will improve our knowledge of the abundance, distribution and genetic characteristics for the Upper Klamath River population which will provide a better understanding of the potential ecological interactions between natural and hatchery produced coho salmon over time. As previously discussed, under the HGMP the number of coho salmon smolts released will be limited to a maximum of 82,500 (75,000 +/- 10%) smolts and the quality of smolts will be monitored to ensure that when released, smolts travel downstream quickly and are less likely to be residualized, thus reducing the potential for adverse ecological interactions to occur.

Overall, NMFS anticipates that the beneficial effects of the HGMP to spatial structure and diversity of the Upper Klamath River population outweigh potential adverse effects associated with trapping adult fish to collect broodstock and those potential negative effects related to ecological interactions between juvenile/smolt hatchery and natural origin coho salmon. Beneficial effects to life history and genetic diversity, which are discussed above, will help to maintain and improve the current spatial structure and may help to increase spatial distribution over the long term as habitat restoration efforts improve habitat conditions in the future.

2.7.1.2.5 Summary

While factoring the status of the SONCC coho salmon ESU, the environmental baseline in the action area, and the cumulative effects in the action area, NMFS believes the proposed action is likely to (1) result in a decrease in the extinction risk of the Upper Klamath River and Shasta River coho salmon populations and (2) not result in an increase in the extinction risk of the Upper Klamath River, Shasta, Scott, Middle Klamath, Salmon, South Fork Trinity, Lower Trinity, and Upper Trinity river populations. All effects, positive and negative, considered, NMFS concludes that the proposed action is likely to benefit or enhance the Upper Klamath River and Shasta River populations in the long term. In addition, NMFS does not expect that the proposed action will reduce the viability or reduce the probability of an increase in the viability of any of the nine coho salmon population in the Klamath River basin. Therefore, NMFS does not expect that the proposed action will appreciably reduce the likelihood of survival and recovery of the species at the ESU level.

2.7.1.3 SONCC Coho Salmon ESU Critical Habitat

Section 2.2.2.2of this Opinion, Status of SONCC Critical Habitat, details the condition of critical habitat at the ESU scale. In summary, the current condition of critical habitat of the SONCC coho salmon ESU is mostly degraded. 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 and past human activities. Water use 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. Meanwhile, habitat restoration throughout the range of the SONCC coho salmon ESU has been improving the conservation value of critical habitat for coho salmon.

The current condition of critical habitat in the action area is degraded. Sedimentation, low summer flows, poor water quality, stream habitat simplification, and habitat loss from poorly designed road crossings and diversion structures continue to impair coho salmon streams in this stratum. Past and ongoing human activities often preclude sufficient recovery of critical habitat in the Interior Klamath diversity stratum to establish essential features. Water use in many regions throughout the action area (e.g., Shasta and Scott rivers) reduces summer base flows, which, in turn, limit the re-establishment of the essential features of water quantity and water quality. Since the early 1990s, habitat restoration efforts in much of the Klamath basin has been incrementally improving the conservation value of critical habitat in the action area. This is evidenced by significant strides in the implementation of livestock exclusion riparian fencing, dam removals, riparian planting, thermal refugia protection/enhancement, wetland habitat enhancement, fish exclusion screening, water use efficiency, and agricultural water leasing programs. The aggregate benefits from these habitat restoration efforts will be integral to the recovery of SONCC coho salmon in the action area.

2.7.1.4 Effects of the Action on Essential Habitat Types and PBFs

Critical habitat for SONCC coho salmon ESU is comprised of physical and biological features that are essential for the conservation of coho salmon, including substrate, water quality, water quantity, water temperature, water velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions. As summarized below, the conservation value of critical habitat in certain reaches of the Klamath River between IGD and the Trinity River mouth is likely to be reduced by fish trapping facilities associated with the Program, and the release of hatchery juvenile coho salmon. These activities may affect the essential features of adult migration corridor and juvenile rearing areas as described below.

Adverse effects of the fish trapping facilities on the juvenile rearing areas are expected to be minimal and temporary because no earth disturbance or vegetation removal is required. If adult trapping is needed at Bogus Creek or the auxiliary fish ladder at IGH, the adult migration corridor essential habitat type of SONCC coho salmon critical habitat will be temporarily adversely affected. Effects of this will be minimized by close monitoring of the traps. The traps will be checked a minimum of twice a day (7-days per week) for the presence of coho salmon adults. Caught fish will be removed from the trap and transported to the adult holding facilities at FCH if needed for broodstock. If not needed for broodstock, captured fish will be released upstream of the weir to continue their migration.

The annual release of hatchery coho salmon smolts is likely to minimally decrease food availability and space for juvenile rearing areas because of the relatively low numbers of hatchery smolts being released (up to 82,500), food and habitat availability increase downstream, and hatchery coho salmon have many miles of the mainstem Klamath River to occupy. As discussed in the Effects of the Action on SONCC Coho Salmon section, the release of hatchery juvenile coho salmon may cause adverse effects to NOR coho salmon through increases in predation, competition, and displacement. The juvenile summer and winter rearing areas are the only essential habitat types that will be adversely affected by the proposed release of hatchery coho salmon smolts. The proposed annual release of up to 82,500 coho salmon smolts will decrease food availability and space within juvenile rearing areas in the mainstem Klamath River.

2.7.1.5 Response and Risk to the SONCC Coho Salmon ESU Critical Habitat

Many of the PBFs that are essential for the conservation of SONCC coho salmon are currently degraded. As a result of implementing the proposed action, some of those physical and biological features will likely remain degraded, especially in the Klamath River near the current IGH site. After factoring the minimization measures under the proposed action, the environmental baseline and the status of SONCC coho salmon ESU critical habitat, any remaining adverse effects resulting from the proposed action to the quantity and quality of the essential features are not likely to reduce the overall conservation value of critical habitat at the diversity stratum or ESU level.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and the cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the SONCC coho salmon ESU or destroy or adversely modify their designated critical habitat.

2.9 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Harass" is further defined by interim guidance as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.9.1 Amount or Extent of Take

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

In this instance, and for the actions considered in this opinion, much of the take associated with the proposed action is direct take not incidental take. The reason for this is that the take contemplated in this document would be carried out under a permit that allows CDFW to directly take the animals in question for hatchery and monitoring purposes. Because these hatchery and monitoring actions would not cause incidental take, we are not specifying an amount or extent of incidental take that would serve as a reinitiation trigger. Nonetheless, the amounts of direct take have been specified in the Proposed Federal Action section, Amount of Direct Take Included in the Permit Application (1.3.1.10)(Table 5 through Table 9), and analyzed in the effects section above (2.5). Those amounts constitute hard limits on both the amount and extent of direct take CDFW would be allowed in a given year. Those amounts are also noted in the reinitiation clause (Section 2.10) below because exceeding them would likely trigger the need to reinitiate consultation.

In addition to direct take for hatchery purposes, the proposed action may result in incidental take through release of juvenile HOR coho salmon that can result in take through ecological interactions on rearing and spawning habitat. In order for the Program not to have effects different from those analyzed in this opinion, it is critical for the Program to function as intended as an integrated recovery program. Because the Bogus Creek population is a critical for maintaining the Program as an integrated recovery program, no more than 50% of the adult NOR coho salmon may be removed at the Bogus Creek weir to be used as broodstock. In addition, not less than 10% of the broodstock may consist of NOR adults. If more than 50% of the adult NOR are removed at the Bogus Creek weir, or less than 10% of the broodstock consist of NOR adults, reasonable sidebars for an integrated recovery program will be violated, and the amount of incidental take will be considered exceeded (Table 15).

Table 15. Annual expected incidental take of coho salmon resulting from the proposed action.

Take	Origin	Stressor	Amount or Extent of Take
Genetic Interactions in the Hatchery	HOR	Reduction in adult productivity, domestication selection (poor survival of progeny)	not less than 10% of the broodstock may consist of NOR adults
Genetic Interactions on Spawning Grounds	NOR	Reduction in fitness of juveniles	no more than 50% of the adult NOR coho salmon may be removed at the Bogus Creek weir to be used as broodstock

2.9.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

NMFS believes that the following reasonable and prudent measures and terms and conditions are necessary and appropriate to minimize the impacts of the amount or extent of incidental take of SONCC ESU coho salmon resulting from the proposed action.

1. Minimize incidental take from ecological interactions between hatchery and natural coho salmon.

2. Ensure real-time decision making occurs using best available technical information during implementation of the proposed action.

2.9.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. The NMFS or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1: NMFS must ensure that CDFW continues to operate the Program as an integrated recovery program as intended. CDFW shall provide reports to NMFS by September 30 each year that, at a minimum, include data on all of the performance metrics included Table 4 (FCH coho salmon Program performance indicators, metrics, and M&E methods), and information gathered from the Bogus Creek fish counting facility weir, including the number of HOR and NOR individuals that pass and that are collected as broodstock. CDFW shall develop and collect all information sufficient to annually calculate the proportionate natural influence (PNI), including the proportion of natural origin broodstock (pNOB), and the proportion of hatchery origin spawners in Bogus Creek.

2. The following terms and conditions implement reasonable and prudent measure 2: CDFW shall convene and consider the recommendations of the Hatchery Technical Team frequently during implementation of the action as described in Section 1.3.1.11. The hatchery technical team will be convened to make recommendations to CDFW and NMFS on various hatchery activities, including, at a minimum, any changes in: the release location and timing of surplus HOR broodstock, juvenile coho salmon release location or timing, and marking or tagging strategies for HOR fish to be released from FCH.

2.10 Reinitiation of Consultation

This concludes formal consultation for "Consultation on the Issuance of an ESA Section 10(a)(1)(A) Enhancement Permit to the California Department of Fish and Wildlife for Implementation of the Fall Creek Hatchery coho salmon program, including an accompanying Hatchery and Genetic Management Plan".

Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion or written concurrence; or (4) If a new species is listed or critical habitat designated that may be affected by the identified action."

In the context of this opinion, there is no incidental take anticipated and the reinitiation trigger set out in § 402.16(a)(1) is not applicable. If any of the direct take amounts specified in this opinion's effects analysis (Section 2.5) are exceeded, reinitiation of formal consultation will be required because the regulatory reinitiation triggers set out in § 402.16(a)(2) and/or (a)(3) will have been met.

2.11 "Not Likely to Adversely Affect" Determinations

NMFS determined that the proposed action is not likely to adversely affect Southern Residents, the Southern DPS Eulachon, the Southern DPS North American Green Sturgeon, or their critical habitats

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR 402.02). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b). When evaluating whether the proposed action is not likely to adversely affect listed species or critical habitat, NMFS considers whether the effects are expected to be completely beneficial, insignificant, or discountable. Completely beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Effects are considered discountable if they are extremely unlikely to occur.

2.11.1 Southern Resident DPS Killer Whale (Southern Residents)

Southern Residents occur throughout the coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as Southeast Alaska (Ford et al. 2017; Carretta et al. 2021; NMFS 2021c). A comprehensive review of Southern Resident use of coastal waters is available in the Final Biological Report on SRKW critical habitat (NMFS 2021c). Southern Residents are described as killer whales from the J, K and L pods, is listed as endangered under the ESA (50 CFR 224.101(h)). A 5-year review under the ESA completed in 2016 concluded that SRKWs should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2016c). The limiting factors described in the final recovery plan include reduced prey availability and quality, high levels of contaminants from pollution, and disturbances from vessels and sound (NMFS 2008).

Southern Residents consume a variety of fish species (22 species) such as herring, rockfish, and various flatfish sp., and one species of squid (Ford et al. 1998; Hanson et al. 2021). However, long-term diet studies have identified salmon as their primary prey (i.e., a high percent of prey consumed during spring, summer and fall)(Hanson et al. 2021). Research indicates that Southern Residents have a strong preference for Chinook salmon in the Puget Sound and inland waters during the summer and fall, likely because they are the largest salmon species and contain the highest lipid content. They also appear to target large individual fish, for probably the same reasons (Ford et al. 2010; Hanson et al. 2021).

The proposed action would result in the release of up to 82,500 HOR coho salmon from FCH annually. The proposed action will have no adverse effect on the quantity and quality of Klamath River Chinook salmon propagated at FCH, or wild NOR Chinook salmon that emigrate from the Klamath River basin. As such, the proposed action is expected to result in providing slightly more food for Southern Residents particularly in the fall and winter months, as they frequent coastal waters off the Pacific Coast where their range overlaps with the ocean distribution of FCH coho salmon. Because the effect of the proposed action on Southern Residents is expected to be completely beneficial by slightly increasing their prey base, the proposed action "may affect but is not likely to adversely affect" Southern Residents.

2.11.2 Southern Residents Critical Habitat

Critical habitat for the SRKWs was first designated in 2006 (71 FR 69054 (November 29, 2006)), which included approximately 2,560 square miles of inland water of Washington. In 2019, NMFS proposed to revise the critical habitat designation for the Southern Residents under the ESA by designating six new areas (covering approximately 15,626 square miles) along the U.S. West Coast from the U.S.-Canada border to Point Sur, California (84 FR 49214 (September 19, 2019)). The final rule on revised critical habitat was published on in 2021 and went into effect on September 1, 2021 (86 FR 41668 (August 2, 2021)). The revised critical habitat added approximately 15,910 square miles to the previous designation, including marine waters between the 6.1-meter and 200-meter depth contours from the U.S.-Canada border to Point Sur, California. PBFs for Southern Residents include water quality, prey availability and quality, ocean conditions including noise pollution, and migration passage conditions (86 FR 41668 (August 2, 2021)). Of these, only prey availability is expected to be affected by the proposed action, and these effects are expected to be completely beneficial, so NMFS concludes that the proposed action is not likely to adversely affect PBFs of critical habitat of the Southern Residents.

2.11.3 Southern DPS Eulachon

In March 2010, NMFS listed the Southern DPS Pacific eulachon, which includes the Klamath River population of eulachon, as threatened (75 FR 13012 (March 18, 2010)). NMFS reaffirmed this threatened status conclusion in its most recent 5-year status review (NMFS 2016b). NMFS designated critical habitat for the southern DPS eulachon in 16 specific areas in California, Oregon, and Washington, but excluding Indian lands for four Federally-recognized Tribes in the States of California, Oregon and Washington (75 FR 13012 (March 18, 2010)). More information on the biology, ecology, and status of this species can be found in the recovery plan (NMFS 2017).

Historically, large aggregations of eulachon were reported to have consistently spawned in the Klamath River (Fry 1979; Moyle et al. 1995; Larson and Belchik 1998; Moyle 2002; Hamilton et al. 2005). Allen et al. (2006) indicated that eulachon usually spawn no further south than the Lower Klamath River and Humboldt Bay tributaries. 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). However, Larson and Belchik (1998) report that eulachon have not been commercially important in the Klamath River. With funding from NMFS, the Yurok Tribal fisheries biologists surveyed for eulachon in the lower Klamath River and found only two eulachon (tribal fishermen caught another five) in early 2011 and 40 in 2012 (YTFP 2011; YTFP 2012). Reports from Yurok tribal fisheries biologists also report capturing adult eulachon in presence/absence surveys (seine/dip nets) in the Klamath River in 2013 (112 eulachon), and 2014 (1,000 eulachon) (Robert Anderson, NMFS, personal communication[3]). Surveys for presence/absence using eDNA were conducted in 2020 and have yet to be analyzed, but according to tribal fishers, few fish have been observed recently (Barry McCovey Jr., Yurok Senior Fisheries Biologist, personal communication[4]). Based on the available information, NMFS concludes that the current run size in the Klamath River is very small relative to the number of eulachons in the Southern DPS.

Potential adverse effects on this species would be limited to predation on larval eulachon during the spring hatchery smolt outmigration period. These effects would be limited to the lower Klamath River, the Klamath River estuary, and nearshore environment. Presently, specific information regarding the predation on larval eulachon by juvenile salmonids is non-existent, and predation of juvenile or adult eulachon by coho salmon has not been cited as contributing to the decline of eulachon (NMFS 2016b). Eulachon larvae occur in the water column and move downstream with the prevailing currents into pelagic areas where they begin to feed on small plankton (e.g., copepods and euphausiids). Eulachon larvae are semitransparent and very small, making them more difficult to spot in the water column. Juvenile coho salmon are generally present along shorelines in areas with abundant cover. Juvenile and smolt salmonids typically feed during the day and prefer aquatic insects at the surface of a stream, such as mayflies, caddis flies, and stoneflies, while juvenile eulachon are plankton-feeders, chiefly eating crustaceans such as copepods and euphausiids in pelagic and open water habitats. Differences in habitat selection and in the diets of the two species, along with the abundance of alternative prey items available to juvenile coho salmon in the lower Klamath River, greatly reduce the likelihood that FCH coho salmon would use similar habitat types as larval eulachon in the lower Klamath River and estuary. Given the relatively limited spatial overlap between hatchery smolts and larval eulachon within the action area, and the small number of eulachon in the action area, predation on eulachon by FCH coho salmon is extremely unlikely to occur and is considered discountable. Therefore, the proposed action "may affect but is not likely to adversely affect" Southern DPS Pacific Eulachon.

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[3] Email from Robert Anderson (NMFS) to Heather Wiedenhoft (NMFS), September 9, 2021

[4] Email from Barry McCovey Jr., (Yurok Senior Fisheries Biologist) to Heather Wiedenhoft (NMFS) September 16, 2021.

2.11.4 Southern DPS Eulachon Critical Habitat

In 2011, NMFS designated critical habitat for the southern DPS of Pacific eulachon. 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 (76 FR 65324 (October 20, 2011)). The designation includes 16 rivers and creeks extending from and including the Mad River, California to the Elwha River, Washington, and all of these areas are considered migration and spawning habitat for this species. In the Klamath River, critical habitat is designated from the mouth of the Klamath River upstream to the confluence with Omogar Creek at approximately RM 10.5 from the mouth; however, critical habitat does not include any tribal lands of the Yurok Tribe or the Resighini Rancheria. Therefore, designated critical habitat is located outside of the action area, and NMFS concludes that the proposed action will have no effect on critical habitat for the Southern DPS eulachon.

2.11.5 Southern DPS North American Green Sturgeon

The Southern DPS of North American green sturgeon is listed as a threatened species, and includes all green sturgeon originating from the Sacramento River basin and from coastal rivers south of the Eel River (exclusive) (50 CFR 223.102(e)). The only known spawning population is in the Sacramento River (71 FR 17757 (April 7, 2006)). Sub-adult and adult southern DPS of North American green sturgeon enter coastal bays and estuaries north of San Francisco Bay, CA, during the summer months to forage (Lindley et al. 2008). As such, individuals of the southern DPS of North American green sturgeon's potential occurrence in the lower Klamath River is limited to only the sub-adult and adult life stages, only during summer months, and only in the Klamath River estuary. Sub-adult and adult life stages of Southern DPS green sturgeon likely only occur in these areas during the summer and fall. Because the proposed action is not expected to adversely affect the physical, chemical, and biological resources in the lower Klamath River and estuary, NMFS believes that that the proposed action may affect, but is not likely to adversely affect the Southern DPS of North American green sturgeon.

2.11.6 Southern DPS North American Green Sturgeon Critical Habitat

Critical habitat for the southern DPS of North American green sturgeon is not designated in the Klamath River (74 FR 52300 (October 9, 2009)). NMFS does not anticipate that the proposed action will have an effect on waters offshore from the Klamath River, where critical habitat for the southern DPS does occur. Therefore, NMFS concludes that the proposed action may affect, but is not likely to adversely affect critical habitat for the southern DPS of North American green sturgeon.

3 Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration 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 or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)].

This analysis is based, in part, on the EFH analysis completed by NMFS, and descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The Proposed Action would adversely affect EFH for Pacific Coast salmon (PFMC 2014) for Chinook salmon and coho salmon in the Klamath River basin. Habitat Areas of Particular Concern (HAPCs) for salmon are: complex channel and floodplain habitat, spawning habitat, thermal refugia, estuaries, and submerged aquatic vegetation.

3.2 Adverse Effects on Essential Fish Habitat

The adverse effects to EFH for Pacific Coast salmon are similar to that of SONCC coho salmon described in section 2.5. The adverse effects to EFH include:

1. removal of adult coho salmon for broodstock, which in low abundance populations can impact spawning habitat by leading to inbreeding depression,

2. brief impacts to migration habitat when the broodstock collection facilities are being operated at Bogus Creek and the IGH auxiliary fish ladder,

3. ecological interactions between HOR and NOR coho salmon that can degrade rearing and spawning habitat for wild spawning coho salmon.

3.3 Essential Fish Habitat Conservation Recommendations

Activities to be implemented under the proposed action are primarily biological, and will have limited adverse effects on salmon EFH. The HGMP has been developed to conserve and protect genetic and life history characteristics of coho salmon in the Upper Klamath River population.

For each of the Proposed Action's adverse effects on EFH for salmon, NMFS believes that the Proposed Action, as described in the HGMP (CDFW 2023a) and the Incidental Take Statement (Section 2.9) include the best approaches to avoid or minimize those adverse effects. Therefore, NMFS is not proposing additional conservation measures at this time. This concludes the EFH portion of this consultation.

3.4 Supplemental Consultation

NMFS must reinitiate EFH consultation if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations [50 CFR 600.920(l)].

4 Data Quality Act Documentation and Pre-Dissemination Review

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion is NMFS. Other interested users could include CDFW. Individual copies of this opinion were provided to CDFW. The document will be available within 2 weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adhere to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR part 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion [*and EFH consultation, if applicable*] contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA [*and MSA implementation, if applicable*], and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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