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

Issuance of ESA 10(a)1(A) Enhancement Permit to the U.S. Corps of Engineers, San Francisco District for the Operation of the Russian River Coho Salmon Captive Broodstock Program and Accompanying Hatchery and Genetic Management Plan

NMFS Consultation Number: WCRO-2019-04048
Action Agency: National Marine Fisheries Service, NOAA

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?
Central California Coast coho salmon (*Oncorhynchus kisutch)*	Endangered	Yes	No	No	No
Central California Coast steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
Northern California steelhead (*O. mykiss*)	Threatened	Yes	No	No	No
California Coastal Chinook (*O. tshawytscha*)	Threatened	Yes	No	No	No
Southern Resident killer whale (*Orcinus orca*)	Endangered	No	No	No	No

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

Issued By:

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

Date: September 14, 2020

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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 USC 1531 et seq.), and implementing regulations at 50 CFR Part 402, as amended.

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 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). A complete record of this consultation is on file at the NMFS office in Santa Rosa, California and online at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome].

The Russian River Coho Salmon Conservation Broodstock Program (Program) was started in 2001 in response to the nearly complete extirpation of coho salmon from the Russian River basin. The Russian River coho salmon population is the largest historically independent population in the Central California Coast (CCC) coho salmon Evolutionarily Significant Unit (ESU), and the Russian River population is an important component in the recovery of this ESU. The Program is intended to aid in the recovery of this ESU by producing, rearing and releasing coho salmon in the Russian River basin and elsewhere in the CCC coho salmon ESU. Recovery plans have been published by the California Department of Fish and Wildlife (2004) and NMFS (2012). Both documents contain numerous recovery tasks, and both include recommendations regarding the use of conservation hatcheries to maintain and recover populations of coho salmon in this ESU. The Program has previously been operated under the authority of ESA Section 10 Permit 1067, Modification 3, issued by NMFS to CDFW on September 26, 2001, and reissued on September 23, 2008.

1.2 Consultation History

NMFS received a Section 10(a)(1)(A) permit application from the U.S. Army Corps of Engineers (USACE) for the Program at the Don Clausen Fish Hatchery (DCFH) on October 2, 2017. The permit application is supplemented by a Hatchery Genetic Management Plan (HGMP) that details current and proposed hatchery operations, and related fish monitoring which was submitted to NMFS September of 2017. Subsequently, additional information was requested and supplied by USACE and CDFW to complete the application October 2, 2019. ESA and EFH intra-agency consultation was initiated by the NMFS Santa Rosa Office on June 5, 2020.

As the federal action agency for the issuance of the 10(a)(1)(A) permit, NMFS initiated internal section 7 consultation for the operation of the Program through August of 2028. The internal section 7 analyzes the potential effects of implementing the Program on endangered CCC coho salmon, Central California Coast (CCC) steelhead, California Coastal (CC) Chinook salmon, and Northern California (NC) steelhead and their designated critical habitat.

1.3 Proposed Federal Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02).

The proposed action is NMFS' issuance of a 10(a)(1)(A) permit for a HGMP submitted by USACE and CDFW. The HGMP for DCFH Russian River Captive Broodstock Program, September 2017 (CDFW and USACE 2017) describes how USACE and CDFW will conduct hatchery operations and monitoring using endangered CCC coho salmon at the DCFH in Sonoma County near Healdsburg, California (see Figure 1). NMFS' permit will be issued to USACE for the operations and implementation of the HGMP with the CDFW as a co-investigator on the permit.

USACE is responsible for mitigating and supplementing Russian River Coho Salmon through artificial propagation that is part of the DCFH operation under congressional authorization and annual congressional appropriations. To accomplish this mission, USACE partners with the CDFW, which assists with operation of the Program, and NMFS who provides oversite for the Program. Additionally, USACE supports the Program by providing funding for genetic analysis of broodstock and field monitoring and evaluation of progeny and adult returns, which are performed by the NMFS Southwest Fisheries Science Center (SWFSC) and California Sea Grant (CA Sea Grant) respectively. The Program is adaptively managed through collaborative management by USACE, CDFW and NMFS program managers, with input from a Hatchery Coordination Team, and a Technical Advisory Committee (TAC) comprised of local, state and federal agencies and NGO's.

This HGMP describes the collecting, rearing, releasing and monitoring of coho salmon from the Russian River and Lagunitas/Olema Creek basins and other areas within the northern portion of the ESU to support ESU-wide recovery efforts (Figure 1). Coho salmon populations that are collected for broodstock, reared and artificially propagated at DCFH currently include the Russian River basin and Lagunitas/Olema Creek populations. Beginning with the initiation of the Program in 2001, fish were first sourced from various Russian River tributaries, and then derived predominantly from hatchery-reared coho salmon juveniles retained from artificial propagation at DCFH. Since 2008, an increasing percentage of broodstock consisting of natural-origin young-of-the-year (YOY) coho salmon from various tributaries within the Russian River and the Lagunitas/Olema Creek basins were also incorporated into the broodstock (primarily for outbreeding. In addition, coho salmon returning to the DCFH are utilized as broodstock for the Program.

Coho salmon have and may also be collected within the ESU via rescue efforts during drought conditions from various populations. These have included Lagunitas/Olema, Redwood Creek, and the Garcia and Navarro river populations. Rescued fish have been either temporarily reared and re-released to their respective streams (i.e., Redwood Creek), incorporated into broodstock for propagation (i.e., Russian River) or released to supplement or re-introduce coho to barren populations (i.e., Salmon and Walker creeks). Recently (2018 and 2019) coho salmon were rescued from, and are being captively reared for supplementing the Garcia, Navarro, and eventually the Gualala River populations. Other focus or supplemental populations within the ESU Diversity Strata's (Marin, Mendocino, and Sonoma counties) identified in the federal coho salmon Recovery Plan (NMFS 2012a) may be included for captive rearing or supplementation activities under this Program (Figure 1).

Coho salmon from the Santa Cruz Mountains Diversity Strata (Figure 1) are also temporarily reared at DCFH as a backup facility to the Kingfisher Flat Hatchery (KFH) from the southern portion of the ESU via oversight from the Southwest Fisheries Science Center (SWFSC). These fish are returned to the KFH prior to the release (these activities are covered under a separate HGMP for that program).

The HGMP also describes a Monitoring and Evaluation (M&E) Program under contract to USACE, which performs field monitoring throughout the Russian River basin.

We considered whether the proposed action would cause any other activities and determined that it would not.

Figure 1. Program location within the Russian River watershed and Central California Coast Coho Salmon ESU.

1.3.1 Program Facilities

Collection of broodstock, rearing various life stage of coho salmon and releasing these fish to specific stream reaches requires an extensive amount of equipment and facilities. For the majority of collection activities the Corps has various sized tank trucks (150 to 350-gallon) to transport fish into the facilities at DCFH. Larger 1200-gallon trucks are used for release of fish to streams or acclimation sites (e.g., streamside tanks) where juveniles are held prior to release. All truck tanks are well insulated and are fitted with the appropriate oxygen or aeration systems to reduce stress during transportation.

Hatchery facilities consist of two buildings: 1) DCFH, which includes a fish ladder from Dry Creek, ponds for holding and sorting, incubation stacks and rearing troughs; and 2) the coho conservation building located adjacent to DCFH. For adults that return to the DCFH ladder, there are holding ponds and troughs to hold fish while they ripen. Holding ponds and troughs allow hatchery staff to temporarily hold fish and organize broodstock for easy access and efficiency during spawning. Eggs taken from adults are placed in the incubation stacks in the hatchery building at the DCFH. Vertical incubation trays are utilized until progeny reach the swim-up stage and fish are transferred from the DCFH hatchery building to the coho conservation building.

The majority of the rearing for the Program is carried out in the coho conservation building where captive broodstock rearing, and captive progeny rearing and future incubation expansion is proposed. Captive broodstock rearing is conducted using 12 large fiberglass circular tanks where fish reach 2 to 3 years of age and then are spawned or released as adults. Broodstock juveniles are then reared in 24 rectangular tanks that are later transported to tributaries for direct release as fry, fingerlings or pre-smolts, to acclimation facilities/sites on tributaries (e.g., currently Dutch Bill Creek, and Mill Creek) for release as smolts, or to streamside incubators as eggs or fry for release. Measures have been incorporated to the rearing facilities to minimize loss of water to facilities, flooding, and disease transmission during captive rearing of adults, juveniles, and egg incubation activities.

All spawning currently occurs at DCFH, thus fish must be transported back to the hatchery from the conservation building prior to spawning annually when ripening. The Program proposes additional incubation for the coho conservation building which will double the capacity of incubation infrastructure. Also proposed are fine infiltration and UV-treatment for incubation, a lab, space for spawning and starter troughs to improve water quality. Other facilitates and equipment include on-stream and off-stream acclimation sites and Remote Streamside Incubators (RSIs) to incubate eggs in remote stream sites to increase early life stage survival and improve survival and imprinting in various streams within populations the Program serves.

1.3.2 Program Operations

1.3.2.1 Collection of Broodstock

The maximum number of coho salmon collected annually and reared to adulthood for artificial propagation is 1,500 individuals. Fish are collected for two purposes, either for use as broodstock for propagation, or for captive rearing and release without propagation. The number, life stages, and sources of fish collected for use as broodstock in a given year varies from stream to stream, and includes both natural-origin juveniles for broodstock, and fish that are collected for captive rearing without propagation. CDFW collects broodstock by capturing YOY coho salmon from selected streams using hand seines and backpack electrofishing. Hand seining is the preferred collection method, with backpack electrofishing limited to those areas where seining is not effective or sufficient numbers of YOY cannot be collected by seining alone. Program broodstock collection activities generally occur between June and September, but additional broodstock collections may occur as needed between March and November associated with fish rescue activities. Program broodstock collections are conducted when water temperatures are less than 18°C to minimize fish stress. Broodstock collections associated with coho salmon rescues from drying streams may occur when water temperatures are 18°C or greater.

Broodstock collected from the wild for the Program may originate from one or more of the following sources:

- ≤ 700 natural-origin YOY collected from Russian River tributaries (up to 200 per sub-basin or stream);
- ≤ 700 natural-origin YOY collected from out-of-basin streams (up to 200 per stream and not greater than 20 fish from each pool) for propagation, outbreeding, or captive rearing without propagation (currently Lagunitas/Olema Creek); and
- ≤ 100 hatchery-origin and natural-origin adults returning to the hatchery.

  A portion of the above collection of natural origin juveniles may be from populations in the Navarro to Gualala Point diversity strata within the CCC coho salmon ESU.

Limiting collection of natural-origin juveniles to 200 per sub-basin or stream and 20 fish per pool will minimize the number of related individuals collected from the wild (assuming an average fecundity of 2,000 eggs per female spawner). To ensure enough broodstock are available to the program, up to 1,500 hatchery-propagated progeny are initially retained from each brood year for future use as broodstock. Hatchery-origin broodstock are derived from matings of captive-reared coho salmon Russian River and appropriate out-of-basin coho salmon (currently Lagunitas/Olema Creek) and from specific populations within the Navarro Point to Gualala Point Diversity Strata. Once the number of fish collected from the wild is known, the number of retained hatchery-origin juveniles will be reduced accordingly and can range from zero to 1,500 fish. Hatchery progeny not kept for broodstock are released as juveniles. The sources and number of fish rescued and temporarily reared varies from year to year based on drought conditions and space to rear in the hatchery. CDFW field personnel in coordination with hatchery personnel determine this number of fish.

1.3.2.2 Program Broodstock Spawning and Mating

Genetic analysis is conducted by the NOAA SWFSC, and includes all potential broodstock used for spawning. To minimize inbreeding and increase genetic diversity the SWFSC provides a genetic spawning matrix for all potential broodstock fish. The spawning matrix provides a ranked list of potential male breeding partners for each female broodstock. The ranking is based on relatedness of each male and female broodstock, with pairings for spawning conducted to reduce relatedness of spawning fish. Each female can be spawned with four males, and each male can be spawned with four females prior to being removed from the matrix.

Program goals for utilizing natural-origin broodstock (pNOB) for propagation has been 25%. Over the last eleven spawning seasons of the program, pNOB at the Program has exceeded 20% in only two years (2010/11 and 2013/14) and has ranged from 2-16% for the remaining years. The Program proposes to increase the proportion of natural-origin broodstock (pNOB) for propagation to ≥ 50 percent.

1.3.2.3 Program Incubation and Rearing

Currently, water supplied to the Coho building is raw water pumped directly to the facility, with only coarse filtration provided by a rotating debris screen, the incubation facility includes specifically designed additional filtration. Prior to reaching the incubation stacks, all water runs through two 5-micron Jacuzzi filters to help reduce the amount of silt to which the eggs are exposed. An expansion that will double the egg incubation capacity for Program coho salmon in the Coho building is expected to be completed within the next two years (by end of 2021). The proposed expansion of the Program's spawning and incubation facilities includes increasing incubation capacity to up to 1,000,000 eggs to be taken per brood year with subsequent survival and rearing of up to 500,000 progeny, consisting of 250,000 juveniles (which is the upper limit of juvenile production capacity) and 250,000 eyed eggs/unfed fry for release. The completion of the increased incubation capacity will also include a new water treatment system for the incubation and start tanks consisting of fine sediment filtration and UV sterilization units.

Established hatchery protocols generally result in approximately 60 percent of eggs surviving to the eyed stage, 65 percent of eyed eggs surviving through hatching, with an overall survival rate from fertilization to juvenile release of about 40 percent. At the current spawning and incubation capacity, total egg take per brood year since the first spawning event in December 2003 has ranged from approximately 95,000 to over 478,000, with fecundity averaging approximately 2,200 eggs per female. Increases in pNOB to 50% is expected to substantially improve egg survival and fitness of Program stock.

Conditions within the incubation stacks are monitored and maintained to provide optimal egg development prior to transferring to started tanks. Key parameters include flow rate, water temperature, dissolved oxygen, and treatment of water to minimize exposure of sediment and fine silt to incubating eggs.

Rearing capacity for juveniles is proposed to continue to be for 250,000 juveniles for release to Russian River or other specified streams. An additional 250,000 fry could be transferred to new starter troughs, unfed and released to streams for natural rearing or utilized in RSI's. Specific numbers of eggs, unfed fry and juvenile coho salmon released will be adaptively managed according to recommendations developed by the TAC prior to the first fish release of the year.

1.3.2.4 Annual Fish Release Levels (Maximum Number) by Life Stage and Release Location

Given its current production capacity, the Program's goal is to adaptively manage annual releases of up to 500,000 total progeny (≤ 250,000 early life stages and ≤ 250,000 juveniles) and up to 700 surplus adult coho salmon into selected Russian River tributaries and other northern ESU streams where appropriate (Table 1).

Coho salmon early life stages that may be released include eyed eggs and unfed fry, while juvenile life stages include fingerlings (age 0+, spring release), advanced fingerlings (age 0+, fall release), pre-smolts (age 1+, winter release), and smolts (age 1+, spring release). Adults may be released as precocious adults (age 2+, winter release) or as adults (age 3 or 4, winter release). Actual release locations and the number and proportion of each life stage released into each stream are adaptively managed each year based on recommendations from the TAC, and with approval by CDFW and NMFS. The TAC's recommendations are based on a habitat capacity model that uses desired fish density and available habitat estimated from CDFW stream survey data to determine the number of fish to be released in a given location (Nickelson 1998). Actual release numbers may be modified depending on stream flow and other habitat conditions in a given year.

A combined maximum of 700 adult coho salmon (age 2-4) may be released, with up to 700 being released in the Russian River and up to 500 being released in natal or non-natal northern ESU streams to allow for natural spawning. Any releases into non-natal streams will be adaptively managed and monitored, based on recommendations from the TAC and implemented with approval by CDFW and NMFS. Reintroductions and supplementation of naturally spawning coho salmon populations within the CCC ESU will be implemented in accordance with population status as outlined in the federal coho salmon Recovery Plan (NMFS 2012a), giving priority to Focus Populations designated as 'Functionally Independent' over those designated as 'Dependent', followed by populations designated as 'Supplemental' (Table 1).

	Life Stage	**Annual Maximum Released**	**Release Season**
Early Life Stages	Eggs	250,000	Jan - Mar
	Unfed Fry		Feb - Apr
Juveniles	Fingerling (age 0^+)	250,000	May - Jun
	Advanced Fingerling (age 0^+)		Oct - Dec
	Yearling (age 1^+)		Feb-Mar
	Smolt (age 1^+) (up to 30,000 per year)		Apr - Jun
Adults	Adult (age 2-4)	700	Dec - Feb
Total All Life Stages Combined		500,700	Jan-Jun; Oct-Dec

Table 1. Annual maximum release levels of the Program by life stage and season. All life stages may be released into Russian River tributaries or within the defined action area below in Section 2.3.

1.3.2.5 Performance Standards and Indicators to Program Benefits and Risks

Performance standards and indicators proposed in the HGMP provide measurable metrics to determine if the goals of the Program are being met. Proposed standards for the plan have been adapted from the list suggested in the Artificial Production Review (NPPC 1999), and are designed to assess the performance standards addressing program benefits or risks. Standards include hatchery management practices, fish marking strategies, release strategies, population diversity integration, recovery plan strategies, and implementation of nutrient enhancement compliance. Each of these standards includes various performance indicators along with specific benefits and risks associated each performance indicator. In addition, monitoring and evaluation methods are included to track performance indicators as proposed. Specific details for performance standards, indicators and monitoring methods can be found in the HGMP (CDFW and USACE 2017).

Impact minimization measures are inherently part of the performance indicators that are proposed for the Program. Specific indicators that minimize production of coho salmon, and target natural origin broodstock are proposed to minimize potential genetic and fitness to natural populations. Proposed hatchery health protocols minimize disease outbreaks, and the tagging program allows a genetic spawning matrix to reduce inbreeding depression in the population. Fish release strategies for the program are proposed to minimize over seeding of available habitat, improve survival, and reduce intraspecific and interspecific competition in release streams. Growth and size of hatchery-released fish will be managed to minimize the potential effects to natural populations such as competition and divergence of run timing that could occur.

The Program TAC provides recommendations for the program, which is adaptively managed through collaborative decisions from the responsible agencies (i.e., USACE, CDFW and NMFS) program managers Adaptive management of the Program through the TAC considers scientifically justifiable needs, adequate funding, infrastructure capacity, sufficient staff level, and compliance with all relevant federal, State, and local laws and statutes. In addition to input from the TAC, the process of adaptive management in the Program relies on periodic feedback from the program's monitoring and evaluation program relative to the targets associated with each proposed performance indicator. Generally, if a target is not met, the responsible agencies consider possible management actions to reach the target and provide appropriate guidance to the affected program activities.

1.3.2.6 Monitoring and Evaluation Program

A monitoring and evaluation (M&E) program designed to determine the success of the Program has been in existence since the first release of program Coho Salmon in 2004. The Program M&E program will primarily be used to monitor and evaluate performance indicators. Specific metrics and targets associated with each performance indicator are listed in the HGMP (CDFW and USACE 2017). Supplemental information from complementary monitoring programs (e.g., captive rearing evaluations, research studies from collaborators, water agency and district monitoring, Coastal Monitoring Programs (CMP) which inform population trends, etc.) will be used whenever available and applicable. For the Program M&E program, all operational activities within the hatchery are monitored by CDFW and USACE DCFH staff, and all field monitoring is currently performed by the California (CA) Sea Grant under contract with USACE. Reporting of progress towards project objectives and performance targets and field monitoring activities are provided to NMFS in annual reports prepared by DCFH staff and CA Sea Grant, respectively.

In Russian River tributaries, complementary coho salmon monitoring includes Coastal Salmonid Monitoring Plan (CMP) trend monitoring by the Sonoma Water Agency (SWA) and CA Sea Grant, and evaluation of the effects of stream flow and habitat enhancement projects on juvenile coho salmon over-summer survival by the CA Sea Grant. Complementary coho salmon monitoring is also conducted by Marin Municipal Water District (MMWD) in Lagunitas and Walker creeks as part of their Fisheries Program, by Goldridge Resource Conservation District in Salmon Creek, and by the National Park Service Point Reyes National Seashore Association in Olema and Redwood creeks. Funding for these programs are occasionally supported with state and federal funding such as the state CDFW Fisheries Restoration Grants Program that is cost-shared with federal Pacific Salmon Recovery funds. Additional partners will be added to accomplish required and desired monitoring in streams that may be supplemented with program Coho Salmon, or where surplus broodstock are released as part of a reintroduction effort.

Data collected for the Program M&E program, along with any relevant supplemental data from other studies, will be used to: Ensure that performance indicators are evaluated properly and performance standards are met; Facilitate adaptive management of the Program; And, evaluate the success of the Program with respect to regional CCC coho salmon recovery targets as indicated by adult and smolt abundance, spawning success, and other metrics.

1.3.2.7 Hatchery Monitoring

- All performance indicators related to hatchery rearing and spawning activities are monitored and relevant data recorded and reported by USACE hatchery staff. The numbers of male and female broodstock available for spawning, the number and calculated percentage of natural-origin broodstock, PIT tag identities of Coho Salmon matings, and the number and calculated percentage of out-of-basin broodstock used for outbreeding are recorded immediately prior to spawning, which usually occurs between mid-December and late January. During spawning, hatchery staff record data on individual spawner performance. After spawning through release, hatchery staff collects data on life stage-specific survival. Hatchery staff retains two randomly chosen juvenile coho salmon from each family group (totaling up to 1,500 fish) for potential use as broodstock in the event sufficient natural-origin fish from the same brood year are not available from Program streams.

- Mortalities that occur during the routine operation of the program are removed from their respective rearing tanks on a daily basis, and hatchery staff records and evaluates these daily mortalities to ensure that the number of mortalities among fry and more

> advanced life stages does not exceed 0.2% of the program over any 24-hour period. Hatchery staff record compliance with all applicable hatchery operations and health guidelines, as well as required specific effluent testing, year-round. In addition, hatchery staff performs, monitors, and records all marking and tagging of coho salmon including: PIT tagging of all fish collected from the natural environment; Disk tagging of all adults used for artificial spawning; Coded wire tagging of all Program progeny to facilitate distinguishing between hatchery-origin and natural-origin fish; PIT tagging of ≥15% (minimum 30,000) of juvenile Program progeny released to allow Smolt to Adult Return (SAR) calculations; and Floy tagging of all adults that are released to allow identification of hatchery-reared adult Coho Salmon during spawner surveys.

Hatchery staff regularly presents all hatchery monitoring data at periodic TAC meetings and in monthly and annual data reports provided to NMFS.

All performance indicators related to release of juvenile coho salmon are monitored and relevant data recorded by hatchery staff. A draft release strategy based on hatchery production, environmental variables, habitat capacity, landowner access and the TAC develops pertinent information from previous releases in the spring of each year. CDFW and CA Sea Grant monitoring staff perform pre-release surveys. Hatchery staff leads juvenile releases, smolt acclimation, and associated monitoring activities. Smolt acclimation in streamside acclimation tanks or ponds is done for a minimum of 14 days to improve imprinting on release streams and increase homing fidelity. RSI's are monitored several times a week, and in-field counts are conducted to compare survival with in-hatchery control lots. Hatchery staff records release size (fork lengths) and type (hatchery forced or volitional, direct stream release). Hatchery staff regularly presents all release-related data at periodic TAC meetings and in monthly and annual data reports provided to NMFS.

1.3.2.8 Stream Monitoring and Evaluation

Monitoring and evaluation to address all performance indicators related to post-release program performance has been conducted annually in a minimum of four index streams in the Russian River basin (currently Dutch Bill, Green Valley, Mill, and Willow creeks) via the M&E program. Relevant data are collected, recorded and reported by CA Sea Grant staff. Data are collected annually to estimate and evaluate instream abundance and survival of various juvenile coho salmon life stages, proportion of natural-origin juveniles and their spatial distribution, smolt-to-adult return ratio, number of redds and adult returns and spawning success. Additional data are collected to evaluate whether hatchery-origin and natural-origin juveniles exhibit similar size and outmigration timing, and hatchery-origin and natural-origin adults exhibit similar diversity in return timing, spatial distribution, size, and sex composition. Since juvenile coho salmon are released into multiple tributaries at different life stages, population parameters will be estimated for these tributaries and release groups so that different release strategies can be evaluated.

The Russian River biological opinion (RRBO) (NMFS 2008a) provides ESA coverage for the flood control and water supply operations of Coyote Valley Dam and Warm Springs Dam by the U.S Army Corps of Engineers and Sonoma Water (formerly the Sonoma County Water Agency).

The RRBO required a minimum of four index streams to be monitored in the Russian River. The HGMP identifies that at least four index streams will be dedicated to the monitoring of performance standards and indicators described above. Index streams are chosen to be geographically representative of the stocking universe, and to facilitate evaluation of different release strategies (e.g., release number, type and timing). Through the TAC, the Program will continue to evaluate and, if necessary, revise the composition of the group of index streams to support implementation of performance standards and be representative of the proposed Program footprint. For the Russian River, the TAC will evaluate the composition of the group of index streams using a sub-basin approach (e.g., lower Russian River, Dry Creek, Austin Creek, Mark West, and/or Maacama creeks). Index streams or reaches would be established separately for other release programs (e.g., Walker, Salmon, Navarro, or Garcia rivers).

Downstream Migrant Trapping

Beginning in March of each year, downstream migrant traps are installed and operated through the end of June or until flows become too low to operate the trap effectively. A funnel trap design is used that includes removable weir panels constructed of wooden framing and vexar screening. While in operation, traps are checked at least once per day and more frequently during high flows or windy conditions that may cause debris to accumulate in the trap. Fish are netted from the trap into an aerated bucket for sampling. Juvenile salmon and steelhead are anesthetized using MS 222, scanned for CWT and PIT tags, and measured for length and weight. A fraction of the fish is fin clipped for genetic analysis, and a PIT tag is applied to a fraction of the non-PIT tagged fish (see fish handling section for detail). Adult salmonids are scanned for CWT and PIT tags, and measured for length.

Non-salmonids are identified to species and enumerated. After handling, all fish are placed in aerated buckets until they recover and then released downstream of the trap, with the exception of adult salmonids which are not anesthetized and are released immediately downstream. PIT tagging goals for natural-origin coho salmon are 500 per stream. These targets are based on simulations run by SCWA and CA Sea Grant using average survival rates and detection efficiencies observed within the Russian River watershed to estimate both freshwater and marine survival using a multistate emigration mark-recapture model.

Electrofishing

Backpack electrofishing surveys are conducted to capture, collect and measure juvenile coho salmon, determine presence of a tag, and collect fin clips for genetic analysis. Electrofishing surveys follow the NMFS 2000 Electrofishing Guidelines (NMFS 2000). Only experienced staff (>100 hrs electrofishing experience) lead field crews. Captured fish are placed in aerated buckets until the electrofishing pass is complete. Juvenile salmonids are anesthetized using MS 222, scanned for CWT and PIT tags, and measured for length and weight. A fraction of the fish are fin-clipped for genetic analysis, and a PIT tag is applied to a fraction of the non-PIT-tagged fish for future survival estimates. All non-salmonid fish are handled as described above under "Downstream Migrant Trapping". Surveys are coordinated with other monitoring conducted by SCWA and CDFW. In cases where electrofishing is necessary to accomplish the goals of more than one study, or by more than one entity in a given stream reach, only one survey is conducted and sampling procedures are adapted to accomplish the goals of all studies.

Spawner Surveys
Adult spawner surveys are conducted following CDFW protocols (Adams et al. 2011; Gallagher and Gallagher 2005; Gallagher et al. 2007; Gallagher et al. 2010). Following the first high flow event in November that reconnects the tributaries with the mainstem of the Russian River, surveys are conducted approximately every 7-10 days until mid-April. Surveyors document the number of live spawners, carcasses, and redds. Species, sex, fork length, fish condition, and location are recorded. Carcasses are scanned for presence of a CWT, PIT tag, adipose clip, and other marks or tags. If a carcass is still in good condition, scales are collected, a small piece of fin tissue is collected from the caudal or dorsal fin and otoliths are extracted. If the carcass has a CWT in the snout, the head is removed and frozen for subsequent CWT extraction and identification of the CWT number. If redds are complete and no fish are present, redd measurements are taken without disturbing redds or spawning areas.

Snorkeling Surveys
Snorkeling surveys are conducted during late spring and summer following protocols based on O'Neal (2007) and Garwood and Ricker (2014). Surveyors enter each habitat unit wearing a dry or wet suit, mask and snorkel, and count the number of coho salmon, steelhead, and Chinook salmon present, typically working in a downstream to upstream direction. On the first day of the survey, typically half (but up to 100%) of the pools and flatwaters are snorkeled. On the second day, a fraction (~20%) of the habitat units snorkeled on the first day is resampled to estimate sampling error.

Operation of PIT Tag Detection Systems
Stationary antennas (typically a 16' x 2' coil of wire inside a 4" PVC frame) are placed in a vertical or horizontal position spanning the width of the stream channel. When fish pass over or through the antenna, the tag number, date and time are recorded. Between June and October of each year, portable PIT tag detection (i.e., wanding) surveys are conducted monthly on up to five Russian River tributaries. During each survey, two to three persons wade through a pool from a downstream to upstream direction and wave PIT tag wands through the water to detect Program fish.

Minimization and Avoidance Measures Implemented for Monitoring Efforts
CA Sea Grant uses sampling methods that adhere to all applicable monitoring and fish handling protocols. Specific measures taken to reduce the risk of injury or mortality to fish associated with backpack electrofishing are outlined in the NMFS 2000 Electrofishing Guidelines. Specific risk aversion measures associated with other types of monitoring (e.g., seining, fyke traps) or releases include minimizing fish handling, holding fish in appropriate temperatures and containers, frequency of monitoring traps, etc. are included in the Program HGMP (CDFW and USACE 2017).

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 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 provides 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 non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

NOAA Fisheries determined the proposed action is not likely to adversely affect endangered Southern Resident killer whales. This determination can be found in Section 2.12.

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 "to jeopardize the continued existence of" a listed species, which is "to engage in an action that 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 relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (50 CFR Part 402.02).

The designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. The 2016 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 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition 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 rangewide 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 both species and their habitat using an "exposure-response-risk" 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, to analyze whether the proposed action is likely to: (1) directly or indirectly, appreciably reduce 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.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would 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' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. 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 current function of the essential PBFs that help to form that conservation value.

This biological opinion analyzes the effects of the action on the following listed Salmonids and their critical habitat.

- **Endangered CCC coho salmon (*Oncorhynchus kisutch*) Evolutionarily Significant Unit (ESU)**
  Listing determination (70 FR 37160; June 28, 2005)
  Critical habitat designation (64 FR 24049; May 5, 1999);

- **Threatened CC Chinook salmon (*O. tshawytscha*) ESU**
  Listing determination (70 FR 37160; June 28, 2005)
  Critical habitat designation (70 FR 52488; September 2, 2005);

- **Threatened CCC steelhead (*O. mykiss*) Distinct Population Segment (DPS)**
  Listing determination (71 FR 834; January 5, 2006)
  Critical habitat designation (70 FR 52488; September 2, 2005);

- **Threatened NC steelhead (*O. mykiss*) Distinct Population Segment (DPS)**
  Listing determination (71 FR 834; January 5, 2006)
  Critical habitat designation (70 FR 52488; September 2, 2005).

2.2.1 Species Description and Life History

2.2.1.1 Coho Salmon

The life history of coho salmon in California has been well documented by Shapovalov and Taft (1954) and Hassler (1987). In contrast to the life history patterns of other anadromous salmonids, coho salmon in California generally exhibit a relatively simple three year life cycle. Adult coho salmon typically begin the freshwater migration from the ocean to their natal streams after heavy late fall or winter rains breach the sandbars at the mouths of coastal streams (Sandercock 1991). Delays in river entry of over a month are not unusual (Salo and Bayliff 1958, Eames et al. 1981). Migration continues into March, generally peaking in December and January, with spawning occurring shortly after arrival to the spawning ground (Shapovalov and Taft 1954).

Coho salmon are typically associated with medium to small coastal streams characterized by heavily forested watersheds; perennially-flowing reaches of cool, high-quality water; dense riparian canopy; deep pools with abundant overhead cover; instream cover consisting of large, stable woody debris and undercut banks; and gravel or cobble substrates.

Female coho salmon choose spawning areas usually near the head of a riffle, just below a pool, where water changes from a laminar to a turbulent flow and small to medium gravel substrate are present. The flow characteristics surrounding the redd usually ensure good aeration of eggs and embryos, and flushing of waste products. The water circulation in these areas also facilitates fry emergence from the gravel. Preferred spawning grounds have: nearby overhead and submerged cover for holding adults; water depth of 4 to 21 inches; water velocities of 8 to 30 inches per second; clean, loosely compacted gravel (0.5 to 5 inch diameter) with less than 20 percent fine silt or sand content; cool water ranging from 39 to 50 degrees Fahrenheit (°F) with high dissolved oxygen of 8 mg/L; and inter-gravel flow sufficient to aerate the eggs. Lack of suitable gravel often limits successful spawning.

Each female builds a series of redds, moving upstream as she does so, and deposits a few hundred eggs in each. Fecundity of female coho salmon is directly proportional to size; each adult female coho salmon may deposit from 1,000 to 7,600 eggs (Sandercock 1991). Briggs (1953) noted a dominant male accompanies a female during spawning, but one or more subordinate males may also engage in spawning. Coho salmon may spawn in more than one redd and with more than one mate (Sandercock 1991). Coho salmon are semelparous meaning they die after spawning. The female may guard a redd for up to two weeks (Briggs 1953).

The eggs generally hatch after four to eight weeks, depending on water temperature. Survival and development rates depend on temperature and dissolved oxygen levels within the redd. According to Baker and Reynolds (1986), under optimum conditions, mortality during this period can be as low as 10 percent; under adverse conditions of high scouring flows or heavy siltation, mortality may be close to 100 percent. McMahon (1983) found that egg and fry survival drops sharply when fine sediment makes up 15 percent or more of the substrate. The newly hatched fry remain in the redd from two to seven weeks before emerging from the gravel

(Shapovalov and Taft 1954). Upon emergence, fry seek out shallow water, usually along stream margins. As they grow, juvenile coho salmon often occupy habitat at the heads of pools, which generally provide an optimum mix of high food availability and good cover with low swimming cost (Nielsen 1992). Chapman and Bjornn (1969) determined that larger parr tend to occupy the head of pools, with smaller parr found further down the pools. As the fish continue to grow, they move into deeper water and expand their territories until, by July and August; they reside exclusively in deep pool habitat. Juvenile coho salmon prefer: well shaded pools at least 3.3 feet deep with dense overhead cover, abundant submerged cover (undercut banks, logs, roots, and other woody debris); water temperatures of 54° to 59° F (Brett 1952, Reiser and Bjornn 1979), but not exceeding 73° to 77° F (Brungs and Jones 1977) for extended time periods; dissolved oxygen levels of 4 to 9 mg/L; and water velocities of 3.5 to 9.5 inches per second in pools and 12 to 18 inches per second in riffles. Water temperatures for good survival and growth of juvenile coho salmon range from 50° to 59° F (Bell 1973, McMahon 1983). Growth is slowed considerably at 64° F and ceases at 68° F (Bell 1973).

Preferred rearing habitat has little or no turbidity and high sustained invertebrate forage production. Juvenile coho salmon feed primarily on drifting terrestrial insects, much of which are produced in the riparian canopy, and on aquatic invertebrates growing within the interstices of the substrate and in leaf litter in pools. As water temperatures decrease in the fall and winter months, fish stop or reduce feeding due to lack of food or in response to the colder water, and growth rates slow. During December through February, winter rains result in increased stream flows. By March, following peak flows, fish resume feeding on insects and crustaceans, and grow rapidly.

In the spring, as yearlings, juvenile coho salmon undergo a physiological process, or smoltification, which prepares them for living in the marine environment. They begin to migrate downstream to the ocean during late March and early April, and out-migration usually peaks in mid-May, if conditions are favorable. Emigration timing is correlated with peak upwelling currents along the coast. Entry into the ocean at this time facilitates more growth and, therefore, greater marine survival (Holtby et al. 1990). At this point, the smolts are about four to five inches in length. After entering the ocean, the immature salmon initially remain in nearshore waters close to their parent stream. They gradually move northward, staying over the continental shelf (Brown et al. 1994). Although they can range widely in the north Pacific, movements of coho salmon from California are poorly understood.

2.2.1.2. Chinook Salmon

Chinook salmon return to freshwater to spawn when they are three to eight years old (Healey 1991). Some Chinook salmon return from the ocean to spawn one or more years before they reach full adult size, and are referred to as jacks (males) and jills (females). Chinook salmon runs are designated based on adult migration timing; however, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and actual time of spawning (Myers et al. 1998). Both winter-run and spring-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. For comparison, fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

Fall-run CC Chinook salmon migrate upstream during June through November, with peak migration periods occurring in September and October. Spawning occurs from late September through December, with peaks in late October. Adequate instream flows and cool water temperatures are more critical for the survival of spring-run Chinook salmon (compared to fall-run or winter-run Chinook salmon) due to over-summering by adults and/or juveniles. Chinook salmon generally spawn in gravel beds that are located at the tails of holding pools (Bjornn and Reiser 1991). Adult female Chinook salmon prepare redds in stream areas with suitable gravel composition, water depth, and velocity. Optimal spawning temperatures range between 42° to 57° F. Redds vary widely in size and location within the river. Preferred spawning substrate is clean, loose gravel, mostly sized between 1 and 10 cm, with no more than 5 percent fine sediment. Gravels are unsuitable when they have been cemented with clay or fine particles or when sediments settle out onto redds, reducing inter-gravel percolation (62 FR 24588). Minimum inter-gravel percolation rate depends on flow rate, water depth, and water quality. The percolation rate must be adequate to maintain oxygen delivery to the eggs and remove metabolic wastes. Chinook salmon require a strong, constant level of subsurface flow; as a result, suitable spawning habitat is more limited in most rivers than superficial observation would suggest. After depositing eggs in redds, most adult female Chinook salmon guard the redd from 4 to 25 days before dying.

Chinook salmon eggs incubate for 90 to 150 days, depending on water temperature. Successful incubation depends on several factors including dissolved oxygen levels, temperature, substrate size, amount of fine sediment, and water velocity. Maximum survival of incubating eggs and pre-emergent fry occurs at water temperatures between 42° and 56° F with a preferred temperature of 52° F. CC Chinook salmon fry emerge from redds during December through mid-April (Leidy and Leidy 1984).

After emergence, Chinook salmon fry seek out areas behind fallen trees, back eddies, undercut banks, and other areas of bank cover (Everest and Chapman 1972). As they grow larger, their habitat preferences change. Juveniles move away from stream margins and begin to use deeper water areas with slightly faster water velocities, but continue to use available cover to minimize predation risk and reduce energy expenditure. Fish size appears to be beneficially correlated with water velocity and depth (Chapman and Bjornn 1969, Everest and Chapman 1972). Optimal temperatures for both Chinook salmon fry and fingerlings range from 54° to 57° F, with maximum growth rates at 55° F (Boles 1988). Chinook salmon feed on small terrestrial and aquatic insects and aquatic crustaceans. Cover, in the form of rocks, submerged aquatic vegetation, logs, riparian vegetation, and undercut banks provide food, shade, and protect juveniles from predation. CC Chinook salmon will rear in freshwater for a few months and outmigrate from April through July (Myers et al. 1998).

2.2.1.3 Steelhead

Steelhead are anadromous forms of O. mykiss, spending some time in both freshwater and saltwater. Steelhead young usually rear in freshwater for one to three years before migrating to the ocean as smolts, but rearing periods of up to seven years have been reported. Migration to the ocean usually occurs in the spring. Steelhead may remain in the ocean for one to five years (two to three years is most common) before returning to their natal streams to spawn (Busby et al. 1996). The distribution of steelhead in the ocean is not well known. Coded wire tag recoveries indicate that most steelhead tend to migrate north and south along the continental shelf (Barnhart 1986).

Steelhead can be divided into two reproductive ecotypes, based upon their state of sexual maturity at the time of river entry and the duration of their spawning migration: stream maturing and ocean maturing. Stream maturing steelhead enter fresh water in a sexually immature condition and require several months to mature and spawn, whereas ocean maturing steelhead enter fresh water with well-developed gonads and spawn shortly after river entry. These two reproductive ecotypes are more commonly referred to by their season of freshwater entry (i.e., summer [stream maturing] and winter [ocean maturing] steelhead). The timing of upstream migration of winter steelhead is correlated with higher flow events, such as freshets or sandbar breaches. Adult summer steelhead migrate upstream from March through September. In contrast to other species of Oncorhynchus, steelhead may spawn more than one season before dying (iteroparity); although one-time spawners represent the majority.

Because rearing juvenile steelhead reside in freshwater all year, adequate flow and temperature are important to the population at all times [California Department of Fish and Game (CDFG) 1997]. Outmigration appears to be more closely associated with size than age. In Waddell Creek, Shapovalov and Taft (1954) found steelhead juveniles migrating downstream at all times of the year, with the largest numbers of young-of-year and age 1+ steelhead moving downstream during spring and summer. Smolts can range from 5.5 to 8 inches in length. Steelhead outmigration timing is similar to coho salmon (CDFG 2002).

Survival to emergence of steelhead embryos is inversely related to the proportion of fine sediment in the spawning gravels. However, steelhead are slightly more tolerant than other salmonids, with significantly reduced survival when fine materials of less than 0.25 inches in diameter comprise 20 to 25 percent of the substrate. Fry typically emerge from the gravel two to three weeks after hatching (Barnhart 1986).

Upon emerging from the gravel, fry rear in edgewater habitats and move gradually into pools and riffles as they grow larger. Older fry establish territories, which they defend. Cover is an important habitat component for juvenile steelhead, both as a velocity refuge and as a means of avoiding predation (Meehan and Bjornn 1991). Steelhead, however, tend to use riffles and other habitats not strongly associated with cover during summer rearing more than other salmonids. Young steelhead feed on a wide variety of aquatic and terrestrial insects, and emerging fry are sometimes preyed upon by older juveniles. In winter, juvenile steelhead become less active and hide in available cover, including gravel or woody debris.

Water temperature can influence the metabolic rate, distribution, abundance, and swimming ability of rearing juvenile steelhead (Barnhart 1986, Bjornn and Reiser 1991, Myrick and Cech 2005). Optimal temperatures for steelhead growth range between 50° and 68° F (Hokanson et al. 1977, Wurtsbaugh and Davis 1977, Myrick and Cech 2005). Variability in the diurnal water temperature range is also important for the survivability and growth of salmonids (Busby et al.

1996).

Suspended sediment concentrations, or turbidity, also can influence the distribution and growth of steelhead (Bell 1973, Sigler et al. 1984, Newcombe and Jensen 1996). Bell (1973) found suspended sediment loads of less than 25 milligrams per liter (mg/L) were typically suitable for rearing juvenile steelhead.

2.2.2 Status of Species and Critical Habitat

In this biological opinion, 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 growth rate, spatial structure, and diversity (McElhaney 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 NOAA Fisheries' Recovery Plan for the Evolutionary Significant Unit of Central California Coast Coho salmon (NMFS 2012a) and NOAA Fisheries' Coastal Multispecies Recovery Plan (NMFS 2015), to determine the general condition of each population and factors responsible for the current status of each DPS or ESU.

We use these population viability parameters as surrogates for numbers, reproduction, and distribution, the criteria found within the regulatory definition of jeopardy (50 CFR 402.20). For example, the first three parameters are used as surrogates for numbers, reproduction, and distribution. We relate the fourth parameter, diversity, to all three regulatory criteria. Numbers, reproduction, and distribution are all affected when genetic or life history variability is lost or constrained resulting in reduced population resilience to environmental variation at local or landscape-level scales.

2.2.2.1 CCC Coho Salmon

Historically, the CCC coho salmon ESU was comprised of approximately 76 coho salmon populations. Most of these were dependent populations that needed immigration from other nearby populations to ensure their long-term survival, as described above. Historically, there were 11 functionally independent populations and one potentially independent population of CCC coho salmon (Spence et al. 2008, Spence et al. 2012). Most of the populations in the CCC coho salmon ESU are currently doing poorly; low abundance, range constriction, fragmentation, and loss of genetic diversity is documented, as described below.

Brown et al. (1994) estimated that annual spawning numbers of coho salmon in California ranged between 200,000 and 500,000 fish in the 1940's, which declined to about 100,000 fish by the 1960's, followed by a further decline to about 31,000 fish by 1991. Adams et al. (1999) found that in the mid 1990's, coho salmon were present in 51 percent (98 of 191) of the streams where they were historically present, and documented an additional 23 streams within the CCC coho salmon ESU in which coho salmon were found for which there were no historical records. In the next decade, abundance estimates dropped to approximately 600 to 5,500 adults (NMFS 2005a). Genetic research in progress by both the NMFS Southwest Fisheries Science Center

(SWFSC) and the Bodega Marine Laboratory documented reduced genetic diversity within CCC coho salmon subpopulations (Bjorkstedt et al. 2005). The influence of hatchery fish on wild stocks has also contributed to the poor diversity through outbreeding depression and disease.

All past status reviews (NMFS 2003, NMFS 2005a, Williams et al. 2011, Rogers et al. 2016) indicated that the CCC coho salmon were likely continuing to decline in number. CCC coho salmon have also experienced acute range restriction and fragmentation. Williams et al. (2011), in a SWFSC status update, noted that for all available time series, population trends were downward with particularly poor adult returns from 2006 to 2010. In addition, many independent populations were well below low-risk abundance targets and several were either extinct or below the high-risk dispensation thresholds that were identified by Spence et al. (2008). It appears that none of the five diversity strata defined by Bjorkstedt et al. (2005) currently support viable populations based on criteria established by Spence et al (2008).

However, information on population status and trends for CCC Coho Salmon has improved considerably since the 2011 status review due to recent implementation of the Coastal Monitoring Program (CMP) across significant portions of the ESU. Within the Lost Coast – Navarro Point stratum, current population sizes range from 4% to 12% of proposed recovery targets, with two populations (Albion River and Big River, respectively) at or below their high-risk depensation thresholds. Most independent populations show beneficial but non-significant population trends; however, the trend in the Noyo River has been beneficial for the past 5-6 years. Dependent populations within the stratum have declined significantly since 2011, with average adult returns ranging from 417 in Pudding Creek (42 percent of the recovery target) to no adult returns observed within Usal and Cottaneva creeks (Rogers et al. 2016).

Similar results were obtained immediately south within the Navarro Point – Gualala Point stratum, where two of the three largest independent populations, the Navarro and Garcia rivers, have averaged 257 and 46 adult returns, respectively, during the past six years (both populations are below their high-risk depensation threshold). Data from the three dependent populations within the stratum (Brush, Greenwood, and Elk creeks) suggest little to no adult coho salmon escapement since 2011.

In the Russian River and Lagunitas Creek watersheds, which are the two largest within the Central Coast strata, recent coho salmon population trends suggest limited improvement, although both populations remain well below recovery targets. Likewise, most dependent populations within the strata remain at very low levels, although excess broodstock adults from the Russian River and Olema Creek were recently stocked into Salmon Creek and the subsequent capture of juvenile fish indicates successful reproduction occurred. Finally, recent sampling within Pescadero Creek and San Lorenzo River, the only two independent populations within the Santa Cruz Mountains strata, suggest coho salmon have likely been extirpated within both basins. A bright spot appears to be the recent improvement in abundance and spatial distribution noted within the strata's dependent populations; Scott Creek experienced the largest coho salmon run in a decade during 2014/15, and researchers recently detected juvenile coho salmon within four dependent watersheds where they were previously thought to be extirpated (San Vincente, Waddell, Soquel and Laguna creeks).

Summarizing the information to inform the larger ESU, most independent CCC coho salmon populations remain at critically low levels, with those in the southern Santa Cruz Mountains strata likely extirpated. Data suggests some populations show a slight beneficial trend in annual escapement, but the improvement is not statistically significant. Overall, all CCC coho salmon populations remain, at best, a slight fraction of their recovery target levels, and, aside from the Santa Cruz Mountains strata, the continued extirpation of dependent populations continues to threaten the ESU's future survival and recovery. Available data from the few remaining independent populations shows continuing declines and many independent populations that supported the species overall numbers and geographic distributions have been extirpated. This suggests that populations that historically provided support to dependent populations via immigration have not been able to provide enough immigrants for many dependent populations for several decades. The near-term (10 - 20 years) viability of many of the extant independent CCC coho salmon populations is of serious concern. These populations may not have sufficient abundance levels to survive additional natural or human caused environmental change. The 2016 status review for this species (Rogers et al. 2016) summarized the best available information on the biological status of the ESU and the threats facing the ESU and found that it continues to remain endangered.

The substantial decline in the Russian River coho salmon abundance led to the formation of the Russian River Coho Salmon Captive Broodstock Program in 2001. Under this program, offspring of wild captive-reared coho salmon are released as juveniles into tributaries within their historic range with the expectation that some of them will return as adults to naturally reproduce. Juvenile coho salmon and coho salmon smolts have been released into several tributaries within the lower Russian River and Dry Creek watersheds. Estimated adult abundance for coho salmon in has improved in these watersheds, which has ranged from 219 to 484 fish for spawning years 2104/15 to 2017/18 (Bauer et al. 2018).

The NMFS's recovery plan (NMFS 2012a) for the CCC coho salmon ESU identified the major threats to population recovery. These major threats include roads, water diversions and impoundments; residential and commercial development; and severe weather. The impacts of these major threats are described in the status of critical habitat section.

2.2.2.2 CC Chinook Salmon

The CC Chinook salmon ESU was historically comprised of approximately 32 Chinook salmon populations (Bjorkstedt et al. 2005). Many of these populations (14) were independent, or potentially independent, meaning they have a high likelihood of surviving for 100 years absent anthropogenic impacts. The remaining populations were likely more dependent upon immigration from nearby independent populations than dependent populations of other salmonids (Bjorkstedt et al. 2005).

Data on CC Chinook abundance, both historical and current, is sparse and of varying quality (Bjorkstedt et al. 2005). Estimates of absolute abundance are not available for populations in this ESU (Myers et al. 1998). In 1965, CDFG (1965) estimated escapement for this ESU at over 76,000. Most were in the Eel River (55,500), with smaller populations in Redwood Creek (5,000), Mad River (5,000), Mattole River (5,000), Russian River (500) and several smaller streams in Humboldt County (Myers et al. 1998). More recent information from Sonoma Water monitoring at their Mirabel fish ladder from 2000 to 2014 suggests moderate to good abundance of Russian River Chinook salmon with 1,113 to 6,696 adult fish reported (Martini and Manning 2015).

CC Chinook salmon populations remain widely distributed throughout much of the ESU. Notable exceptions include the area between the Navarro River and Russian River and the area between the Mattole and Ten Mile River populations (Lost Coast area). The lack of Chinook salmon populations both north and south of the Russian River (the Russian River is at the southern end of the species' range) makes it one of the most isolated populations in the ESU. Myers et al. (1998) reports no viable populations of Chinook salmon south of San Francisco, California.

Because of their prized status in the sport and commercial fishing industries, CC Chinook salmon have been the subject of many artificial production efforts, including out-of-basin and out-of-ESU stock transfers (Bjorkstedt et al. 2005). It is, therefore, likely that CC Chinook salmon genetic diversity has been adversely affected despite the relatively wide population distribution within the ESU. An apparent loss of the spring-run Chinook life history in the Eel River Basin and elsewhere in the ESU also indicates risks to the diversity of the ESU.

Data from the 2009 adult CC Chinook salmon return counts and estimates indicated a further decline in returning adults across the range of CC Chinook salmon on the coast of California (Jeffrey Jahn, NMFS, personal communication 2010). Ocean conditions are suspected as the principal short-term cause because of the wide geographic range of declines (SWFSC 2008). However, the number of adult CC Chinook salmon returns in the Russian River Watershed increased substantially in 2010/2011 compared to 2008/09 and 2009/10 returns. Increases in adult Chinook salmon returns during 2010/2011 have been observed in the Central Valley populations as well.

The most recent status review summary by Seghesio and Wilson (2016) reports that the new information available since the last status review (Williams et al. 2011) does not appear to suggest there has been a change in extinction risk for this ESU. Williams et al. (2011) found that the loss of representation from one diversity stratum, the loss of the spring-run history type in two diversity substrata, and the diminished connectivity between populations in the northern and southern half of the ESU pose a concern regarding viability for this ESU. Based on consideration of this updated information, Williams et al. (2011) concluded the extinction risk of the CC Chinook salmon ESU has not changed since the last status review which affirmed no change to the determination that the CC Chinook salmon ESU is a threatened species, as previously listed (NMFS 2011b), 76 FR 50447). NMFS' previous status review (Williams et al. 2011) discussed the fact that populations that lie between the lower boundary of the Central Valley Fall Chinook salmon ESU (Carquinez Straits) and the southern boundary of CC Chinook salmon ESU (Russian River) were not included in either ESU, despite the fact that Chinook salmon had been reported in several basins. Available genetic evidence indicated fish from the Guadalupe and Napa rivers in San Francisco and San Pablo Bays had close affinity with Central Valley Fall Chinook salmon (Garza et al., unpublished data B; Garza and Pearse 2008a), and it was recommended that fish from these two watersheds be included in the Central Valley Fall

Chinook ESU. Evidence for fish in Lagunitas Creek was equivocal, with 17 samples assigned almost equally between CC Chinook salmon and Central Valley Fall Chinook salmon. The biological review team in 2011 from SWFSC tentatively concluded that Lagunitas Creek Chinook salmon should be considered part of the CC Chinook salmon ESU pending additional data (Williams et al. 2011). NMFS subsequently indicated that a boundary change was under consideration (76 FR 50447); however, no action has been taken to date. Currently there is no new genetic information that helps resolve this issue (Spence 2016). This most recent status review of this CC Chinook salmon suggest that spatial gaps between extant populations along the Mendocino coast are not as extensive as previously believed (Seghesio and Wilson 2016). As stated above, this information has not changed the determination that the extinction risk for this ESU remains as threatened (Seghesio and Wilson 2016).

The NMFS's recovery plan (NMFS 2015) for the CC Chinook salmon ESU identified the major threats to recovery. These major threats include channel modification, roads, logging and timber harvesting; water diversions and impoundments; and severe weather. The impacts of these major threats are described in the effects to critical habitat section. New threats to Chinook salmon populations identified since the last status review include poor ocean conditions, drought, and marijuana cultivation (Seghesio and Wilson 2016).

2.2.2.3 CCC Steelhead

Historically, approximately 70 populations of steelhead existed in the CCC steelhead DPS (Spence et al. 2008). Many of these populations (about 37) were independent, or potentially independent, meaning they had a high likelihood of surviving for 100 years absent anthropogenic impacts (Bjorkstedt et al. 2005). The remaining populations were dependent upon immigration from nearby CCC steelhead DPS populations to ensure their viability (McElhaney et al. 2000, Bjorkstedt et al. 2005).

While historical and present data on abundance are limited, CCC steelhead numbers are substantially reduced from historical levels. A total of 94,000 adult steelhead were estimated to spawn in the rivers of this DPS in the mid-1960's, including 50,000 fish in the Russian River – the largest population within the DPS (Busby et al. 1996). Near the end of the 20th century, McEwan (2001) estimated that the wild steelhead population in the Russian River watershed was between 1,700 and 7,000 fish. Abundance estimates for smaller coastal streams in the DPS indicate low but stable levels, with recent estimates for several streams (Lagunitas, Waddell, Scott, San Vicente, Soquel, and Aptos creeks) of individual run sizes of 500 fish or less (62 FR 43937).

Some loss of genetic diversity has been documented and attributed to previous among-basin transfers of stock and local hatchery production in interior populations in the Russian River (Bjorkstedt et al. 2005). In San Francisco Bay streams, reduced population sizes and habitat fragmentation has likely also led to loss of genetic diversity in these populations. For more detailed information on trends in CCC steelhead abundance, see: Busby et al. 1996, NMFS 1997, Good et al. 2005, and Spence et al. 2008.

CCC steelhead have experienced serious declines in abundance and long-term population trends suggest an adverse growth rate. This indicates the DPSs may not be viable in the long term. DPS populations that historically provided enough steelhead immigrants to support dependent populations may no longer be able to do so, placing dependent populations at increased risk of extirpation. However, because CCC steelhead have maintained a wide distribution throughout the DPS, roughly approximating the known historical distribution, CCC steelhead likely possess a resilience that is likely to slow their decline relative to other salmonid DPSs or ESUs in worse condition. The 2005 status review concluded that steelhead in the CCC steelhead DPS remain "likely to become endangered in the foreseeable future" (Good et al. 2005), a conclusion that was consistent with a previous assessment (Busby et al. 1996) and supported by the most recent NMFS Technical Recovery Team work (Spence et al. 2008). On January 5, 2006, NMFS issued a final determination that the CCC steelhead DPS is a threatened species, as previously listed (71 FR 834). Although numbers did not decline further during 2007/08, the 2008/09 adult CCC steelhead return data indicated a decline in returning adults across their range. Escapement data from 2009/2010 indicated a slight increase; however, the returns were still well below data observed within recent decades (Jeffrey Jahn, personal communication, 2010).

A status review by Williams et al. (2011) concluded that steelhead in the CCC steelhead DPS remain “likely to become endangered in the foreseeable future” (Williams et al. 2011), which affirmed no change to the determination that the CCC steelhead DPS is a threatened species, as previously listed (NMFS 2011c, 76 FR 76386).

The most recent status review by NMFS (Howe 2016) found that the scarcity of information on steelhead abundance in the CCC DPS continues to make it difficult to assess whether conditions have changed appreciably since the previous status review of Williams et al. (2011), which concluded that the population was likely to become endangered in the foreseeable future. In the North Coastal and Interior strata, steelhead still appear to occur in the majority of watersheds, though in the Russian River basin, the ratio of hatchery fish to natural origin fish returning to spawn remain largely unknown and continues to be a source of concern. New information from three years of CMP implementation in the Santa Cruz Mountain stratum indicates that population sizes are perhaps higher than previously thought. However, the downward trend in the Scott Creek population, which has the most robust estimates of abundance, is a source of concern. The status of populations in the two San Francisco Bay diversity strata remains highly uncertain, and it is likely that many populations where historical habitat is now inaccessible due to dams and other passage barriers are at high risk of extinction (Howe 2016).

The NMFS’s recovery plan (NMFS 2015) for the CCC steelhead DPS identified the major threats to recovery. These major threats include channel modification, residential and commercial development, roads, and water diversions and impoundments. The impacts of these major threats are described in the effects to critical habitat section.

2.2.2.4 NC Steelhead

Historically, the NC steelhead DPS was comprised of 41 independent populations (19 functionally and 22 potentially independent) of winter run steelhead and 10 functionally independent populations of summer run steelhead (Bjorkstedt et al. 2005). Based on the limited data available (dam counts of portions of stocks in several rivers), NMFS’ initial status review of

NC steelhead (Busby et al. 1996) determined that population abundance was very low relative to historical estimates (1930s and 1960s dam counts), and recent trends were downward in most stocks. Overall, population numbers are severely reduced from pre-1960s levels, when approximately 198,000 adult steelhead migrated upstream to spawn in the major rivers supporting this Distinct Population Segment (DPS) (Busby et al. 1996, 65 FR 36074).

NMFS status reviews reached the same conclusion, and noted the poor amount of data available, especially for winter run steelhead (NMFS 1997, Good et al. 2005). The information available suggested that the population growth rate was adverse. It is known that dams on the Mad River and Eel River block large amounts of habitat historically used by NC steelhead (Busby et al. 1996). Hatchery practices in this DPS have exposed the wild population to genetic introgression and the potential for deleterious interactions between native stock and introduced steelhead. Historical hatchery practices at the Mad River hatchery are of particular concern, and included out-planting of non-native Mad River hatchery fish to other streams in the DPS and the production of non-native summer steelhead (65 FR 36074). The conclusion of an earlier status review by (Good et al. (2005) echoes that of previous reviews. Abundance and productivity in this DPS are of most concern, relative to NC steelhead spatial structure (distribution on the landscape) and diversity (level of genetic introgression).

NMFS evaluated the listing status of NC steelhead and proposed maintaining the threatened listing determination (71 FR 834) in 2006. A subsequent status review by Williams et al. (2011) reported a mixture of patterns in population trend information, with more populations showing declines than increases. Although little information was available to assess the status for most population in the NC steelhead DPS, overall Williams et al. (2011) found little evidence to suggest a change in status compared to the last status review by Good et al. (2005).

The most recent status review (Seghesio and Wilson 2016) found that information on steelhead populations in the NC steelhead DPS has improved considerably in the past 5 years, due to implementation of the CMP across a significant portion of the DPS. Nevertheless, significant gaps in information still remain, particularly in the Lower Interior and North Mountain Interior diversity strata, where there is very little information from which to assess status (Figure 2). Overall, the available data for winter-run populations— predominately in the North Coastal, North-Central Coastal, and Central Coastal strata— indicate that all populations are well below viability targets, most being between 5% and 13% of these goals. For the two Mendocino Coast populations with the longest time series, Pudding Creek and Noyo River, the 13-year trends have been adverse and neutral, respectively (Spence 2016). However, the short-term (6-year) trend has been generally beneficial for all independent populations in the North-Central Coastal and Central Coastal strata, including the Noyo River and Pudding Creek (Spence 2016). Data from Van Arsdale Station likewise suggests that, although the long-term trend has been adverse, run sizes of natural-origin steelhead have stabilized or are increasing (Spence 2016). Thus, we have no strong evidence to indicate conditions for winter-run populations in the DPS have worsened appreciably since the status review by Williams et al. (2011).

Most populations for which there are population estimates available remain well below viability targets; however, the short-term increases observed for many populations, despite the occurrence of a prolonged drought in northern California, suggests this DPS is not at immediate risk of extinction (Seghesio and Wilson 2016).

2.2.3.5 CCC and NC Steelhead, CC Chinook Salmon, and CCC Coho Salmon Critical Habitat

In designating critical habitat, NMFS considers, among other things, the following requirements of the species: 1) space for individual and population growth, and for normal behavior; 2) food, water, air, light, minerals, or other nutritional or physiological requirements; 3) cover or shelter; 4) sites for breeding, reproduction, or rearing offspring; and, generally; and 5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species (50 CFR 424.12(b)). In addition to these factors, NMFS also focuses on physical and biological features, or PBFs, and/or essential habitat types within the designated area that are essential to conserving the species and that may require special management considerations or protection.

PBFs for CCC, NC steelhead and CC Chinook salmon critical habitat, and their associated essential features within freshwater include:

1. freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
2. freshwater rearing sites with:
    a. water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
    b. water quality and forage supporting juvenile development; and
    c. natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks;
3. freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

For CCC coho salmon (and generally for CC Chinook salmon, and CCC, NC steelhead) critical habitat the following essential habitat types were identified: 1) juvenile summer and winter rearing areas; 2) juvenile migration corridors; 3) areas for growth and development to adulthood; 4) adult migration corridors; and 5) spawning areas. Within these areas, essential features of coho salmon critical habitat include adequate: 1) substrate, 2) water quality, 3) water quantity, 4) water temperature, 5) water velocity, 6) cover/shelter, 7) food, 8) riparian vegetation, 9) space, and 10) safe passage conditions (64 FR 24029).

The condition of CCC coho salmon, CC Chinook salmon, and CCC, NC, S-CCC steelhead 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: 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; Busby et al. 1996; 64 FR 24049; 70 FR 37160; 70 FR 52488). 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.

2.2.3 Additional Threats to CC Chinook Salmon, CCC Coho Salmon, CCC, NC Steelhead and their Critical Habitat

Global climate change presents an additional potential threat to salmonids and their critical habitats. Impacts from global climate change are already occurring in California. For example, average annual air temperatures, heat extremes, and sea level have all increased in California over the last century (Kadir et al. 2013). Snow melt from the Sierra Nevada Mountains has declined (Kadir et al. 2013). However, total annual precipitation amounts have shown no discernable change (Kadir et al. 2013). Listed salmonids may have already experienced some detrimental impacts from climate change. NMFS believes the impacts on listed salmonids to date are likely fairly minor because natural, and local, climate factors likely still drive most of the climatic conditions steelhead experience, and many of these factors have much less influence on steelhead abundance and distribution than human disturbance across the landscape.

The threat to listed salmonids from global climate change will increase in the future. Modeling of climate change impacts in California suggests that average summer air temperatures are expected to continue to increase (Lindley et al. 2007; Moser et al. 2012). Heat waves are expected to occur more often, and heat wave temperatures are likely to be higher (Hayhoe et al. 2004, Moser et al. 2012; Kadir et al. 2013). Total precipitation in California may decline; critically dry years may increase (Lindley et al. 2007; Schneider 2007; Moser et al. 2012). Wildfires are expected to increase in frequency and magnitude (Westerling et al. 2011, Moser et al. 2012).

For Northern California, most models project heavier and warmer precipitation. Extreme wet and dry periods are projected, increasing the risk of both flooding and droughts (OEHHA 2018). Estimates show that snowmelt contribution to runoff in the Sacramento/San Joaquin Delta may decrease by about 20 percent per decade over the next century (Cloern et al. 2011). Many of these changes are likely to further degrade listed salmonid habitat by, for example, reducing streamflows during the summer and raising summer water temperatures. Estuaries may also experience changes detrimental to salmonids. Estuarine productivity is likely to change based on changes in freshwater flows, nutrient cycling, and sediment amounts (Scavia et al. 2002, Ruggiero et al. 2010). In marine environments, ecosystems and habitats important to juvenile and adult salmonids are likely to experience changes in temperatures, circulation, water chemistry, and food supplies (Brewer and Barry 2008; Feely 2004; Osgood 2008; Turley 2008; Abdul-Aziz et al. 2011; Doney et al. 2012). The projections described above are for the mid to late 21st Century. In shorter time frames, climate conditions not caused by the human addition of carbon dioxide to the atmosphere are more likely to predominate (Cox and Stephenson 2007).

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).

Figure 2 and 3 depict the action area streams (tributaries not depicted) within Marin, Sonoma and Mendocino counties, which include a total of 1,480 miles of potential coho salmon habitat. The Russian River and its tributaries comprise the primary watershed in the action area targeted by the Program (Figure 2). Specifically, the majority of the Program actions take place in Dry Creek and its tributaries, and the lower Russian River (below Dry Creek) and its tributaries. Dry Creek is where the majority of the program facilities are located. Additionally, some streams in watersheds outside of the Russian River are included as part of the recovery efforts that collect and release coho salmon. These watersheds include Lagunitas/Olema Creek, Redwood Creek and Walker Creek (Marin County), and Salmon Creek in Sonoma County. Additional watersheds within Mendocino County are included in the action area (Figure 3). The larger watersheds such as the Navarro River, Garcia River and Gualala River identified in the NMFS Recovery Plan (NMFS 2012a) as the populations that are essential for recovery, will have Program actions over the permit period.

Figure 2. Program coho salmon broodstock streams within Sonoma and Marin counties, California.

Figure 3. Program coho salmon broodstock streams within Mendocino County, California.

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).

The action area includes specific watersheds and tributaries within, from the Navarro River in Mendocino County south to Redwood Creek in Marin County as identified in Figures 2 and 3 above. Table 2 provides a list of watersheds where CCC coho salmon could be collected and outplanted as a result of the Program actions.

Table 2. Coho Salmon watersheds included in the proposed Program. Tributary streams are not listed due the large number in each watershed area.

Diversity Stratum	Watershed (Focus Population)	Watershed (Supplemental Population)
Navarro-Gualala Point	**Navarro River**	Greenwood Creek
	Garcia River	Elk Creek
	Gualala River	Alder Creek
		Brush Creek
Coastal	**Russian River**	
		Salmon Creek
		Pine Gulch
	Walker Creek	
	Lagunitas Creek	
		Redwood Creek

The action area encompasses the southern coastal area of Mendocino County and the coastal areas of Sonoma and Marin counties located in northern California. Native vegetation varies from redwood (*Sequoia sempervirens*) forest along the lower drainages to Douglas fir (*Pseudotsuga menziesii*) intermixed with hardwoods and chaparral, to ponderosa pine (*Pinus ponderosa*) and Jeffery pine (*Pinus jefferyi*) stands along the upper elevations. Areas of grasslands are also found along the main ridge tops and south facing slopes of the watersheds.

The action area has a Mediterranean climate characterized by cool wet winters with typically high runoff, and dry warm summers characterized by greatly reduced instream flows. Fog is a dominant climatic feature along the coast, generally occurring daily in the summer and not infrequently throughout the year. Higher elevations and inland areas tend to be relatively fog free. Most precipitation falls during the winter and early spring as rain, with occasional snow above 1,600 ft. Along the coast, average air temperatures range from 46° to 56° Fahrenheit (F). Further inland and in the southern part of the action area, annual air temperatures are much more varied, ranging from below freezing in winter to over 100°F during the summer months.

High seasonal rainfall on bedrock and other geologic units with relatively low permeability, erodible soils, and steep slopes contribute to the flashy nature (stream flows rise and fall quickly) of the watersheds within the action area. In addition, these high natural runoff rates have been increased by road systems, urbanization, and other land uses. High seasonal rainfall combined with rapid runoff rates on unstable soils delivers large amounts of sediment to river systems. As a result, many river systems within the action area contain a relatively large sediment load, typically deposited throughout the lower gradient reaches of these systems.

2.4.1 Status of the Species and/or Critical Habitat in the Action Area

This section provides a synopsis of the four geographic areas of consideration, the ESUs/DPSs and HUCs present within each area, specific recent information on the status of Chinook salmon, coho salmon or steelhead, and a summary of the factors affecting the listed species within the action area. The best information presently available demonstrates that a multitude of factors, past and present, have contributed to the decline of west coast salmonids (Weitkamp et al. 1995, Busby et al. 1996, NMFS 1996, Myers et al. 1998, NMFS 1998, CDFG 2002, CRWQCB 2001). The following is a summary of the factors affecting the environment of the species or critical habitat within each coastal area.

2.4.1.1 North Central Coast Area

The North Central Coast area includes all coastal California streams entering the Pacific Ocean in Mendocino, Sonoma, and Marin counties, excluding streams draining into San Francisco and San Pablo bays. The North Central Coast Area includes portions of four ESUs/DPSs (CC Chinook salmon, CCC coho salmon, NC steelhead, and CCC steelhead) and five USGS 4th field HUCs (Big-Navarro-Garcia, Bodega Bay, Gualala-Salmon, Russian, and Tomales-Drakes Bay). Forestry is the dominant land-use throughout the northern part of this area (north of the Russian River). Agriculture and urbanization are more predominant in the Russian River and areas south.

Navarro and Garcia Rivers

The Navarro and Garcia rivers are located along the Mendocino County coast and drain directly to the Pacific Ocean. The urban development within these watersheds is limited primarily to small to few small towns scattered throughout these basins. In these larger basins, private forest lands average about 75 percent of the total acreage (65 FR 36074). Forestry is the dominant land use activity; in some subwatersheds, significant portions (up to 100 percent) have been harvested (CRWQCB 2001). Excessive sedimentation, low LWD abundance and recruitment, and elevated water temperature are issues in some larger order streams; these issues are largely attributable to forestry activities (NMFS 2015). Agriculture has likely contributed to depressed habitat conditions within the Navarro River watershed, and gravel mining may affect salmonids in the Garcia River watershed. The effects of land use activities are exacerbated by the naturally erosive geology, the mountainous and rugged terrain, and legacy impacts from historically large storms (e.g., 1964, 1982). Estuaries have likely decreased in size due to sedimentation and flood control actions (e.g., diking and channelization). Most of the larger watersheds within along the Mendocino coast are included on the 2012 Clean Water Act section 303(d) list of water quality limited segments (CSWRCB 2012), and have TMDLs in place that address sediment pollution.

These watersheds are within the CCC coho salmon ESU, CC Chinook salmon ESU, and NC steelhead DPS. Steelhead are widespread yet reduced in abundance, and coho salmon have a patchy distribution with populations significantly reduced from historic levels (Weitkamp et al. 1995; Busby et al. 1996; CRWQCB 2001). Garcia River steelhead escapement was estimated at 422 adults and 743 for the Navarro River in 2012 (Gallagher et al. 2013). Coho abundance for remains at low levels with estimates for Coho salmon for the Navarro River ranging from an estimate of zero to 633 adult fish for escapement years 2009-2014 (Holloway et al. 2014). Surveys of the Garcia River has shown it remains at low levels of abundance of with weak year classes of less than 20 adults and stronger years with 200 to 600 adult spawners (Holloway et al. 2014). Chinook salmon abundance is very low to nonexistent in these coastal watersheds. Similar surveys for Chinook salmon were conducted from 20019 to 2014 as part of the Coastal Mendocino County Salmonid Life Cycle and Regional Monitoring effort. These surveys reflect the sporadic returns of adult Chinook salmon to the Mendocino Coastal area. For the six years monitored from 2009 to 2014, Chinook were detected in the Navarro two years and the Garcia 3 years (Holloway et al. 2014). Low numbers of Chinook were reported during these years with the highest estimates of 83 fish (Garcia River) and 173 adult Chinook (Navarro River) in 2011 (Holloway et al. 2014).

Gualala River

The Gualala River is the only large watershed within this area of the southern Mendocino coast and has is limited urban development across the basin. Within the Gualala River watershed, private forestlands make up about 94 percent of the total acreage, and forestry is the dominant land use of the watershed (65 FR 36074). Agriculture has been a significant land use within the Gualala River watershed; historically orchards and grazing were the dominant agricultural activities, though more recently vineyard development and illicit marijuana cultivation has become more common within the basin (NMFS 2014). Gravel mining is largely a historic activity, although a rather large gravel mining operation near the confluence of the Wheatfield Fork remains. Gravel extraction is currently limited to 40,000 tons per year, though extractions in the past 10 years have not reached that limit (CRWQCB 2001). The Gualala River is included on the 2012 Clean Water Act section 303(d) list of water quality limited segments (CSWRCB 2012). The pollution factors for the Gualala River are sedimentation, temperature, DO, and a host of chemical pollutants; forestry, agriculture, and land development are listed as the potential sources for those factors (CSWRCB 2012). In 2001, a TMDL for sediment was approved for the Gualala River (www.epa.gov).

This watershed had historic populations of CCC coho salmon and CC Chinook salmon and a current NC steelhead populations that appears to relatively healthy. Higgins et al. (1992) considered coho salmon from the Gualala River as being at a high risk of extinction. More recently, the CDFG (2002) concluded that the Gualala River contains no known remaining viable coho salmon populations; no population data exists from the past 5 years, and NMFS suspects the number of coho salmon in the Gualala River is very low (Williams et al. 2016). Recent steelhead data suggests the Gualala River may contain the largest remaining steelhead population within the NC DPS (Williams et al. 2016).

Russian River

Portions of the Russian River are in both Sonoma and Mendocino counties with significant urban development centered on the Highway 101 corridor. Santa Rosa is the largest city in this area with scattered small towns and rural residences throughout the basin. Forestry and agriculture are other significant land uses within the basin, and there are some in-channel gravel mining operations. Brown and Moyle (1991) reported that logging and mining in combination with naturally erosive geology have led to significant aggradation of up to 10 feet in some areas of Austin Creek - a lower Russian River tributary. NMFS's status reviews (Weitkamp et al. 1995; Busby et al. 1996; Myers et al. 1998) identified two large dams within the Russian River that block access to anadromous fish habitat: Coyote Valley Dam and Warm Springs Dam. Steiner Environmental Consulting (SEC) (1996) cite unpublished data from the California State Water Resources Control Board (CSWRCB), which state that there are over 500 small dams on the Russian River and its tributaries. These dams have a variety of functions including residential, commercial, and agricultural water supply, flood and/or debris control, and recreation. These small dams interfere with fish migration, affect sediment transport, and affect water flow and temperature.

USACE (1982) concluded that the loss of tributary habitat was the primary factor limiting the recovery of the anadromous fishery in the Russian River. The Russian River is included on the 2013 Clean Water Act section 303(d) list of water quality limited segments (CSWRCB 2013). The pollution factors for the Russian River are vary by sub-watershed, but commonly include sediment, temperature, dissolved oxygen, various nutrients, and many chemical pollutants and pathogens. Forestry, agriculture, dams with flow regulation, urban and land development, and nonpoint sources are listed as the potential sources for these factors. Lake Sonoma, a reservoir impounded by Warm Springs Dam, is included on the section 303(d) list because of elevated levels of mercury associated with historic mining. Currently, there is no approved TMDL for the Russian River watershed (www.epa.gov).

Many releases of in-basin and out-of-basin Chinook salmon, coho salmon and steelhead occurred throughout the Russian River since the late 1800s (Weitkamp et al. 1995; Busby et al. 1996; Myers et al. 1998; NMFS 1999a). From the late 1970s to late 1990s, the Don Clausen Fish Hatchery operated at Warm Springs Dam and released coho salmon, Chinook salmon, and steelhead into the Russian River watershed. However, significant changes in hatchery operations began in 1998, in which the production of coho salmon and Chinook salmon was discontinued. More typical CDFW spawning and release production of steelhead continues at Don Clausen Fish Hatchery.

The Russian River is within the CCC coho salmon ESU, CC Chinook salmon ESU, and CCC steelhead DPS. The CDFG (2002) reported that recent monitoring data indicate that widespread extirpation of coho salmon has occurred within the Russian River basin. In 2001, a conservation hatchery program was developed for coho salmon at the Don Clausen Fish Hatchery. Juvenile coho salmon from the program have been released for reintroduction into several historical coho salmon Russian River tributaries annually beginning in fall 2004. Recent monitoring data indicate the coho salmon population in the lower Russian River (Dry Creek downstream, inclusive) ranged from 206 to 536 adult fish during the past four years (Williams et al. 2016). Early systematic monitoring work conducted during Program broodstock surveys from 2001 to

2004 indicate that coho salmon were present in only 5 tributaries of the Russian River (Conrad et al. 2005). Monitoring conducted more recently indicate broodstock efforts have increased spatial structure and presence of natural origin coho salmon juveniles in 28 of 41 stream surveyed in 2017 (McClary, et al. 2018).

The Russian River population of Chinook salmon has shown no discernable trend in population abundance during the past 14-year period, with an average annual escapement counted at the Mirabel counting facility of 3,257 fish (Williams et al. 2016). The lack of adequate spawner surveys within the Russian River precludes the estimation of wild steelhead escapement within the basin; however, hatchery returns suggest the vast majority of returning fish are of hatchery origin. Current population abundance for all three species remains a mere fraction of their target recovery levels.

Salmon Creek

The Salmon Creek watershed is wholly within Sonoma County, whereas the Americano Creek and Stemple Creek watersheds are in both Sonoma and Marin counties. There is limited urban development within these watersheds; agriculture is the dominant land use within all of the watersheds within this HUC, with dairy farming being the primary activity. There are some forestlands in the headwaters of Salmon Creek. Large winter storms have exacerbated the impact of land use activities and natural erosive geology of Salmon Creek (Brown and Moyle 1991) and adversely affected rearing habitat quality and quantity. Americano Creek and Stemple Creek and their estuaries are included on the 2012 Clean Water Act section 303(d) list of water quality limited segments for elevated levels of nutrients and sediment (CSWRCB 2012). The pollution factors for these streams are sedimentation, nutrients, invasive species, and temperature; Diazinon is listed as a pollutant in Estero de San Antonio. Agriculture and land development are listed as the potential sources for those factors. Many of the streams lack riparian cover, causing increased water temperatures.

This watershed is within the CCC coho salmon ESU and CCC steelhead DPS. The distribution and abundance of salmonids within the watershed are highly reduced. Coho salmon have been found in two watersheds in the area: Salmon Creek and Valley Ford Creek (Brown and Moyle 1991; Hassler et al. 1991; Weitkamp et al. 1995). Excess coho salmon broodstock fish from Warm Springs Hatchery have been released into Salmon Creek during the past several years in an attempt to re-establish a self-sustaining run within the watershed (Williams et al. 2016). Steelhead are found throughout Salmon Creek, but the status of steelhead distribution in tributary streams is unknown.

Redwood, Walker, and Lagunitas Creeks

All of these watersheds drain into the Pacific Ocean from Rodeo Cove north to Tomales Bay. These streams are predominately in Marin County, with the exception of a small portion of the headwaters of Walker Creek, which is in Sonoma County. Most of the watersheds in this area are small with the exception of Walker Creek and Lagunitas Creek, both tributaries of Tomales Bay, a prominent artifact of the San Andreas Rift Zone. Urban development within the in these basins range from single homes to small towns and municipal complexes. Although urbanization has been limited, flood control activities, contaminated runoff from paved lots and roads, and seepage from improperly designed and/or maintained septic systems, continue to impact habitat and water quality in portions of the watershed (Ketcham 2003). Recreation is a significant factor in land use in these watersheds as there are county, state, and Federal parks across these areas. Agriculture is a dominant land-use, particularly in the northern half of the Marin County, and forestry was a historic land use activity. Lagunitas Creek, Walker Creek, and Tomales Bay are included on the 2002 Clean Water Act section 303(d) list of water quality limited segments (CSWRCB 2012); nutrients, pathogens, and sedimentation are the factors and are attributed to agriculture and urban runoff or storm sewers. Mercury, associated with mining, is an additional factor for Walker Creek and Tomales Bay. The construction of Kent Reservoir and Nicasio Reservoir cut off 50 percent of the historical salmonid habitat within the Lagunitas Creek watershed; and construction of two large reservoirs within the Walker Creek watershed, Laguna Lake, and Soulejoule Reservoir, cut off access to significant amounts of habitat (Weitkamp et al. 1995; Busby et al. 1996; Myers et al. 1998, CDFG 2002, NMFS 2015). Sedimentation has had a profound effect on fish habitat in Walker Creek. Many of the deep, cool pools and gravel that salmonids depend on for spawning and rearing, have been filled in with fine sediment.

Elevated stream temperatures are also a concern within many watersheds throughout these watersheds. Summer water temperatures are usually below lethal thresholds for salmonids, but can be high enough to retard growth. It was reported that juvenile salmonids in Lagunitas Creek did not show appreciable growth during the summer of 1984, and it is believed that this lack of growth was due to the relatively high summer water temperatures that occurred during this time (Bratovich and Kelly 1988). The National Park Service has documented water temperatures well over the preferred range for salmonids in Olema Creek and one of its tributaries (Ketcham 2003).

These watersheds are within the CCC coho salmon ESU and CCC steelhead DPS. With the exception of Lagunitas Creek, the abundance of coho salmon is very low in the remaining watersheds. Lagunitas Creek may have the largest populations of coho salmon remaining in the CCC coho salmon ESU. Although Lagunitas Creek is presumed to have a relatively stable and healthy population of coho salmon, at least when compared with other CCC coho salmon streams, NMFS (2001) noted that this stream had experienced a then recent reduction in coho salmon abundance. Small persistent populations of coho salmon are in Pine Gulch Creek and Redwood Creek. Anecdotal evidence of a once thriving coho salmon and steelhead run in Walker Creek exists. The species was thought to be extirpated from the subbasins of this watershed by both Adams et al. (1999) and CDFG (2002) in the mid- 1980s. This was verified during the 1990 through 2000 by CDFW watershed program surveys. In an attempt to increase population spatial distribution, excess coho salmon broodstock from Warm Spring hatchery were introduced into Walker Creek from 2008-2014, and observations of juvenile coho salmon following those plantings indicate successful spawning by those released broodstock fish (Spence 2016). Small numbers of Chinook salmon are often encountered within Lagunitas Creek, which is outside the current CC ESU boundary that ends at the Russian River. NMFS is currently considering extending the CC ESU boundary to include these fish (Williams et al. 2016).

2.4.1.2 Climate-Related Environmental Conditions in the Action Area

Another factor affecting the rangewide status of coho salmon, Chinook salmon and steelhead, and aquatic habitat at large, is climate change. Global climate change presents an additional potential threat to salmonids and their critical habitats. Impacts from global climate change are already occurring in California. For example, average annual air temperatures, heat extremes, and sea level have all increased in California over the last century (Kadir et al. 2013). Snow melt from the Sierra Nevada has declined (Kadir et al. 2013). However, total annual precipitation amounts have shown no discernable change (Kadir et al. 2013). Listed salmonids may have already experienced some detrimental impacts from climate change. NMFS believes the impacts on listed salmonids to date are likely fairly minor because natural, and local, climate factors likely still drive most of the climatic conditions CCC steelhead experience, and many of these factors have much less influence on steelhead abundance and distribution than human disturbance across the landscape.

The threat to salmonids from global climate change will increase in the future. Modeling of climate change impacts in California suggests that average summer air temperatures are expected to continue to increase (Lindley et al. 2007; Moser et al. 2012). Heat waves are expected to occur more often, and heat wave temperatures are likely to be higher (Hayhoe et al. 2004, Moser et al. 2012; Kadir et al. 2013). Total precipitation in California may decline; critically dry years may increase (Lindley et al. 2007; Schneider 2007; Moser et al. 2012). Wildfires are expected to increase in frequency and magnitude (Westerling et al. 2011, Moser et al. 2012). California appears to already be experiencing some of these impacts, i.e., the recent severe drought and large wildfires.

For Northern California, most models project heavier and warmer precipitation. Extreme wet and dry periods are projected, increasing the risk of both flooding and droughts (DWR 2013). Estimates show that snowmelt contribution to runoff in the Sacramento/San Joaquin Delta may decrease by about 20 percent per decade over the next century (Cloern et al. 2011). Many of these changes are likely to further degrade CCC coho salmon and steelhead habitat by, for example, reducing stream flow during the summer and raising summer water temperatures. Estuaries may also experience changes detrimental to salmonids. Estuarine productivity is likely to change based on changes in freshwater flows, nutrient cycling, and sediment amounts (Scavia et al. 2002, Ruggiero et al. 2010). In marine environments, ecosystems and habitats important to juvenile and adult salmonids are likely to experience changes in temperatures, circulation, water chemistry, and food supplies (Brewer and Barry 2008; Feely 2004; Osgood 2008; Turley 2008; Abdul-Aziz et al. 2011; Doney et al. 2012). The projections described above are for the mid to late 21st Century. In shorter time frames, climate conditions not caused by the human addition of carbon dioxide to the atmosphere are more likely to predominate (Cox and Stephenson 2007; Santer et al. 2011).

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. 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 actions, we considered 50 CFR 402.17(a) and (b).

2.5.1 General Overview of Hatchery Effects on ESA Protected Species and on Designated Critical Habitat

2.5.1.1 Factors That Are Considered When Analyzing Hatchery Effects

NMFS has substantial experience with hatchery programs, has developed, and published a series of guidance documents for designing and evaluating hatchery programs following best available science. These documents are available upon request from the NMFS Salmon Management Division in Portland, Oregon. "Pacific Salmon and Artificial Propagation under the Endangered Species Act" (Hard et al. 1992) was published shortly following the first ESA-listings of Pacific salmon on the West Coast and it includes information and guidance that is still relevant today. In 2000, NMFS published "Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units" (McElhany et al. 2000) and then followed that with a "Salmonid Hatchery Inventory and Effects Evaluation Report" for hatchery programs up and down the West Coast (NMFS 2004). In 2005, NMFS published a policy that provided greater clarification and further direction on how it analyzes hatchery effects and conducts extinction risk assessments (NMFS 2005b). NMFS then updated its inventory and effects evaluation report for hatchery programs on the West Coast (Jones 2006) and followed that with "Artificial Propagation for Pacific Salmon: Assessing Benefits and Risks and Recommendations for Operating Hatchery Programs Consistent with Conservation and Sustainable Fisheries Mandates"). More recently, NMFS published its biological analysis and final determination for the harvest of Puget Sound Chinook salmon which included discussion on the role and effects of hatchery programs (NMFS 2011d).

A key factor in analyzing a hatchery program for its effects, beneficial and adverse, on the status of salmon and steelhead are the genetic resources that reside in the program. Genetic resources that represent the ecological and genetic diversity of a species can reside in a hatchery program. "Hatchery programs with a level of genetic divergence relative to the local natural population(s) that is no more than what occurs within the ESU are considered part of the ESU and will be included in any listing of the ESU" (NMFS 2005b). NMFS monitors hatchery practices for whether they promote the conservation of genetic resources included in an ESU or steelhead DPS and updates the status of genetic resources residing in hatchery programs every five years. Generally speaking, hatchery programs that are reproductively connected or "integrated" with a natural population, if one still exists, and that promote natural selection over selection in the hatchery, contain genetic resources that represent the ecological and genetic diversity of a species and are included in an ESU or steelhead DPS.

When a hatchery program actively maintains distinctions or promotes differentiation between hatchery fish and fish from a native population, then NMFS refers to the program as "isolated". Generally speaking, isolated hatchery programs have a level of genetic divergence, relative to the local natural population(s), that is more than what occurs within the ESU and are not considered part of an ESU or steelhead DPS. They promote domestication or selection in the hatchery over selection in the wild and select for and culture a stock of fish with different phenotypes, for example different ocean migrations and spatial and temporal spawning distribution, compared to the native population (extant in the wild, in a hatchery, or both). For Pacific salmon, NMFS evaluates extinction processes as influenced (or not) by the Proposed Action beginning at the scale of individuals up through the population scale (McElhany et al. 2000). NMFS defines population performance measures in terms of natural-origin fish and four key parameters or attributes: abundance, productivity, spatial structure, and diversity and then relates effects of the Proposed Action at the population scale and ultimately to the survival and recovery of an entire ESU or DPS.

"Because of the potential for circumventing the high rates of early mortality typically experienced in the wild, artificial propagation may be useful in the recovery of listed salmon species. However, artificial propagation entails risks as well as opportunities for salmon conservation" (Hard et al. 1992). A Proposed Action is analyzed for effects, beneficial and adverse, on the attributes that define population viability, including abundance, productivity, spatial structure, and diversity. The effects of a hatchery program on the status of an ESU or steelhead DPS "…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" (70 FR 37215, June 28, 2005). The presence of hatchery fish within the ESU can beneficially 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". NMFS also analyzes and takes into account the effects of hatchery facilities, for example, weirs and water diversions, on each VSP attribute and on designated critical habitat.

NMFS' analysis of the Proposed Action is in terms of effects it would be expected to have on ESA-listed species and on designated critical habitat, based on the best scientific information on the general type of effect of that aspect of hatchery operation in the context of the specific application in the Russian River. This allows for effects of the various factors of hatchery operation to be applied to each applicable life-stage of the listed species at the population level (in Section 2.6). Then this allows for the combination of all such effects with other effects accruing to the species to determine the likelihood of posing jeopardy to the species as a whole (in Section 2.7).

The effects, beneficial and adverse, for two categories of hatchery programs are summarized in Table 2. Generally speaking, effects range from beneficial to adverse for programs that use local fish[1] for hatchery broodstock and from negligible to adverse when a program does not use local fish for broodstock.[2] Hatchery programs can benefit population viability but only if they use genetic resources that represent the ecological and genetic diversity of the target or affected

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[1] The term "local fish" is defined to mean fish with a level of genetic divergence relative to the local natural population(s) that is no more than what occurs within the ESU or steelhead DPS (70 FR 37215, June 28, 2005).

[2] Exceptions include restoring extirpated populations and gene banks.

natural population(s). When hatchery programs use genetic resources that do not represent the ecological and genetic diversity of the target or affected natural population(s), NMFS is particularly interested in how effective the program will be at isolating hatchery fish and avoiding co-occurrence and effects that potentially disadvantage fish from natural populations. The range in effects for a specific hatchery program are refined and narrowed after available scientific information and the circumstances and conditions that are unique to individual hatchery programs are accounted for.

Natural population viability parameter	**Hatchery broodstock originate from the local population and are included in the ESU or DPS**	**Hatchery broodstock originate from a non-local population or from fish that are not included in the same ESU or DPS**
Productivity	**Beneficial to adverse effect** Hatcheries are unlikely to benefit productivity except in cases where the natural population's small size is, in itself, a predominant factor limiting population growth (i.e., productivity) (NMFS 2004).	**Negligible to adverse effect** This is dependent on differences between hatchery fish and the local natural population (i.e., the more distant the origin of the hatchery fish the greater the threat), the duration and strength of selection in the hatchery, and the level of isolation achieved by the hatchery program (i.e., the greater the isolation the closer to a negligible affect).
Diversity	**Beneficial to adverse effect** Hatcheries can temporarily support natural populations that might otherwise be extirpated or suffer severe bottlenecks and have the potential to increase the effective size of small natural populations. Broodstock collection that homogenizes population structure is a threat to population diversity.	**Negligible to adverse effect** This is dependent on the differences between hatchery fish and the local natural population (i.e., the more distant the origin of the hatchery fish the greater the threat) and the level of isolation achieved by the hatchery program (i.e., the greater the isolation the closer to a negligible affect).
Abundance	**Beneficial to adverse effect** Hatchery-origin fish can beneficially affect the status of an ESU by contributing to the abundance and productivity of the natural populations in the ESU (70 FR 37204, June 28, 2005, at 37215).	**Negligible to adverse effect** This is dependent on the level of isolation achieved by the hatchery program (i.e., the greater the isolation the closer to a negligible affect), handling, RM&E and facility operation, maintenance and construction effects.
Spatial Structure	**Beneficial to adverse effect** Hatcheries can accelerate re-colonization and increase population spatial structure, but only in conjunction with remediation of the factor(s) that limited spatial structure in the first place. "Any benefits to spatial structure over the long term depend on the degree to which the hatchery stock(s) add to (rather than replace) natural populations" (70 FR 37204, June 28, 2005 at 37213).	**Negligible to adverse effect** This is dependent on facility operation, maintenance, and construction effects and the level of isolation achieved by the hatchery program (i.e., the greater the isolation the closer to a negligible affect).

Table 3. Overview of the range in effects on natural population viability parameters from two categories of hatchery programs. The range in effects are refined and narrowed after the circumstances and conditions that are unique to individual hatchery programs are accounted for.

Information that NMFS needs to analyze the effects of a hatchery program on ESA-listed species must be included in an HGMP. Draft HGMPs are reviewed by NMFS for their sufficiency before formal review and analysis of the Proposed Action can begin.

Analysis of an HGMP or Proposed Action for its effects on ESA-listed species and on designated critical habitat depends on seven factors. These factors are:

(1) the hatchery program does or does not promote the conservation of genetic resources that represent the ecological and genetic diversity of a salmon ESU or steelhead DPS;
(2) hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities;
(3) hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas;
(4) hatchery fish and the progeny of naturally spawning hatchery fish in the migration corridor, estuary, and ocean;
(5) RM&E that exists because of the hatchery program;
(6) the operation, maintenance, and construction of hatchery facilities that exist because of the hatchery program; and
(7) fisheries that exist because of the hatchery program, including terminal fisheries intended to reduce the escapement of hatchery-origin fish to spawning grounds.

The analysis assigns an effect for each factor from the following categories. The categories are:

(1) beneficial effect on population viability,
(2) negligible effect on population viability, and
(3) adverse effect on population viability.

“The effects of hatchery fish on the status of an ESU will depend on which of the four key attributes are currently limiting the ESU, and how the hatchery within the ESU affect each of the attributes” (NMFS 2005b). The category of affect assigned is based on an analysis of each factor weighed against the affected population(s) current risk level for abundance, productivity, spatial structure and diversity, the role or importance of the affected natural population(s) in ESU or steelhead DPS recovery, the target viability for the affected natural population(s), and the Environmental Baseline including the factors currently limiting population viability.

2.5.1.1.1 Factor 1. The degree which the hatchery program affects the conservation of genetic resources that represent the ecological and genetic diversity of a salmon ESU or steelhead DPS

This factor considers broodstock practices and whether they promote the conservation of genetic resources that represent the ecological and genetic diversity of a salmon ESU or steelhead DPS.

A primary consideration in analyzing and assigning effects for broodstock collection is the origin and number of fish collected. The analysis considers whether broodstock are of local origin, the biological pros, and the biological cons of using ESA-listed fish (natural or hatchery-origin) for hatchery broodstock. It considers the maximum number of fish proposed for collection and the proportion of the donor population tapped to provide hatchery broodstock. "Mining" a natural population to supply hatchery broodstock can reduce population abundance and spatial structure. Also considered here is whether the program "backfills" with fish from outside the local or immediate area.

2.5.1.1.2 Factor 2. Hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities

NMFS also analyzes the effects of hatchery fish 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. NMFS generally views genetic effects as detrimental because at this time, based on the weight of available scientific information, we believe that artificial breeding and rearing is likely 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. Hatchery fish thus pose a threat to natural population rebuilding and recovery when they interbreed with fish from natural populations.

However, NMFS recognizes that there are benefits as well, and that the risks just mentioned may be outweighed under circumstances where demographic or short-term extinction risk to the population is greater than risks to population diversity and productivity. Conservation hatchery programs may accelerate recovery of a target population by increasing abundance faster than may occur naturally (Waples 1999). Hatchery programs can also be used to create genetic reserves for a population to prevent the loss of its unique traits due to catastrophes (Ford 2011). Furthermore, NMFS also recognizes there is considerable uncertainty regarding genetic risk. 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 that hatchery intervention is a legitimate and useful tool to alleviate short-term extinction risk, 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 (NMFS 2011d).

Hatchery fish can have a variety of genetic effects on natural population productivity and diversity when they interbreed with natural-origin fish. Although there is biological interdependence between them, NMFS considers three major areas of genetic effects of hatchery programs: within-population diversity, outbreeding effects, and hatchery-induced selection. As we have stated above, in most cases, the effects are viewed as risks, but in small populations, these effects can sometimes be beneficial, reducing extinction risk.

Within-population genetic diversity is a general term for the quantity, variety and combinations of genetic material in a population (Busack and Currens 1995). Within-population diversity is gained through mutations or gene flow from other populations (described below under outbreeding effects) and is lost primarily due to genetic drift, a random loss of diversity due to population size. The rate of loss is determined by the population's effective population size (N_e), which can be considerably smaller than its census size. For a population to maintain genetic diversity reasonably well, the effective size should be in the hundreds (e.g., Lande and Barrowclough 1987), and diversity loss can be severe if N_e drops to a few dozen.

Hatchery programs, simply by virtue of creating more fish, can increase N_e. In very small populations this can be a benefit, making selection more effective and reducing other small-population risks (e.g., Lacy 1987; Whitlock 2000; Willi et al. 2006). Conservation hatchery programs can thus serve to protect genetic diversity; several, such as the Snake River sockeye salmon program are important genetic reserves. However, hatchery programs can also directly depress N_e by two principal methods. One is by the simple removal of fish from the population so that they can be used in the hatchery. If a substantial portion of the population is taken into a hatchery, the hatchery becomes responsible for that portion of the effective size, and if the operation fails, the effective size of the population will be reduced (Waples and Do 1994). N_e can also be reduced considerably below the census number of broodstock by using a skewed sex ratio, spawning males multiple times (Busack 2007), and by pooling gametes. Pooling semen is especially problematic because when semen of several males is mixed and applied to eggs, a large portion of the eggs may be fertilized by a single male (Gharrett and Shirley 1985; Withler 1988). Factorial mating schemes, in which fish are systematically mated multiple times, can be used to increase N_e (Fiumera et al. 2004; Busack and Knudsen 2007). An extreme form of N_e reduction is the Ryman-Laikre effect (Ryman and Laikre 1991; Ryman et al. 1995), when N_e is reduced through the return to the spawning grounds of large numbers of hatchery fish from very few parents.

Inbreeding depression, another N_e-related phenomenon, 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.

Outbreeding effects are caused by gene flow from other populations. Gene flow occurs naturally among salmon and steelhead populations, a process referred to as straying (Quinn 1993; Quinn 1997). Natural straying serves a valuable function in preserving diversity that would otherwise be lost through genetic drift and in re-colonizing vacant habitat, and straying is considered a risk only when it occurs at unnatural levels or from unnatural sources. Hatchery programs can result in straying outside natural patterns for two reasons. First, hatchery fish may exhibit reduced homing fidelity relative to natural-origin fish (Grant 1997; Quinn 1997; Jonsson et al. 2003; Goodman 2005), resulting in unnatural levels of gene flow into recipient populations, either in terms of sources or rates. Second, even if hatchery fish home at the same level of fidelity as natural-origin fish, their higher abundance can cause unnatural straying levels into recipient populations. One goal for hatchery programs should be to ensure that hatchery practices do not lead to higher rates of genetic exchange with fish from natural populations than would occur naturally (Ryman 1991). Rearing and release practices and ancestral origin of the hatchery fish can all play a role in straying (Quinn 1997).

Gene flow from other populations can have two effects. It can increase genetic diversity (e.g., Ayllon et al. 2006) (which can be a benefit in small populations) but it can also alter established allele frequencies (and co-adapted gene complexes) and reduce the population's level of adaptation, a phenomenon called outbreeding depression (Edmands 2007; McClelland and Naish 2007). In general, the greater the geographic separation between the source or origin of hatchery fish and the recipient natural population, the greater the genetic difference between the two populations (ICTRT 2007), and the greater potential for outbreeding depression. For this reason, NMFS advises hatchery action agencies to develop locally derived hatchery broodstock. Additionally, unusual rates of straying into other populations within or beyond the population area, ESU or a steelhead DPS can have an homogenizing effect, decreasing intra-population genetic variability (e.g., Vasemagi et al. 2005), and increasing risk to population diversity, one of the four attributes measured to determine population viability. Reduction of within-population and among-population diversity can reduce adaptive potential.

The proportion of hatchery fish among natural spawners is often used as a surrogate measure of gene flow. Appropriate cautions and qualifications should be considered when using this proportion to analyze hatchery affects. Adult salmon may wander on their return migration, entering and then leaving tributary streams before finally spawning (Pastor 2004). These "dip-in" fish may be detected and counted as strays, but may eventually spawn in other areas, resulting in an overestimate of the number of strays that potentially interbreed with the natural population (Keefer et al. 2008). Caution must also be taken in assuming that strays contribute genetically in proportion to their abundance. Several studies demonstrate little genetic impact from straying despite a considerable presence of strays in the spawning population (Saisa et al. 2003; Blankenship et al. 2007). The causative factors for poorer breeding success of strays are likely similar to those identified as responsible for reduced productivity of hatchery-origin fish in general, e.g., differences in run and spawn timing, spawning in less productive habitats, and reduced survival of their progeny (Reisenbichler and McIntyre 1977; Leider et al. 1990; McLean et al. 2004; Williamson et al. 2010).

Hatchery-induced selection (often called domestication) occurs when selection pressures imposed by hatchery spawning and rearing differ greatly from those imposed by the natural environment and causes genetic change that is passed on to natural populations through interbreeding with hatchery-origin fish, typically from the same population. These differing selection pressures can be a result of differences in environments or a consequence of protocols and practices used by a hatchery program. Hatchery selection can range from relaxation of selection, that would normally occur in nature, to selection for different characteristics in the hatchery and natural environments, to intentional selection for desired characteristics (Waples 1999).

Genetic change and fitness reduction resulting from hatchery-induced 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 the proportion of natural-origin fish being used as hatchery broodstock and the proportion of 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, all three levels must be considered. Strong selective fish culture with low hatchery-wild interbreeding can pose less risk than relatively weaker selective fish culture with high levels of interbreeding.

Most of the empirical evidence of fitness depression due to hatchery-induced selection comes from studies of species that are reared in the hatchery environment for an extended period – one to two years – prior to release (Berejikian and Ford 2004). Exposure time in the hatchery for fall and summer Chinook salmon and Chum salmon is much shorter, just a few months. One especially well publicized steelhead study (Araki et al. 2007; Araki et al. 2008), showed dramatic fitness declines in the progeny of naturally spawning hatchery steelhead. Researchers and managers alike have wondered if these results could be considered a potential outcome applicable to all salmonid species, life-history types, and hatchery rearing strategies.

Critical information for analysis of hatchery-induced selection includes the number, location and timing of naturally spawning hatchery fish, the estimated level of interbreeding between hatchery-origin and natural-origin fish, the origin of the hatchery stock (the more distant the origin compared to the affected natural population, the greater the threat), the level and intensity of hatchery selection and the number of years the operation has been run in this way.

Ecological effects for this factor (i.e., hatchery fish and the progeny of naturally spawning hatchery fish on the spawning grounds) refer effects from competition for spawning sites and 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. For example, 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; Piorkowski 1995; Larkin and Slaney 1996; Gresh et al. 2000; Murota 2003; Quamme and Slaney 2003; Wipfli et al. 2003). As a result, the growth and survival of juvenile salmonids may increase (Hager and Noble 1976; Bilton et al. 1982; Holtby 1988; Ward and Slaney 1988;

Hartman and Scrivener 1990; Johnston et al. 1990; Larkin and Slaney 1996; Quinn and Peterson 1996; Bradford et al. 2000; Bell 2001; Brakensiek 2002).

Additionally, studies have demonstrated that perturbation of spawning gravels by spawning salmonids loosens cemented (compacted) gravel areas used by spawning salmon (e.g., Montgomery et al. 1996). The act of spawning also coarsens gravel in spawning reaches, removing fine material that blocks interstitial gravel flow and reduces the survival of incubating eggs in egg pockets of redds.

The added spawner density resulting from hatchery-origin fish spawning in the wild can have adverse consequences in that to the extent there is spatial overlap between hatchery and natural spawners, the potential exists for hatchery-derived fish to superimpose or destroy the eggs and embryos of ESA listed species. Redd superimposition has been shown to be a cause of egg loss in pink salmon and other species (e.g., Fukushima et al. 1998).

The analysis also considers the effects from encounters with natural-origin that are incidental to the conduct of broodstock collection. Here, NMFS analyzes effects from sorting, holding, and handling natural-origin fish in the course of broodstock collection. Some programs collect their broodstock from fish volunteering into the hatchery itself, typically into a ladder and holding pond, while others sort through the run at large, usually at a weir, ladder, or sampling facility. , the more a hatchery program accesses the run at large for hatchery broodstock that is, the more fish that are handled or delayed during migration the greater the adverse effect on natural-origin and hatchery-origin fish that are intended to spawn naturally and to ESA-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 collection is conducted, and the encounter rate for ESA-listed fish.

NMFS also analyzes the effects of structures, either temporary or permanent, that are used to collect hatchery broodstock. NMFS analyzes effects on fish, juveniles and adults, from encounters with these structures and effects on habitat conditions that support and promote viable salmonid populations. NMFS wants to know, for example, if the spatial structure, productivity, or abundance of a natural population is affected when fish encounter a structure used for broodstock collection, usually a weir or ladder. NMFS also analyzes changes to riparian habitat, channel morphology and habitat complexity, water flows, and in-stream substrates attributable to the construction/installation, operation, and maintenance of these structures. NMFS also analyzes the effects of structures, either temporary or permanent, that are used to remove hatchery fish from the river or stream and prevent them from spawning naturally, effects on fish, juveniles and adults, from encounters with these structures and effects on habitat conditions that support and promote viable salmonid populations.

2.5.1.1.3 Factor 3. Hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas

NMFS also analyzes the potential for competition, predation, and premature emigration when the progeny of naturally spawning hatchery fish and hatchery releases share 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 fish from the natural population (SIWG 1984). Naturally produced fish may be competitively displaced by hatchery fish early in life, especially when hatchery fish are more numerous, are of equal or greater size, when hatchery fish take up residency before naturally produced fry emerge from redds, and if hatchery fish residualize. Hatchery fish might alter naturally produced salmon behavioral patterns and habitat use, making them more susceptible to predators (Hillman and Mullan 1989; 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 (Hillman and Mullan 1989; 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).

Competition may result from direct interactions, or through indirect means, as when utilization of a limited resource by hatchery fish reduces the amount available for naturally produced fish (SIWG 1984). Specific hazards associated with competitive impacts of hatchery salmonids on listed naturally produced salmonids may include competition for food and rearing sites (NMFS 2012b). In an assessment of the potential ecological impacts of hatchery fish production on naturally produced salmonids, the Species Interaction Work Group (SIWG 1984) concluded that naturally produced coho and Chinook salmon and steelhead are all potentially at “high risk” due to competition (both interspecific and intraspecific) from hatchery fish of any of these three species. In contrast, the risk to naturally produced pink, chum, and sockeye salmon due to competition from hatchery salmon and steelhead was judged to be low.

Several factors influence the risk of competition posed by hatchery releases: whether competition is intra- or interspecific; the duration of freshwater co-occurrence of hatchery and natural-origin fish; relative body sizes of the two groups; prior residence of shared habitat; environmentally induced developmental differences; and, density in shared habitat (Tatara and Berejikian 2012). Intraspecific competition would be expected to be greater than interspecific, and competition would be expected to increase with prolonged freshwater co-occurrence. Although newly released hatchery smolts are commonly larger than natural-origin fish, and larger fish usually are superior competitors, natural-origin fish have the competitive advantage of prior residence when defending territories and resources in shared natural freshwater habitat. Tatara and Berejikian (2012) further reported that hatchery-induced developmental differences from co-occurring natural-origin fish life stages are variable and can favor both hatchery- and natural-origin fish. They concluded that of all factors, fish density of the composite population in relation to habitat carrying capacity likely exerts the greatest influence.

En masse hatchery salmon smolt releases may cause displacement of rearing naturally produced juvenile salmonids from occupied stream areas, leading to abandonment of advantageous feeding stations, or premature out-migration (Pearsons et al. 1994). Pearsons et al. (1994) reported small-scale displacement of juvenile naturally produced rainbow trout from stream sections by hatchery steelhead. Small-scale displacements and agonistic interactions observed between hatchery steelhead and naturally produced juvenile trout were most likely a result of size differences and not something inherently different about hatchery fish.

A proportion of the smolts released from a hatchery may not migrate to the ocean but rather reside for a period of time in the vicinity of the release point. These non-migratory smolts (residuals) may directly compete for food and space with natural-origin juvenile salmonids of similar age. They also may prey on younger, smaller-sized juvenile salmonids. Although this behavior has been studied and observed, most frequently in the case of hatchery steelhead, residualism has been reported as a potential issue for hatchery coho and Chinook salmon as well. Adverse impacts from residual Chinook and coho hatchery salmon on naturally produced salmonids is definitely a consideration, especially given that the number of smolts per release is generally higher, however, the issue of residualism for these species has not been as widely investigated compared to steelhead. Therefore, for all species, monitoring of natural stream areas in the vicinity of hatchery release points may be necessary to determine the significance or potential effects of hatchery smolt residualism on natural-origin juvenile salmonids.

The risk of adverse competitive interactions between hatchery-origin and natural-origin fish can be minimized by:

- Releasing hatchery smolts that are physiologically ready to migrate. Hatchery fish released as smolts emigrate seaward soon after liberation, minimizing the potential for competition with juvenile naturally produced fish in freshwater (Steward and Bjornn 1990; California HSRG 2012).
- Operating hatcheries such that hatchery fish are reared to sufficient size that smoltification occurs in nearly the entire population.
- Releasing hatchery smolts in lower river areas, below areas used for stream-rearing naturally produced juveniles.
- Monitoring the incidence of non-migratory smolts (residuals) after release and adjusting rearing strategies, release location and timing if substantial competition with naturally rearing juveniles is determined likely.

Critical to analyzing competition risk is information on the quality and quantity of spawning and rearing habitat in the action area,[3] including the distribution of spawning and rearing habitat by quality and best estimates for spawning and rearing habitat capacity. Additional important information includes the abundance, distribution, and timing for naturally spawning hatchery fish and natural-origin fish; the timing of emergence; the distribution and estimated abundance for

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[3] "Action area" means all areas to be affected directly or indirectly by the action in which the effects of the action can be meaningfully detected and evaluated.

progeny from both hatchery and natural-origin natural spawners; the abundance, size, distribution, and timing for juvenile hatchery fish in the action area; and the size of hatchery fish relative to co-occurring natural-origin fish.

Another potential ecological effect of hatchery releases is predation. Salmon and steelhead are piscivorous and can prey on other salmon and steelhead. Predation, either direct (direct consumption) or indirect (increases in predation by other predator species due to enhanced attraction), can result from hatchery fish released into the wild. Considered here is predation by hatchery-origin fish and by the progeny of naturally spawning hatchery fish and by avian and other predators attracted to the area by an abundance of hatchery fish. Hatchery fish originating from egg boxes and fish planted as non-migrant fry or fingerlings can prey upon fish from the local natural population during juvenile rearing. Hatchery fish released at a later stage, so they are more likely to emigrate quickly to the ocean, can prey on fry and fingerlings that are encountered during the downstream migration. Some of these hatchery fish do not emigrate and instead take up residence in the stream (residuals) where they can prey on stream-rearing juveniles over a more prolonged period. The progeny of naturally spawning hatchery fish also can prey on fish from a natural population and pose a threat. In general, the threat from predation is greatest when natural populations of salmon and steelhead are at low abundance and when spatial structure is already reduced, when habitat, particularly refuge habitat, is limited, and when environmental conditions favor high visibility.

SIWG (1984) rated most risks associated with predation as unknown, because there was relatively little documentation in the literature of predation interactions in either freshwater or marine areas. More studies are now available, but they are still too sparse to allow many generalizations to be made about risk. Newly released hatchery-origin yearling salmon and steelhead may prey on juvenile fall Chinook and steelhead, and other juvenile salmon in the freshwater and marine environments (Hargreaves and LeBrasseur 1986; Hawkins and Tipping 1999; Pearsons and Fritts 1999). Low predation rates have been reported for released steelhead juveniles (Hawkins and Tipping 1999; Naman and Sharpe 2012). Hatchery steelhead timing and release protocols used widely in the Pacific Northwest were shown to be associated with negligible predation by migrating hatchery steelhead on fall Chinook fry, which had already emigrated or had grown large enough to reduce or eliminate their susceptibility to predation when hatchery steelhead entered the rivers (Sharpe et al. 2008). Hawkins (1998) documented hatchery spring Chinook salmon yearling predation on naturally produced fall Chinook salmon juveniles in the Lewis River. Predation on smaller Chinook salmon was found to be much higher in naturally produced smolts (coho salmon and cutthroat, predominately) than their hatchery counterparts.

Predation may be greatest when large numbers of hatchery smolts encounter newly emerged fry or fingerlings, or when hatchery fish are large relative to naturally produced fish (SIWG 1984). Due to their location in the stream or river, size, and time of emergence, newly emerged salmonid fry are likely to be the most vulnerable to predation. Their vulnerability is believed to be greatest immediately upon emergence from the gravel and then their vulnerability decreases as they move into shallow, shoreline areas (USFWS 1994). Emigration out of important rearing areas and foraging inefficiency of newly released hatchery smolts may reduce the degree of predation on salmonid fry (USFWS 1994).

Reports suggest that hatchery fish can prey on fish that are from 1/3 or less their length (Horner 1978; Hillman and Mullan 1989; Beauchamp 1990; Cannamela 1992; CBFWA 1996) up to 1/2 their length (Pearsons and Fritts 1999; HSRG 2004). Hatchery fish may also be less efficient predators as compared to their natural-origin conspecifics, reducing the potential for predation impacts (Sosiak et al. 1979; Bachman 1984; Olla et al. 1998).

There are several steps that hatchery programs can implement to reduce or avoid the threat of predation:

- Releasing all hatchery fish as actively migrating smolts through volitional release practices so that the fish migrate quickly seaward, limiting the duration of interaction with any co-occurring natural-origin fish downstream of the release site.
- Ensuring that a high proportion of the population have physiologically achieved full smolt status. Juvenile salmon tend to migrate seaward rapidly when fully smolted, limiting the duration of interaction between hatchery fish and naturally produced fish present within, and downstream of, release areas.
- Releasing hatchery smolts in lower river areas near river mouths and below upstream areas used for stream-rearing young-of-the-year naturally produced salmon fry, thereby reducing the likelihood for interaction between the hatchery and naturally produced fish.
- Operating hatchery programs and releases to minimize the potential for residualism.

2.5.1.1.4 Factor 4. Hatchery fish and the progeny of naturally spawning hatchery fish in the migration corridor, in the estuary, and in the ocean

Based on a review of the scientific literature, NMFS' conclusion is that the influence of density-dependent interactions on the growth and survival of salmon and steelhead is likely small compared with the effects of large-scale and regional environmental conditions and, while there is evidence that large-scale hatchery production can affect salmon survival at sea, the degree of effect or level of influence is not yet well understood or predictable. The same thing is true for mainstem rivers and estuaries. NMFS will watch for new research to discern and to measure the frequency, the intensity, and the resulting effect of density-dependent interactions between hatchery and natural-origin fish. In the meantime, NMFS will monitor emerging science and information and will consider that re-initiation of section 7 consultation is required in the event that new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not considered in this consultation (50 CFR 402.16).

2.5.1.1.5 Factor 5. Research, monitoring, and evaluation that exists because of the hatchery program

NMFS also analyzes proposed RM&E for its effects on listed species and on designated critical habitat. Generally speaking, adverse effects to the fish from RM&E are weighed against the value or benefit of new information, particularly information that tests key assumptions and that reduces critical uncertainties. RM&E actions including but not limited to collection and handling (purposeful or inadvertent), holding the fish in captivity, sampling (e.g., the removal of scales and tissues), tagging and fin-clipping, and observation (in-water or from the bank) can cause harmful changes in behavior and reduced survival. These effects should not be confused with handling effects analyzed under broodstock collection. In addition, NMFS also considers the overall effectiveness of the RM&E program. There are five factors that NMFS takes into account when it assesses the beneficial and adverse effects of hatchery RM&E: (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, the effects on ESA-listed species, and cost.

Hatchery actions also must be assessed for masking effects. For these purposes, masking is when hatchery fish included in the Proposed Action mix with and are not identifiable from other fish. The effect of masking is that it undermines and confuses RM&E and status and trends monitoring. Both adult and juvenile hatchery fish can have masking effects. 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 takes into account the role of the affected salmon and steelhead population(s) in recovery and whether unidentifiable hatchery fish compromise important RM&E.

2.5.1.1.6 Factor 6. Construction, operation, and maintenance, of facilities that exist because of the hatchery program

The construction/installation, operation, and maintenance of hatchery facilities can alter fish behavior and can injure or kill eggs, juveniles and adults. It can also degrade habitat function and reduce or block access to spawning and rearing habitats altogether. Here, NMFS analyzes changes to riparian habitat, channel morphology and habitat complexity, in-stream substrates, and water quantity and water quality attributable to operation, maintenance, and construction activities and confirms whether water diversions and fish passage facilities are constructed and operated consistent with NMFS criteria.

2.5.1.1.7 Factor 7. Fisheries that exist because of the hatchery program

There are two aspects of fisheries that are potentially relevant to NMFS' analysis of HGMP effects in a section 7 consultation. One is where there are fisheries that exist because of the HGMP (i.e., the fishery exists as a consequence[4] of the program) and listed species are

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[4] 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

inadvertently and incidentally taken in those fisheries. The other is when fisheries are used as a tool to prevent the hatchery fish associated with the HGMP, including hatchery fish included in an ESA-listed ESU or steelhead DPS, from spawning naturally. Policy on the consideration of hatchery-origin fish in Endangered Species Act listing determinations includes the opportunity for harvest when hatchery programs are capable of producing more fish than are immediately useful in the conservation and recovery of an ESU and can play an important role in fulfilling trust and treaty obligations with regard to harvest of some Pacific salmon and steelhead populations. "For ESUs listed as threatened, NMFS will, where appropriate, exercise its authority under section 4(d) of the ESA to allow the harvest of listed hatchery fish that are surplus to the conservation and recovery needs of the ESU, in accordance with approved harvest plans" (NMFS 2005b). In any event, fisheries must be strictly regulated based on the take, including catch and release effects, of ESA-listed species.

2.5.2 Effects of the Russian River Coho Salmon Captive Broodstock Program and Accompanying HGMP

The proposed action utilizes local fish - fish sourced from either the populations they are released to, or from nearby populations within the same diversity strata within the ESU, for the purposes of reintroduction because the target population has become as small as to be considered extirpated or nearly so. Therefore, an analysis of effects for the proposed action would range from beneficial to adverse as discussed in Section 2.5.1. Analysis of the Proposed Action utilizing the seven factors discussed in the previous section identified effects ranging from beneficial, negligible and adverse effects on the populations of CCC coho salmon and factors that will cause adverse effects to individual CC Chinook salmon, CCC steelhead, and NC steelhead (Table 4).

Table 4. A summary of the effects of the CCC coho broodstock program (Program) on CC Chinook salmon, CCC coho salmon, CCC steelhead and NC steelhead individuals, populations and their designated critical habitat. The framework NMFS followed for analyzing effects of the hatchery program is described in Section 2.51 of this opinion above.

Factor	Range in Potential Effects for this Factor	Analysis of Program Effects for each Factor		
		Beneficial	**Negligible**	**Adverse**
Degree that the hatchery program affects the conservation of genetic resources that represent the ecological and genetic diversity of a salmon ESU or steelhead DPS	Beneficial to adverse effect	The Program proposes a strategy to increase genetic diversity and reproductive success by incorporating wild fish into broodstock sources, and to minimize inbreeding by implementing a spawning matrix informed by genetic analysis. Long term improvements in abundance and spatial diversity of many populations.		Collection of broodstock could affect small populations of ESA salmonids via temporarily reducing abundance in tributary streams.
Hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities	Beneficial to adverse effect	Increases in overall abundance of CCC adult coho salmon; ecological benefits via hatchery adults contributing marine-derived nutrients to the system.		Potential loss of reproductive success due to high numbers of hatchery origin fish spawning with natural origin fish.
Hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas	Beneficial to adverse effect	Improvements to juvenile abundance, and spatial diversity are expected from Program fish releases.	Though program fry and fingerling size juveniles are released in tributary reaches, density dependent effects are not likely due to low numbers of ESA listed salmonids.	Competition with natural origin salmonids and predation upon young-of-the year CCC coho salmon, CC Chinook salmon, CCC and NC steelhead in the action area; domestication of juveniles.

Factor	Range in Potential Effects for this Factor	Analysis of Program Effects for each Factor		
		Beneficial	Negligible	Adverse
Hatchery fish and the progeny of naturally spawning hatchery fish in the migration corridor, estuary, and ocean	Negligible effect		Potential for predation, competition in the migration corridor and estuary and ocean is low; density dependent effects are not likely due to low numbers of ESA listed salmonids.	
RM&E that exists because of the hatchery program	Beneficial to adverse effect	The information provided by M&E will inform adaptive management that will benefit the survival of the CCC coho salmon population and minimize effects to other ESA listed salmonids.		Potential for lethal or sub-lethal effects to ESA listed salmonids during M&E operations, does exist, but are minimized and avoided with the M&E operations as proposed.
Construction, operation, and maintenance of facilities that exist because of the hatchery program	Negligible effect		No new construction is proposed. Except for the fish ladder entrance and water diversion, facilities are located away from the river and do not affect designated critical habitat. There is no hatchery weir.	
Fisheries that exist because of the hatchery program	Not Applicable	Fisheries are not proposed as part of the Proposed Action and there are no fisheries that exist because of the Proposed Action.		

2.5.2.1 Factor 1. The degree to which the hatchery program affects the conservation of genetic resources that represent the ecological and genetic diversity of a salmon ESU or steelhead DPS

Beneficial and Adverse Effects: The Proposed Action is a conservation program which collects natural origin juveniles from several populations in the wild, returning hatchery adults from the ocean released as juveniles, and utilizes offspring (F1) produced from the spawning matrix of various populations, as the source for broodstock. A beneficial effect is expected from the implementation of the proposed spawning matrix, and has been verified by improvements to reproductive success. Approximately 50% of the broodstock are collected as wild juveniles, which could have a short-term adverse effect on the existing wild population.

2.5.2.1.1 Adult Spawning and Broodstock Sources/Utilization in the Hatchery

The Program proposes a strategy to increase genetic diversity and to minimize inbreeding by implementing a spawning matrix informed by genetic analysis. These efforts are in cooperation with the NOAA SWFSC. Genetic analysis is conducted for all broodstock reared to adulthood, and a genetic spawning matrix is developed to minimize effects of inbreeding. The spawning matrix provides a ranked list of potential male breeding partners for each female broodstock. The ranking is based on the relatedness coefficient (Rxy; Queller and Goodnight 1989) between each male and female broodstock, with pairings at the top of the list resulting in the lowest value of relatedness (Rxy). To minimize inbreeding, pairings between two individuals that are related at the level that is slightly above that of first cousins (Rxy ≥ 0.10) is decreased by placing related individuals towards the bottom of the list to reduce or excluded them from spawning.

The HGMP (CDFW and USACE 2017) reports inbreeding as a primary influence for reducing survival of progeny at the captive broodstock facility (Conrad et al. 2013). As a further minimization to reduce inbreeding beyond the implementation of the current spawning matrix, the Program currently incorporates 25 percent of its total matings from stock outside of the Russian River (program goal is 50% wild broodstock). CDFW and USACE (2017) states that inbreeding depression is best countered by incorporating natural origin individuals into the broodstock program (Garza, personal communication 2012 as cited in CDFW and USACE 2017). By incorporating 25 percent of Lagunitas/Olema Creek fish in matings, along with 25 percent Russian River, the Program seeks to decrease inbreeding depression, increase heterozygosity and provide hybrid vigor to coho salmon reared in the facility. In summary, while there is a potential for inbreeding depression, the long-term benefit of improved genetic diversity to the population and improved abundance to the ESU overall far outweigh this potential effect. The remaining source of broodstock (currently approximately 75%) has relied upon the propagation of fish within the facility (F1 offspring) which are reared to adults, spawned and incorporated into the annual matrix. Smolt releases from Dry Creek (10,000 annually reared via funding from Sonoma Water Agency as an RPM requirement of the RR BiOp (NMFS 2008), were intended to provide a source of ocean returning adults to the hatchery for broodstock, however, only several adults return annually to the facility.

The California HSRG (2012) standard for broodstock management for hatcheries in California recommends that pNOB approach 100% for conservation programs, but collection of broodstock levels should not be so high they pose demographic risk to the natural population. Increasing pNOB for this Program is done through the collection of natural origin broodstock at the juvenile lifestage and rearing them to adults where some can be released to spawn in the wild, or spawned to provide fish for hatchery rearing and release. Over the past 5 years pNOB for this facility has averaged about 18 percent for 2013/14 to 2017/18 brood years, but reached a pNOB as high as 24 percent for brood years 2010/11 and 2013/14 (CDFW and USACE 2017). The Program proposes a performance standard of pNOB greater than 50 percent to increase fitness of the integrated population.

2.5.2.1.1 Collection of Juveniles for Broodstock

There are potential effects of physical collection of hatchery broodstock from streams within the action area. Collection of natural origin broodstock can injure or kill juvenile ESA-listed species during stream collection, transportation, and subsequent rearing to maturity.

The collection of up to 1,500 juveniles from coho streams in the action area is expected to result in direct adverse effects or mortality of target CCC coho salmon, and indirect adverse effects to non-target CC Chinook salmon, CCC steelhead and NC steelhead that may be encountered during these activities. Non-target fish collection, handling and relocation activities may injure or kill rearing juvenile salmon and steelhead because of the associated risk that collecting poses to fish, including stress, disease transmission, injury, or death (Hayes 1983). The amount of injury and mortality attributable to fish capture varies widely depending on the method used, the ambient conditions, and the expertise and experience of the field crew. The effects of seining and dip-netting on non-target juvenile salmonids include stress, scale loss, physical damage, suffocation, and desiccation. Electrofishing can kill juvenile salmonids, and researchers have found serious sublethal effects including spinal injuries (Nielsen 1998, Nordwall 1999). Captured fish can also be lost during the stress of transportation and transfer to the facility, though injuries incurred during capture likely account for the majority of any post-capture mortality.

Specific collection methods have been developed to minimize the adverse effects of capture, and handling young-of-the year fish. Very few individual coho salmon are likely to be lost during transport activities due to measures such as tanks with cooling equipment, and high efficient coolers for transport of small numbers of juvenile fish. Based on past collection and protocols to be used, unintentional mortality of listed target and non-target juvenile steelhead and salmon from capture and handling is not expected to exceed 5 percent of the fish subjected to handling, and transport to the hatchery. This can be reduced to near one percent with increased skill and experience of crews collecting and transporting fish. Though the HGMP (CDFW and USACE 2017) reports very few juvenile coho salmon have been collected for broodstock since 2003, proposed collections will increase with time, with up to 50 percent (or more) of broodstock consisting from natural origin fish (up to 1500 total per year). Coho salmon juvenile monitoring for the project area, reports summer electrofishing mortality from 2005-2015 as 1.5 percent on average (Obedzinski 2014). We expect that similar mortalities of 2 percent or less per year will occur during broodstock collection activities that will be permitted through the year 2028.

Potential adverse effects to a population from wild juvenile coho salmon collected is expected to be minimized by measures to limit the numbers of juvenile fish collected to reduce the potential for adverse effects to the entire population. Limitations on number of juveniles to be collected in each watershed, stream, and habitat are proposed to minimize the effects such that only small numbers of natural origin fish are collected from the entire population. Additionally, broodstock collection efforts will include target areas where coho salmon are rescued from areas where reduced flows cause potential stranding and mortality.

In addition to physical effects from broodstock collection, there is the potential for adverse effects to populations that are at extremely low levels. For example, the removal of adults from a naturally-spawning population has the potential to reduce the size of the natural population, cause selection effects, and remove nutrients from upstream reaches (Spence et al. 1996). However, these effects are expected to be minimal because nearly all the collection of natural origin broodstock for this program will be at the juvenile life stage, which are available in comparably high numbers with respect to numbers of adults. Only small numbers of adults that do return to DCFH have been collected for broodstock to date. While the proposed action includes utilizing up to 25% of DCFH returning adults be held prior to being assessed and utilized for spawners, these fish are largely those offspring released previously as program smolts.

In summary, the benefit of collecting broodstock for the Program activities outweighs the likelihood that source populations will be "mined" and cause further loss of population viability, or spatial structure. While these activities are likely to cause some direct and indirect mortality of ESA listed salmon and steelhead, these losses are expected to be minimal given the experience of biologists, and measures employed to minimize and avoid adverse effects.

2.5.2.2 Factor 2. Hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities

Adverse and beneficial effects: Potential loss of reproductive success due to high numbers of hatchery origin fish spawning with natural origin fish is likely to result in an adverse effect in the short term over several generations. However, minimization measures to include genetic conservation and management strategies, release protocols, and improved abundance, spatial distribution and improved genetic diversity is likely to outweigh this impact in the long term over many generations.

2.5.2.2.1 Adult Hatchery Fish Spawning in the Wild

Hatchery-influenced selection (often called domestication effects) associated with hatchery adults spawning in the wild are described above in Factor 2, in Section 2.5.1.1.2.

The program is expected to release up to 600 adults annually to target streams for reintroduction and supplementation purposes. Direct reintroduction of adult hatchery spawners into specific extirpated tributaries (e.g., Salmon and Walker creeks), and increased abundance of adult fish from Program stocked as juveniles (e.g., To the Russian River) is expected to result in improving abundance, spatial distribution, and connectivity between populations within the ESU. However, if straying occurs to adjoining populations, adverse effects (reductions) to reproductive success due to high percentages of hatchery spawners is a potential risk. For integrated hatchery programs, some returning hatchery-origin fish are expected to spawn with each other, and with natural-origin fish, and their progeny may be incorporated into the hatchery broodstock when captured from the wild as juveniles or when returning to the hatchery as adults. When hatchery-origin fish spawn with each other in natural areas, domestication and other effects may generally reduce the mean level of fitness of the naturally-spawning population; recruits per spawner will be less than if the naturally-spawning population included no hatchery-origin fish (California HSRG 2012). Minimization measures include ongoing genetic management to select the highest diverse potential mate pairings/lots for release and multiple releases in space and time, timed with the natural occurring runs are expected minimize the potential for closely related hatchery fish spawning together in natural areas.

An HSRG team review of California hatchery programs developed guidelines that recommended that program-specific plans be developed with corresponding population specific targets and thresholds for *proportion of effective hatchery fish origin spawners* (pHOS), *proportion of natural-origin fish in the broodstock* (pNOB), and the effective proportion of hatchery-origin fish in the naturally spawning population (PNI) that reflect these factors. The California HSRG (2012) further states that for conservation-oriented programs that are involved in reintroduction or supplementation efforts, acceptable pHOS may be much higher than 30 percent in order to meet appropriate PNI values for integrated populations. Although specific pHOS percentages for this program are not reported in the HGMP, pHOS is likely greater than recommended in recent hatchery guidance documents, because the fish being released are from a conservation type program which minimizes many of the hatchery related effects that might otherwise occur (California HSRG 2012, HSRG 2014).

Monitoring of spawning for lower Russian River tributaries from 2011 to 2013 shows that pHOS is currently high, which is expected in the early years of this type of preservation and recolonization program. Numbers of returning adults in Program streams has been relatively low (500 adult fish), therefore, information on percent natural origin and percent hatchery fish should be taken with caution. Monitoring since 2006 indicates that the 2012/13 spawning year had the highest proportion of natural origin fish at 19 percent. Video monitoring information collected at the Wohler Dam (lower Russian River) has documented about 80 to 90 percent of the adult coho salmon passing this facility as hatchery origin fish (CDFW and USACE 2017). While high pHOS may be considered acceptable during the early phases of conservation broodstock programs that operate to prevent local extirpation and recolonize population areas, measures to reduce pHOS (such as reducing total hatchery production, or reduce stocking of specific populations, or tributaries where pHOS is high) are included in the Section 10(a)(1)(A) permit to require evaluation by the TAC as recolonization or generational targets are approached.

The influence of the high percentage of hatchery spawners will likely lead to some loss of reproductive success due to reduced fitness from rearing in captivity. Christie et al. (2014)

reports that hatcheries that that use broodstock collected from the wild have fitness values much closer to those of natural origin fish. To some extent, the Program minimizes these effects by collecting broodstock from the wild, but relative reproductive success, or a reduction in offspring compared to fish that are spawned in the wild (Christie et al. 2014) over generations of stocking will likely continue. Loss in reproductive success due to captive hatchery rearing will be an ongoing unavoidable adverse effect of the Program. These effects will be minimized by using broodstock collected from the wild, with the performance standard of greater than 50 percent pNOB proposed to improve the proportionate natural influence of the wild environment on the population. Even with the performance standard of greater than 50 percent pNOB for the Program, the proportion of adult hatchery fish on spawning grounds (pHOS) is expected to remain high which will continue to reduce the percent natural influence for this population. While HSRG guidelines do recognize that hatcheries which artificial propagation are providing a "life support" function to prevent functional expiration of a specific population which may be desirable for both genetic and demographic reasons (HRSG 2004), artificial stocking should taper off and cease when recolonization targets are reached.

While potential risks exist as described above, minimization measures within the 10(a)(1)(A) permit include ongoing genetic management to select the highest diverse potential mate pairings/lots for release, and multiple smaller releases in space and time, timed with the natural occurring runs will minimize the potential for straying, and the potential loss in fitness in adjacent populations. Additionally, large ratios of returning hatchery spawners are recognized as an exception to the HSRG guidelines and are justified due to the prevention of extirpation and conservation benefits across the ESU. Ongoing genetic management in the conservation program provides a benefit to genetic diversity within each stocked population, which would not otherwise occur in these populations experiencing small populations and stochastic decline without hatchery supplementation in this case.

2.5.2.2.2 Ecological Effects

Ecological effects for this factor (i.e., hatchery fish and the progeny of naturally spawning hatchery fish on the spawning grounds) refer to effects from competition between individuals for spawning sites and redd superimposition by multiple individuals, 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; Piorkowski 1995). As a result, the growth and survival of juvenile salmonids may increase (Holtby 1988). In addition to the fish released by the program that will provide carcasses to the action area, the Program proposes to place post-spawned carcasses into action area streams to improve marine derived nutrient levels. The placement of carcasses by the Program is a beneficial effect to stream reaches that currently have minimal marine derived nutrients due to low returns of adult CCC coho salmon and other ESA listed salmonids.

2.5.2.3 Factor 3. Hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas

Beneficial and Adverse effects: Improvements to overall abundance and spatial diversity within the Action Area is a benefit. Adverse effects expected when hatchery released juveniles and smolts compete with natural origin salmonids and may prey upon young-of-the year CCC coho salmon, CC Chinook salmon, CCC and NC steelhead in the action area. Adverse effects also expected from domestication of juveniles.

2.5.2.3.1 Release of Unfed Fry

The Program may release up to 250,000 (newly hatched) fry, or may utilize incubating systems to have fry enter into target streams volitionally from on-stream hatching systems (e.g., remote site incubators or RSI's). These fry will be less exposed to effects of domestication from hatchery rearing. Stocking densities are calculated from habitat surveys described below, and targeted release areas would be monitored to determine that carrying capacity has not been reached. This will ensure fry will have relatively low natural density-dependent interactions when they enter streams in the spring of each year. Interactions with Chinook salmon and steelhead are expected to occur with partitioning of habitat occurring with species preference. Generally, competition is expected to be minimal because target streams currently have low abundance and low densities within pool and riffle habitats, which would allow additional fry to occupy these habitats when released. Early imprinting during hatching, volitional release as fry, and acclimation and imprinting as smolts are benefits of this release strategy. Though higher mortality is expected at this release size, reduced domestication and greater fitness may be benefits which may result in higher SAR overall. This is an area of research, which will be continued for the program.

2.5.2.3.2 Release of Juveniles

The program may release up to 250,000 juveniles, and as many as 60,000 pre-smolt and smolt sizes. Release of various sizes of juveniles and smolts from the Program into Dry Creek and other target streams in action area is intended to have beneficial effects through improving overall abundance and spatial diversity within the Action Area. However, hatchery releases can have adverse effects, including direct competition or predation with natural-origin juveniles. The Program proposes to minimize competition effects by using a habitat capacity model that uses desired fish density and available habitat estimated from CDFW stream survey data to determine the number of fish released at a given location (CDFW and USACE 2017). Release streams are known to have low baseline densities of fry and fingerling juvenile salmonids which is expected to result in minimal competitive interaction between hatchery and natural origin released coho salmon. As natural origin coho salmon, Chinook salmon and steelhead emerge from redd locations in release streams, Program released YOY coho salmon are expected to have adequate space to occupy unused habitat.

Dry Creek is likely to have much higher densities of juveniles compared to other release streams due to the relatively high numbers of natural origin Chinook salmon spawners and hatchery steelhead spawning that occurs between the hatchery and the confluence with the Russian River. However, monitoring of spring-released coho smolts into target areas has shown that these fish migrate out of the system within a few days (Obedzinski 2015). The relatively short residence time of coho smolts likely minimizes competition for available habitat in Dry Creek.

In other Program tributaries, some predation is expected to occur as smolts migrate from streams where they have been released. Tabor et al. (2004) examined 526 coho salmon smolts and found only three juvenile Chinook salmon were consumed by the larger smolts (greater than 105 mm in length). Program smolts have been generally released in the range of 100 to 120 mm (Obedzinski 2017) though program smolts may reach 150 mm which are of sufficient size to prey upon natural origin salmonid fry. Chinook and coho salmon fry and steelhead fry will be exposed to predation as these yearling hatchery coho salmon smolts migrate to the ocean. Many of YOY fry may be less vulnerable as they occupy shallow edge water habitat where smolts are unlikely to forage (Hawkins 1998).

To assess risk of predation and competition, an estimate using the PCDRISK model developed by the Washington State Department of Fish and Wildlife was run to develop qualitative estimates of the predation and competition (i.e., ecological) risks hatchery coho salmon pose to naturally produced coho salmon. The analysis was conducted because quantitative data on ecological risk were not available for the Program. The data for the analysis was pieced together from primarily CMP juvenile trapping efforts conducted in Dry Creek and the mainstem Russian River at Mirabel. Many of the assumptions used in modeling are speculative. Therefore, the results of this modeling should be considered an index of ecological risk the program poses to ESA listed Salmonids in the Russian River.

This model results indicate that Program coho salmon induced adverse effects on natural origin coho salmon from predation and competition is likely less than 10 percent of the natural origin coho salmon population (K. Malone email communication 11-19-18). We expect that adverse effects to YOY Chinook salmon will be much lower than 10 percent threshold because they reside in larger tributaries and the mainstem river that would reduce their exposure to released Program coho salmon smolts. Steelhead generally occupy similar habitat in small tributary streams across the action area, therefore, we use the PCDRISK that was estimated for coho salmon of up to 10 percent of the population adversely affected by Program released coho salmon. Young of the year steelhead (25-50mm) are the only age class of steelhead that are expected to be adversely affected by hatchery smolts. The loss of a low percentage YOY steelhead in Program release streams is not expected to result in a change in the number steelhead that would survive to the next age class across action area, due to habitat carrying capacity during the summer that is generally accepted as the limiting factor for these streams.

There are steps that can be taken to reduce or avoid the threat of predation by hatchery released fish. Section 2.5.1.1.3 describes the steps that have been recommended by the California HSRG (2012) to reduce predation. These steps include release strategies that minimize duration of interaction of release fish and natural origin fish, releasing smolts when they are physiologically ready to migrate rapidly, and the release of smolts and pre-smolts to mainstem river and larger tributary areas to avoid overlap with salmonid fry. These minimization strategies are included in the 10(a)(1)(A) permit for the program, and are expected to reduce the interaction of Program smolts by coordinating releases with environmental conditions to reduce predation and other interactions with natural origin salmonids.

2.5.2.3.3 Domestication Effects on Released Program Fish

NMFS (2008c) summarizes the reduced survival of hatchery-released fish associated with hatchery fish foraging behavior, habitat preference, social behavior, morphological and physiological differences, and reproductive behavior. They respond to food, habitat, conspecifics, and predators in a different manner than do fish reared in natural environments NMFS (2008c). Studies that are more recent suggest that captive rearing may adversely affect osmoregulation and swimming performance that reduces survival of released fish in the wild. Luyer et al. (2017) studied genetic variation and methylation in hatchery reared and natural origin coho salmon. The results suggest that the hatchery environment induces epigenetic[5] modifications induced by hatchery rearing (Luyer et al. 2017). Certain genes are less expressed (downregulated) for important functions associated with ion homeostasis, synaptic and neuromuscular regulation, immune and stress response, as well as swimming functions. In summary, hatcheries induce heritable changes in gene expression, such that the different responses to food, predators, etc. are passed down to subsequent generations.

Coho salmon juveniles reared to various sizes are expected to be affected by domestication selection from Program hatchery rearing environment. Five-hundred-thousand coho salmon per brood year are produced, of which 250,000 may be released as fry, fertilized eggs for on-stream incubators, and 250,000 reared in the facility to juveniles, and up to 60,000 pre-smolt and smolt sizes. In general, the shorter time fish spend in the hatchery, the less likely they are to experience domestication or selection from the artificial environment. For example, the unfed fry and fry released from streamside incubators are not expected to experience domestication selection effects due to their post emergence volitional release.

Juveniles reared in the hatchery environment are likely to experience reduced fitness from domestication, which will likely result in lower *smolt to adult returns* (SARs). Monitoring reported in Obedzinski et al. (2017) of SAR averaged 0.19 percent for the Program from 2007 to 2015. The SARs for the Program are much reduced compared to those reported (Gallagher and Wright 2011) for wild fish SARs in four coastal Mendocino County streams (within the CCC coho salmon ESU) from 2001 to 2011, which averaged 4 percent. The Program has worked to improved its SARs over a ten-tear period by improving husbandry practices, increasing the number of juveniles produced, the use of systematic outbreeding to improve fitness, and initiating a pit-tagging program to monitor survival. Smolts released directly to Dry Creek have returned at a higher rate with SARs of 0.39 to .72 percent from 2012 to 2014 (CDFW and USACE 2017), though this is still below the target of 1-2 percent. Increasing smolt size to 150 mm is included as a special condition of the 10(a)(1)(A) permit to improve program SAR.

Additionally, passage in Dry Creek via several fish ladders that were installed at grade control structures by USACE, should be monitored and improved if passage is shown to be an issue at

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[5] Changes in gene expression arising from chemical modification of DNA

lower flows (80-120 CFS). If the Program can meet the performance standard, this would indicate that domestication effects may have been minimized. We acknowledge that many factors can affect the smolt to adult return, but given the fact that SAR return information suggests that Program fish are less fit, the effects of hatchery rearing is expected to result in some reduction in SAR over the permit period.

2.5.2.4 Factor 4. Hatchery fish and the progeny of naturally spawning hatchery fish in the migration corridor, estuary, and ocean

Negligible effect: Proposed Action may cause density-dependent effects on ESA-listed species in the mainstem Russian River, in the estuary, or in the Pacific Ocean, however, given the large space these fish migrate through, we expect low prey/predator interactions, and negligible effects.

Release of hatchery-reared coho salmon has the potential to impact ESA-listed salmonids in the migration corridor, estuary or ocean. Monitoring studies in four broodstock Program streams show thousands of smolts leaving the tributaries and moving into the mainstem Russian River (Obedzinski 2015). Smolt movement occurs from late winter in February to early June and coincides with changing hydrologic conditions in the mainstem river. Little information exists regarding the carrying capacity of salmon in the mainstem Russian River, its estuary and areas of the Pacific Ocean that will be utilized by hatchery fish. There is little definitive information available to directly address the effects of ecological factors on survival and growth in natural populations of Pacific salmon, thus, many of the ecological consequences of releasing hatchery fish into the wild are unknown.

The lower Russian River and estuary provides a large migration corridor for Program hatchery smolts and natural origin salmonids to migrate during the late winter and spring months. During most water years, Russian River flows in the migration corridor and the estuary provide sufficient flows (>500cfs) to allow the passage of both Program and natural origin smolts to the ocean environment. Given that salmonid populations are currently listed due to reduced abundance, and that Program release levels are far below estimated stream capacity, it is unlikely that density-dependent mechanisms would be at play for these larger waterbodies. Thus, exposure of ESA listed YOY to predation by Program smolts in the larger estuary and ocean environment is considered low and minimal predation and competition is expected to as Program smolts move through the lower mainstem Russian and estuary.

2.5.2.5 Factor 5. Research, monitoring, and evaluation that exists because of the hatchery program

Beneficial and Adverse effects: The Proposed Action addresses the five factors that NMFS takes into account when analyzing and weighing the beneficial and adverse effects of hatchery M&E (Section 2.5.1. Research, monitoring, and evaluation). Benefits include how the M&E proposes to assess the Program and compliance with the proposed permit and inform future decisions over how the hatchery program can make adjustments that further improve survival and reduce risks to ESA-listed salmonids. Adverse effects include the potential for lethal or sub-lethal effects to

ESA listed salmonids during M&E operations, but are minimized and avoided with the M&E operations as proposed.

2.5.2.5.1 Effects of Program Monitoring

Currently, annual monitoring is funded by USACE[6] and carried out in a minimum of four Russian River tributaries utilized as an Index to guide stocking strategies and inform survival and return of various lifestages. Monitoring is also conducted by Program partners in other action area streams identified in Figure 2 and 3 above as needed. The HGMP proposes to identify, evaluate and guide monitoring needs through the TAC, which will evaluate the streams, or composition of streams needed for implementation of performance metrics of the program. Additional streams in the Navarro Point to Gualala Point Diversity strata will be evaluated by the TAC for stocking and have similar field monitoring (currently via CDFW CMP program) to evaluate Program actions in streams such as Navarro, and Garcia Rivers. Should additional streams be added to the Program for stocking (e.g., Gualala River), a Program TAC will guide monitoring efforts similar to other Program protocols.

Monitoring and evaluation programs can also have adverse effects due to trapping and handling required to conduct activities. Proposed downstream migrant trapping will collect and enumerate fish by species and release the majority of captured fish downstream. Not all fish will be anesthetized or marked, but handling can cause some injury or death as fish can be inadvertently crushed during this monitoring. Salmonids can also be killed in traps when they are in live cars from flow velocity within the trap and can be preyed upon by larger salmonids in the live car trap. A portion of trapped fish will be anesthetized, measured and collect genetic samples prior to release.

Minimization measures such as frequent checking of traps and operation by qualified personnel is expected to minimize mortality at outmigration trapping sites. Operation of these traps on Dutch Bill, Green Valley, Mill, and Willow creeks since 2005 shows that thousands of YOY tie to each spring. Indirect mortality at these traps averages approximately 2 percent for each of the four trapping sites.

Summer electrofishing surveys are conducted to determine presence of Program fish and collect genetic samples. Electrofishing effects are described above in Section 2.5.2.1.2 (Collection of Broodstock). Mortality of a small percentage of fish is expected from these activities, which generally is approximately 1 to 2 percent of the fish captured and handled. Impacts are minimized by following NMFS 2000 Electrofishing Guidelines that help reduce mortality, injury and stress to ESA listed juveniles during this sampling. The Program also minimized impacts of this summer sampling by allowing only experienced staff (> 100 hours of electrofishing experience) to lead field crews.

Winter spawning surveys and PIT tag detection systems will be used to estimate the number of returning adult coho salmon. These surveys are not expected to cause adverse effects as no

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[6] Hatchery evaluation monitoring is a RPM of the 2008 Russian River Biological Opinion, which requires the Corps to fund annual monitoring in a minimum of 4 Index streams until 2023

capture or handling of live fish is proposed. Adult fish including coho salmon, Chinook salmon and steelhead could be temporarily disturbed by survey crews. Adult fish are expected to return to spawning activities within a short period of survey crews exiting the stream reach. Only salmonid carcasses will be counted and scanned for coded wire tags, DNA samples, and global positioning system location data, therefore, no live adult salmonids will be adversely affected by these surveys.

In summary, Program M&E is currently a requirement of USACE for operation of the program until 2023, and the 10(a)(1)(A) requires continuation of funding and monitoring to continue through the life of the permit (until 2023).

2.5.2.6 Factor 6. Construction, operation, and maintenance of facilities that exist because of the hatchery program

Negligible effect and adverse effects: Operations, maintenance, and construction activities included in the Proposed Action will have a negligible effect on ESA-listed salmon and steelhead and their designated critical habitat.

The existing physical facility is co-located with the Don Clausen Warm Springs Fish Hatchery located at the base of Warm Springs Dam, where the regulated flow reach of Dry Creek begins. No additional construction is proposed beyond improved capacity of incubation and fry troughs that will be within the existing building. The operation does result in additional effluent from water that is pumped to the Program building and after use flows to DCFH stilling ponds. This additional effluent has not resulted in water quality changes that would adversely affect ESA listed salmon or steelhead in the receiving waters of Dry Creek. Operation of the Program since 2001 has not resulted in the failure of DCFH to comply with water quality standards the existing National Pollution Discharge Permit (NPDES) permit (E. McKenna, personal communication 2019). Flows from the coho salmon building range from three to five cubic feet per second and represent a small fraction of the total flow entering the stilling basin at the DCFH. Streamside acclimation tanks and RSI units are also operated remotely, which provide either pumped or gravity delivered flow from the adjacent stream. These operations have a small footprint relative to the size of stream, and timing of flows when they are operated and ensure a negligible effect.

2.5.2.6.1 Fish Health Management

This Program has developed a Fish Health Management Plan that is included as part of the HGMP. Overall, the Program follows the guidelines set forth in the California Hatchery Scientific Review Group (California HSRG 2012). The plan includes provisions for inspections by fish pathologists and veterinarians, broodstock inspections, hatchery sanitation procedures, water quality parameters etc. Fish health management for this Program closely follows the recommendations of the California HSRG (2012); no adverse effects have been identified for fish health management associated with facilities.

2.5.2.6.2 Disposition of Hatchery Adults

Carcasses arising from hatchery mortalities and spawned fish can be placed into Russian River tributaries and other regional streams (e.g., Salmon Creek) to provide nutrient loading. A small number of adult carcasses are also provided to the AmeriCorps and other entities for educational purposes (e.g., classroom dissections). Marine-derived nutrients provided to regional streams from decaying hatchery adult carcasses would benefit natural productivity in the watershed, improving growth and survival rearing conditions for natural-origin salmon and steelhead in the action area (Bilby et al.1996). Salmon carcass analogs can also be utilized to supplement streams to provide nutrients for rearing hatchery fish. The program should/will follow guidelines for carcass distribution and nutrient enrichment developed by the State of Washington (HSRG 2004).

2.5.2.6.3 Catastrophic Risk Management

The HGMP for this Program includes catastrophic risk management protocols designed to reduce the risk of injury and mortality of listed salmon associated with hatchery operation. Inclusion of these protocols in the proposed plan for the steelhead facility addresses the need to operate the program for the species in a manner that adequately safeguards listed fish while under propagation. The HGMP describes available back-up water supply systems and risk aversion measures that would be applied at the coho facility to minimize the likelihood for listed coho salmon mortalities resulting from equipment failure, water loss from power failure, vandalism, and flooding.

2.5.2.6.4 Hatchery Fish Rearing Operations

Hatchery operations are expected to have some level of mortality associated with egg development, and juvenile rearing within the hatchery environment. Based on hatchery data since 2003, egg-to-release survival (including fingerlings, advanced fingerlings, yearlings, and smolts) has averaged 34.9% for the years 2003-2015, ranging from 6% in 2003 to 52% in 2013 (USACE and DFW 2017). By far the greatest mortality from hatchery operations comes at the eyed egg to hatch lifestage with as much as 50 percent loss occurring in some years (B. White, personal communication 2019). Ongoing genetic management is expected to improve upon survival and will be a requirement for operation of the program.

Performance indicator proposed for egg to age one juvenile is equal to or greater than 40 percent, which is generally expected to be met during the period of the permit. One year old to adult brood performance indicator is proposed at equal to or greater than 85 percent. Based on hatchery records for all release years, fry-to-juvenile release survival at the hatchery for both natural-origin and hatchery-origin Coho Salmon is estimated at > 90% (B. White, personal communication 2019). For broodstock rearing of fish from age one to adulthood the average incidental mortality is 13 percent. Measures to minimize incidental losses from hatchery rearing include disinfection of equipment, general fish health maintenance and sanitation procedures, feeding practices, and “natural “rearing methods (DFW and USACE 2017). “Natural” rearing methods implement low density rearing, shaded ponds, and integration of krill when fish reach age two to improve reproductive success of eggs from these adults.

2.5.2.7 Factor 7. Fisheries that exist because of the hatchery program

There are no fisheries-related effects associated with the Proposed Action. Some adult Program fish returning to spawn are caught and released, according to state regulations during the existing steelhead sport fisheries in the Russian River. The effects to program coho salmon from the steelhead fishery are being addressed in a separate HGMP for the Russian River Steelhead Program (expected completion 2020).

2.5.3 Effects of the Action on Critical Habitat

The action area for this biological opinion includes designated critical habitat for CCC coho salmon, CC Chinook salmon, CCC steelhead and NC steelhead. The effects to physical habitat are minor changes to stream substrates and minor diversions of flow to operate streamside incubators. In addition, minor pruning of streamside vegetation may be conducted to construct release tanks or streamside incubators, and moving of streambed substrates to operate traps during monitoring and evaluation. None of these activities is likely to cause adverse effects to critical habitat for the species specified above.

Hatchery operations that trap adult coho salmon at the Don Clausen Fish Hatchery have been in place since the late 1980's and will not have any additional effects to critical habitat. Similarly the outflow from these facilities, or maintenance actions are not expected to cause adverse effects to critical habitat in Dry Creek which is the receiving water for this facility as described above in section 2.5.2.6.

Release of juvenile coho salmon throughout the action area has the potential to effect critical habitat for ESA-listed salmonids. Critical habitat includes essential features that include adequate: 1) substrate, 2) water quality, 3) water quantity, 4) water temperature, 5) water velocity, 6) cover/shelter, 7) food, 8) riparian vegetation, 9) space, and 10) safe passage conditions (64 FR 24029). Releasing large numbers of juvenile coho salmon has the potential to adversely affect the essential feature 9) space, which is required for stream rearing juvenile salmonids. If coho salmon juveniles are released in numbers that exceed current habitat carrying capacity, space may become limiting causing reduced growth or survival of natural origin salmonids rearing in release streams. As stated in the Environmental Baseline (section 2.4) above, many of the streams within the action area have been impacted by various threats that impact their overall carrying capacity. The program minimizes these potential adverse effects by using habitat typing information (which quantifies available pool habitat) for Program streams along with pre-release monitoring to release the appropriate number of juvenile fish into critical habitat. Habitat release areas are pre-selected and monitored to determine the number and densities of natural origin anadromous species prior to the development of annual release plans by the TAC (CDFW and USACE 2017). Presence and density of natural origin salmonids, and other factors such as water year type are considered in adjusting each allocation of Program juveniles to be released.

CC Chinook salmon use larger tributaries and the mainstem Russian 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. Similar habitat use by juvenile steelhead and coho salmon is could result in the potential for effects to critical habitat (space/density) in the action area. Adverse effects to steelhead and coho salmon critical habitat is minimized or avoided through development of annual release plans, and monitoring data as described previously.

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). 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.

Non-Federal activities that are reasonably certain to occur within the action area include agricultural practices (primarily vineyard production), water withdrawals/diversions, mining, state or privately sponsored habitat restoration activities on non-Federal lands, road work, timber harvest, residential and rural growth. These ongoing threats are identified in this biological opinion's Environmental Baseline (section 2.4) and the CCC coho salmon recovery plan (NMFS 2012a) but we do not expected major increases in these threats due to existing land use county zoning and development regulations. Similar threats ongoing threats that were identified in the CCC coho salmon recovery plan have been identified in the Multispecies recovery plan for CC Chinook salmon and CCC and NC steelhead (NMFS 2015). Threats reported in the NMFS 2015, such as agriculture, timber harvest and recreational fishing are not expected to increase over the permit period from 2020 through 2028.

A search of upcoming timber harvest plans on the CalFire website confirms that timber harvesting is expected to continue in the next five to seven years (https://caltreesplans.resources.ca.gov/caltrees/). NMFS assumes these activities, and similar resultant effects (as described in the Status of the Species and Environmental Baseline sections), on listed salmonids species will continue on an annual basis during permit period analyzed in the biological opinion.

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 areas 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 in the environmental baseline (Section 2.4).

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. 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.

Coho salmon

Currently there are no populations of CCC coho salmon ESU as described in the Status Section that meet the viability targets. Most populations of CCC coho salmon have declined in abundance to levels well below moderate risk level within the action area and several are, if not extirpated, far below the high-risk depensation thresholds specified by Spence et al. (2008). Since 2001, the Program has increased coho salmon abundance in the Russian River population to 200-500 fish per year since 2014 (CSG 2018). Given the potential for extirpation of these populations, the operation of this Program is one of the high priority recovery actions included in the NMFS (2012) Coho Salmon Recovery Plan. NMFS (2012a) recommends the expansion and efforts to secure long term funding of the Warm Springs Hatchery and Russian River Coho Salmon Captive Broodstock Program to provide an expeditious alternative to conserve broodstock across the ESU. The 2008 Russian River biological opinion (NMFS 2008) requires funding of the monitoring component and annual genetic analysis/management of the Program until 2023 to ensure adaptive management and reduction of genetic risks from the Program, respectively. Both these monitoring components are critical to maintain beyond 2023 and for the duration of the Permit period (2028) for the Program.

The proposed Program will continue to conserve broodstock in the Russian River and smaller dependent populations within the Coastal Diversity Stratum and extend broodstock conservation actions to the Navarro Point to Pont Arena Diversity Stratum. Overall, the proposed Program is likely to continue to improve abundance, spatial structure, and diversity of CCC coho salmon in the Russian River, the largest independent population within the Coastal Diversity Stratum. The expansion of the broodstock program into the Navarro Point to Gualala Point Diversity Stratum to include the independent populations (i.e., currently the Garcia River, and Navarro River, and eventually the Gualala River,) will likely increase abundance and spatial structure. Given the extremely low abundance seen across the Navarro Point to the Gualala Point Diversity stratum the Program is likely to bolster populations during the Permit period (nine years), as seen in the Russian River since 2001, and will avoid imminent extinction in the short term.

The Program also has the potential to result in adverse effects to ESA listed species residing within the action area. Some juvenile salmonids may be killed or injured during the collection or transportation of fish to source broodstock for the program. Monitoring activities will also result in a small fraction of sampled salmonids being injured or killed. Minimization measures implemented during broodstock collection and Program monitoring reduce overall impact to Chinook salmon, coho salmon and steelhead juvenile populations in action area streams. The number of juvenile fish injured or killed is not likely to affect the overall abundance within each stream reach, watershed or population. Minimization measures ensure that limitations on numbers of juveniles to be collected in each watershed, stream, and habitat, minimize the effects such that only small numbers of natural origin fish are affected in each basin. Additionally, fish rescue efforts will target areas where stranding of coho salmon is likely to occur from reduced flows as part of the broodstock collection. Releases of hatchery juveniles could also compete with natural origin juveniles for habitat space, or natural origin juveniles could become prey to larger hatchery smolts as they emigrate out of release basins. Generally, these effects are expected to be minimal due to the short period of time Program smolts reside in release streams and release strategies employed.

In the long-term, continued rearing of hatchery juveniles for release, and for broodstock purposes would continue domestication effects from hatchery rearing practices. These effects are expected to impair smolt to adult survival of Program fish released into action area streams. Spawning of adult hatchery returns with each other or with natural origin adults may also reduce fitness of their progeny and result in reduced recruits per spawner. Reduced survival from domestication effects is expected to be offset by higher lifestage survival of embryos, juvenile, adult broodstock due to hatchery rearing conditions. Finally, while broodstock mating in hatcheries has the potential for inbreeding, this effect is minimized by state of the art genetic mating protocols to minimize inbreeding and improve diversity with selective breeding protocols which will continue as an annual operational component.

The length of time that the hatchery program will be implemented should be considered due to the potential risks posed to population viability by these programs. McClure et al. (2008) concluded that artificial programs implemented as short-term means to avoid extinction are more likely to achieve population viability than those that rely on long-term supplementation. The proposed Program seeks to maintain operation until target populations have reached adult abundance levels where hatchery supplementation is no longer needed. This biological opinion analyzes the authorization of a Section 10 (a)(1A) of the ESA permit by NMFS, which would allow the artificial supplementation to operate through 2028. Given the Programs breeding, rearing and release protocols that minimize impacts to CCC coho salmon and other federally listed salmon and steelhead in the action area, the length of time for operating the proposed Program (i.e., 9 years), the Program is not expected to pose viability risks associated with long-term supplementation.

Steelhead and Chinook Salmon

CCC and NC Steelhead are widely distributed across the action area and minor losses from broodstock collection, monitoring and evaluation, and predation or competition are not expected to affect large numbers of individuals that will result in population effects within action area watersheds. Chinook salmon inhabit larger mainstem areas of the Russian River, Dry Creek and the Garcia River and, therefore, due to a smaller overlap in spatial distribution, the Program effects are expected to be low for Chinook salmon. The majority of juvenile Chinook will also emigrate from action area streams prior to summer broodstock collection actions thereby further reducing potential for Program effects. CCC steelhead and NC steelhead overlap habitat types and tributaries where Program fish are proposed for release. Steelhead distribution generally is much more extensive due to differences in temperature tolerance across their respective DPSs. Although, Program smolts are likely to adversely affect up to 10 percent YOY steelhead in release streams, the level of predation and competition is not expected to result population level effects primarily due to the large steelhead spatial distribution, and stream carrying capacity that is expected to control overall steelhead abundance.

Summary
Streams within the action area have a long history of impacts from development, agriculture, and logging, and past hatchery practices. Restoration has been underway for decades with improved land use practices, restoration of stream habitat, and hatchery practices. Summer stream flow remains an issue in many areas and is likely the limiting factor for summer survival for CCC coho salmon (M. Obedzinski, and B. White, personal communication 2019). Future State and non-federal actions in the action area are generally under a high level of regulatory authority and, therefore, are unlikely to result in major reductions to habitat quality in the future. The Program as proposed is likely to improve the VSP parameters in two of three diversity stratum within the CCC coho salmon ESU over the next nine years. Although the Program will have some adverse effects to natural origin juvenile CCC coho salmon, CC Chinook, CCC steelhead and NC steelhead, these adverse effects will not be sufficient to reduce the survival and recovery of these species.

The effects of climate change on listed species and their habitats within the action area are likely to continue to be adverse. Operation of hatchery equipment, driving of hatchery trucks, etc. produce greenhouse gasses and contribute, in a miniscule way, to climate change. The contributions are measurable but cannot be measured regarding how they add to the effects of climate change, at the global or local scale, which are tied to the additive global total of greenhouse gas emissions.

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 cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of CCC coho salmon, CC Chinook salmon, CCC steelhead, or NC steelhead or destroy or adversely modify designated critical habitat for these species.

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). "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.

Below we describe the incidental take that is exempted as part of this biological opinion. All expected direct take described in Tables 1-4 below is authorized in the Section 10(A) 1(a) permit and is shown here for informational purposes only.

2.9.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows.

Factor 1- The degree to which the hatchery program affects the conservation of genetic resources that represent the ecological and genetic diversity of a salmon ESU or steelhead DPS:
Broodstock collection will employ seining and backpack electrofishing methods that can cause incidental mortality of CCC coho salmon, CC Chinook salmon, CCC steelhead and NC steelhead. Incidental mortality is generally less than 2 percent for these activities that are carried out by experienced biologists. Indirect mortality from the collection of juvenile coho salmon for broodstock is shown in Table 1 below.

Factor 2 - Hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities:

Reproductive success of CCC coho salmon is likely to be reduced due to lower fitness from one or both parents being hatchery adults that spawn in the wild. When Program fish (adult hatchery fish) spawn with natural origin, we expect some loss of fitness as described above in this Biological Opinion. This effect is a reduction in reproductive success that is difficult to quantify but has been well documented to be less per capita compared to natural origin spawners. An estimate of the reduction in reproductive success would need to include the survival of offspring of hatchery parents in the wild, which is difficult due to the large geographic area, used by CCC coho salmon, and would be cost prohibitive due to the level of monitoring required to estimate reproductive success of each broodyear in the wild. The loss in reproductive success is also offset with the use of local origin broodstock, and ongoing genetic management, which may help to maintain the fitness in the hatchery population (Christie et al. 2014). Incidental take for this effect will be exceeded if the Program does not meet the Performance Criterion of pNOB equal to or greater than 50 percent wild broodstock incorporated into hatchery spawning each year. Maintaining this level of natural origin broodstock will minimize the reduction of fitness when hatchery fish return and spawn in the wild.

Factor 3 - Hatchery fish and progeny of naturally spawning hatchery fish in juvenile rearing areas:

Released hatchery smolts typically move out of release streams within a few weeks. As these smolts acclimate to release streams and migrate to the ocean they are likely to adversely affect (via predation or competition) natural origin young-of-the-year CCC coho salmon, CC Chinook, CCC steelhead, and NC steelhead. Losses of ESA listed salmonids from predation cannot be precisely quantified due to the large action area and wide range of interactions that take place with hatchery fish. The PCD risk analysis conducted estimated that up to 10 percent of the coho salmon, Chinook salmon, and steelhead populations could experience adverse effects via predation and competition in action area release streams from released juvenile coho salmon from the Program. However, we do not expect actual predation and competition to reach levels of 10 percent due to the large amount of habitat available in the spring where they are stocked, and due to the size of coho salmon smolts that are not expected to be highly efficient predators. The extent of take will be exceeded if the program releases greater numbers of juvenile fish than those proposed in the September 2017 HGMP submitted by USACE and the DFW.

Factor 4 – Monitoring and evaluation that exists because of the hatchery program:

Downstream migrant trapping, snorkel surveys, and summer electrofishing surveys are expected to result in incidental take of CCC coho salmon, CC Chinook salmon, CCC steelhead, and NC steelhead. Incidental mortality may occur during downstream migrant trapping as a result of anesthetizing, trapping, tagging, and tissue sampling of juveniles and adult salmonids. Snorkel surveys are expected to harass some juvenile salmonids but no mortalities are likely to occur. Spring trapping and summer electrofishing will cause low levels of mortalities of salmonids within survey reaches. Indirect or incidental take levels for these actions are shown in Table 4 below.

Factor 5 – The operation, maintenance, and the construction of hatchery facilities that exist because of the hatchery program:

Hatchery operations are anticipated to have mortality at each life stage during hatchery rearing and incubation. The greatest losses are expected to be at the egg to fry life stage, with minor losses throughout the rearing period until fish are released. Some incidental mortalities are also expected from transporting fish to the hatchery during broodstock collection, tagging, tissue sampling, and release activities. Incidental take for hatchery operations are shown in Tables 2 and 3 below.

Table 1. Annual collection and transport and indirect mortality for young-of-the-year coho salmon for the Russian River Coho Salmon Captive Broodstock Program.

Line	Species	Listing Unit	Origin	Life Stage	Expected Direct Take	Indirect Mortality	Take Action	Observe/Collect Method	Procedure
1	Salmon, Coho	CCC ESU	Natural	Juvenile	700	35	Collect, Transport Live Fish	Seining, Backpack Electrofishing	Collected from Russian River tributaries for broodstock, up to 200 annually per stream. Indirect mortality reflects loss associated with capture and handling.
2	Salmon, Coho	CCC ESU	Natural	Juvenile	700	35	Collect, Transport Live Fish	Seining, Backpack Electrofishing	Collected from streams outside of the Russian River basin for broodstock or rearing without propagation, up to 200 annually per stream. Indirect mortality reflects loss associated with capture and handling.
3	Salmon, Coho	CCC ESU	Natural	Juvenile	400	20	Capture, Handle, Release Live Fish	Seining, Backpack Electrofishing	Surplus juvenile Coho Salmon incidentally captured and released immediately downstream. Indirect mortality reflects loss associated with capture and handling.
4	Salmon, Chinook	CC ESU	Natural	Juvenile	400	20	Capture, Handle, Release Live Fish	Seining, Backpack Electrofishing	Juvenile Chinook Salmon incidentally captured and released immediately downstream. Indirect mortality reflects loss associated with capture and handling.
5	Steelhead Trout	CCC DPS	Natural	Juvenile	400	20	Capture, Handle, Release Live Fish	Seining, Backpack Electrofishing	Juvenile Steelhead trout incidentally captured and released immediately downstream. Indirect mortality reflects loss associated with capture and handling.
6	Steelhead Trout	NC DPS	Natural	Juvenile	400	20	Capture, Handle, Release Live Fish	Seining, Backpack Electrofishing	Juvenile Steelhead trout incidentally captured and released immediately downstream. Indirect mortality reflects loss associated with capture and handling.

Table 2. Handling of Coho Salmon, including artificial propagation, rearing, tissue sampling, and marking at the Russian River Coho Salmon Captive Broodstock Program.

Line	Species	Listing Unit	Origin	Life Stage	Expected Direct Take	Indirect Mort	Take Action	Observe/ Collect Method	Procedure
1	Salmon, Coho	CCC ESU	Natural	Juvenile to Adult	1,400	700	Prophylactic treatment; Anesthesia; Tagging; Tissue sampling; Artificial spawning	Hand or Dip Net	The combination of lines 1-3 represents the maximum amount of take (1,500) for annual rearing of Coho Salmon to adulthood to meet broodstock needs (800) plus captive rearing without propagation (700). Indirect mortality reflects any excess fish from lines 1-3 not needed for spawning that will either be released alive or experience mortality during rearing.
2	Salmon, Coho	CCC ESU	Natural	Adult	100		Hormonal treatment; Anesthesia; Tagging; Tissue sampling; Artificial spawning	Fish Ladder, Hand or Dip Net	As above.
3	Salmon, Coho	CCC ESU	Listed Hatchery Intact Adipose	Juvenile to Adult	1,500		Prophylactic treatment; Anesthesia; Tagging; Tissue sampling; Artificial spawning	Hand or Dip Net	As above.

Line	Species	Listing Unit	Origin	Life Stage	Expected Direct Take	Indirect Mort	Take Action	Observe/ Collect Method	Procedure
4	Salmon, Coho	CCC ESU	Natural/ Listed Hatchery Intact Adipose	Adult Carcass	800	N/A	Carcass Transport; Handling; Release; Disposal	N/A	Up to 800 carcasses resulting from spawning under lines 1-3 may be handled and transported for a variety of purposes, including donation to educational programs, instream distribution for nutrient loading and disposal in municipal disposal facilities.
5	Salmon, Coho	CCC ESU	Listed Hatchery Intact Adipose	Fertilized Egg	1,000,000	500,000	Egg Take; Rearing; Prophylactic treatment	Hand or Dip Net	A maximum of 1,000,000 fertilized eggs taken from broodstock during spawning and reared until released. Of this total, up to 250,000 reared until released as eyed eggs or unfed fry (line 6) and up to 250,000 released as juveniles or sub-adults (line 7). Indirect mortality reflects potential loss associated with unsuccessful fertilization, unsuccessful hatching, and culling of fish as needed.
6	Salmon, Coho	CCC ESU	Listed Hatchery Intact Adipose	Fertilized Egg to Unfed Fry	250,000	125,000	Egg Rearing; Prophylactic treatment	Hand and/or Dip Net	A maximum of 500,000 Coho Salmon (combination of lines 6-7) reared to various life stages until release. Of this total, up to 250,000 reared until released as eyed eggs or unfed fry. Indirect mortality reflects potential loss associated with unsuccessful fertilization, unsuccessful hatching, and culling of fish as needed.

Line	Species	Listing Unit	Origin	Life Stage	Expected Direct Take	Indirect Mort	Take Action	Observe/ Collect Method	Procedure
7	Salmon, Coho	CCC ESU	Listed Hatchery Intact Adipose	Fertilized Egg to Juvenile	250,000	125,000	Egg Rearing; Prophylactic treatment; Mark/Tag	Hand or Dip Net	A maximum of 500,000 Coho Salmon (combination of lines 6-7) reared to various life stages until release. Of this total, up to 250,000 reared until released as juveniles of various ages. Indirect mortality reflects potential loss associated with unsuccessful fertilization, unsuccessful hatching, and culling of fish as needed.
8	Salmon, Coho	CCC ESU	Listed Hatchery Intact Adipose	Juvenile	80	0	Health Certification	Hand or Dip Net	Up to 80 juveniles will be euthanized annually for fish health certification. Of these, up to 20 will be euthanized for certification of a potential spring release of Coho Salmon (age ≤ 6 months) and 60 will be euthanized for certification of Coho Salmon released during fall, winter or the following spring (age > 6 months).
9	Salmon, Coho	CCC ESU	Listed Hatchery Intact Adipose	Juvenile	500	25	Transport and Display Live Animal	Hand and/or Dip Net	Up to 500 live Coho Salmon (early life stages or juveniles) may be transported and displayed in tanks for educational purposes. Indirect mortality reflects potential loss associated with handling and transport.

Table 3. Indirect mortality for various life stages released, include juveniles (fingerlings, advanced fingerlings, yearlings, smolts) and adults (rearing without propagation and surplus broodstock) for the Russian River Coho Salmon Captive Broodstock Program.

Line	Species	Listing Unit	Origin	Life Stage	Expected Direct Take	Indirect Mortality	Take Action	Observe/ Collect Method	Procedure
1	Salmon, Coho	CCC ESU	Natural/ Listed Hatchery Intact Adipose	Adult	700	14	Transport and Release	Hand and/or Dip Net	Up to 700 natural-origin or hatchery-origin Coho Salmon reared to maturity may be released if not needed as broodstock. Indirect mortality reflects potential loss associated with handling during transport and release.
2	Salmon, Coho	CCC ESU	Listed Hatchery Intact Adipose	Eyed Egg/ Unfed Fry	250,000	12,500	Transport and Release	Hand and/or Dip Net	Up to 250,000 eyed eggs or unfed fry produced in excess of juvenile rearing capacity may be released into Russian River tributaries or out-of-basin streams. Indirect mortality reflects potential loss associated with handling during transport and release.
3	Salmon, Coho	CCC ESU	Listed Hatchery Intact Adipose	Juvenile	250,000	12,500	Transport and Release	Hand and/or Dip Net	Up to 250,000 juvenile Coho Salmon may be released into Russian River tributaries. Indirect mortality reflects potential loss associated with handling during transport and release.
4	Salmon, Coho	CCC ESU	Natural/ Listed Hatchery Intact Adipose	Adult	500	10	Transport and Release	Hand and/or Dip Net	Up to 500 out-of-basin natural-origin or hatchery-origin Coho Salmon reared to maturation may be released in stream of origin or returned to hatchery of origin. Indirect mortality reflects potential loss associated with handling during transport and release.

Table 4. Monitoring and Evaluation for the Russian River Coho Salmon Captive Broodstock Program. A minimum of four tributaries will be monitored (currently Dutch Bill, Green Valley, Mill, and Willow creeks). Different or additional streams may be selected based on recommendations from the TAC.

Line	Species	Listing Unit	Origin	Life Stage	Expected Direct Take	Indirect Mortality	Take Action	Observe/ Collect Method	Procedure
2	Salmon, Chinook	CC ESU	Natural	Smolt	1000	20	Capture/Handle/Release Fish	Trap	Anesthetize. Trap is a funnel/pipe trap.
4	Salmon, Coho	CCC ESU	Listed Hatchery Intact Adipose	Juvenile	4000	80	Capture/Handle/Release Fish	Trap	Anesthetize.Trap is a funnel/pipe trap.
5	Salmon, Coho	CCC ESU	Listed Hatchery Intact Adipose	Smolt	20000	400	Capture/Handle/Release Fish	Trap	Anesthetize.Trap is a funnel/pipe trap.
6	Salmon, Coho	CCC ESU	Listed Hatchery Intact Adipose	Smolt	2000	40	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Trap	Anesthetize; Tag, PIT; Tissue Sample Fin or Opercle
7	Salmon, Coho	CCC ESU	Natural	Juvenile	500	10	Capture/Handle/Release Fish	Trap	Anesthetize. Trap is a funnel/pipe trap.
8	Salmon, Coho	CCC ESU	Natural	Juvenile	200	4	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Trap	Anesthetize; Tag, PIT; Tissue Sample Fin or Opercle
9	Salmon, Coho	CCC ESU	Natural	Smolt	10000	200	Capture/Handle/Release Fish	Trap	Anesthetize. Trap is a funnel/pipe trap.
10	Salmon, Coho	CCC ESU	Natural	Smolt	2000	40	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Trap	Anesthetize; Tag, PIT; Tissue Sample Fin or Opercle
15	Salmon, Coho	CCC ESU	Natural	Juvenile	10000	10	Observe/Harass	Snorkel/Dive surveys	Observe
16	Salmon, Coho	CCC ESU	Listed Hatchery	Juvenile	10000	10	Observe/Harass	Snorkel/Dive surveys	Observe

Line	Species	Listing Unit	Origin	Life Stage	Expected Direct Take	Indirect Mortality	Take Action	Observe/ Collect Method	Procedure
17	Salmon, Coho	CCC ESU	Listed Hatchery Intact Adipose	Juvenile	5000	100	Capture/Handle/Release Fish	Electrofishing, Backpack	Anesthetize
18	Salmon, Coho	CCC ESU	Natural	Juvenile	3000	60	Capture/Handle/Release Fish	Electrofishing, Backpack	Anesthetize
19	Salmon, Coho	CCC ESU	Natural	Juvenile	2000	40	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Electrofishing, Backpack	Anesthetize; Tag, PIT; Tissue Sample Fin or Opercle
20	Steelhead	CCC DPS	Natural	Juvenile	5000	100	Capture/Handle/Release Fish	Electrofishing, Backpack	Anesthetize
21	Steelhead	CCC DPS	Natural	Juvenile	10000	10	Observe/Harass	Snorkel/Dive surveys	Observe
26	Steelhead	CCC DPS	Natural	Spawned Adult/ Carcass	100	2	Capture/Handle/Release Fish	Trap	Anesthetize. Trap is a funnel/pipe trap.
27	Steelhead	CCC DPS	Natural	Smolt	500	10	Capture/Handle/Release Fish	Trap	Anesthetize. Trap is a funnel/pipe trap.
28	Steelhead	CCC DPS	Listed Hatchery Adipose Clip	Spawned Adult/ Carcass	100	2	Capture/Handle/Release Fish	Trap	Tissue Sample Fin or Opercle; Tissue Sample Otolith; Tissue Sample Scale
29	Steelhead	CCC DPS	Natural	Fry	5000	100	Capture/Handle/Release Fish	Trap	Anesthetize. Trap is a funnel/pipe trap.
30	Steelhead	CCC DPS	Natural	Juvenile	2000	40	Capture/Handle/Release Fish	Trap	Anesthetize. Trap is a funnel/pipe trap.
31	Steelhead	CCC DPS	Listed Hatchery Adipose Clip	Smolt	100	2	Capture/Handle/Release Fish	Trap	Anesthetize. Trap is a funnel/pipe trap.

2.9.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take (indirect/incidental), 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 nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02).

NMFS concludes that the following reasonable and prudent measures are necessary and appropriate to minimize incidental take. These reasonable and prudent measures and their associated terms and conditions must be incorporated by NMFS into the 10(a)(1)(A) permit for the USACE's operation of the broodstock program:

1. Minimize take of listed species by meeting all Program Performance Standards and Criteria.
2. Minimize the effects (i.e., predation, interaction, competition, divergence of run timing) of hatchery released juveniles and adults into action area streams on natural origin coho salmon and other listed species by adhering to release strategies for sizes, timing and locations informed by survey data and guided by a Technical Advisory Committee.
3. Minimize genetic effects (i.e., inbreeding depression, loss of fitness, etc.) of Program operations on natural origin fish by funding annual genetic assessment and management that includes a spawning matrix and release mating pair guidance.
4. Minimize effects of Program operations on natural origin fish growth, survival and return by funding, maintaining an annual monitoring, and evaluation program in at least four Index streams.
5. Minimize effects of Program operations on natural origin fish abundance, density and distribution via program evaluation and adaptive management over multiple generations.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and NMFS as the permittee, and the Corps as applicant for the 10(a)(1)(a) permit must comply with them in order to implement the RPMs (50 CFR 402.14). NMFS 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:

    a. Maximize fitness of broodstock through ensuring that incorporation of natural origin broodstock (pNOB) is equal to or greater than 50 percent for the duration of the permit period.
    b. Limit broodstock collection to a maximum of 1500 juvenile CCC coho salmon. Collection of juveniles for broodstock shall be conducted to maximize the number of family groups in each watershed.
    c. Identify guidelines for program capture which include pre-capture snorkel surveys to identify appropriate reaches with coho salmon presence prior to the fish collection date. Broodstock collection of juveniles must follow proposed protocols set forth in the HGMP.
    d. Based on pre-capture surveys a minimum of 10 natural origin fish should be present in each pool where juvenile broodstock collection is to be conducted.
    e. When sufficient numbers of juveniles are present not more than 20 coho salmon can be captured from an individual pool habitat. When insufficient numbers of fish are present, and fish may be imperiled duet to stranding, up to 100% of all juveniles may be rescued and relocated to wetter habitat or collected based on the input and discretion of the CDFW, USACE or NMFS fisheries biologists in the field.
    f. Juvenile broodstock collection mortalities shall not exceed 2 percent for any ESA listed salmonid species encountered.
    g. If performance criteria are not met by year 3 of the Permit, the TAC will assess specific operations and make recommendations to meet proposed performance standards

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

    a. Limit lifestage releases to not exceed those proposed in CDFW and USACE 2017 HGMP.
    b. Require prioritization of independent watersheds for juvenile and adult release programs to continue to make progress towards Recovery Plan target abundance objectives. Surplus fish can be utilized to supplement dependent populations to improve diversity objectives.
    c. Utilize a mating pair matrix when conducting adult releases to select the highest diverse potential mate pairings/lots for release. Minimize the potential for closely related adult hatchery fish spawning together in natural areas, and avoid skewing run timing of adults by conducting multiple releases in space and time, timed with the natural occurring runs.
    d. Adjust feeding to increase smolt size to 150 mm, to increase SAR. Release smolts and pre-smolts to mainstem river and larger tributary areas to avoid overlap with natural origin salmonid fry.
    e. Implement minor changes to rearing and release strategies and methods to minimize effects of the Program to ESA listed salmonids of natural origin.

Evaluate and modify stream stocking numbers and density according to presence of natural origin coho salmon, and include consideration of water year type in allocating the total stocking target to available wetted habitat.

f. These minimization strategies are expected to reduce the interaction of Program smolts by coordinating releases with environmental conditions to reduce predation and other interactions with natural origin salmonids. Take will be exceeded for predation effects if the Program exceeds its proposed juvenile release numbers as described in CDFW and USACE HGMP (2017).

3. The following terms and conditions implement reasonable and prudent measure 3:

    a. Require genetic assessments of both the naturally-spawning and hatchery-reared components to be conducted over time, to determine the loss or increase of genetic variation in each component.

    b. Incorporate a target of 50% pNOB, 25% F1 and 25% hatchery returns as broodstock sources for propagation.

    c. Require utilization of a spawning matrix for identifying mating pairs, and conducting adult releases.

    d. Given the central importance of the RRCSCBP in efforts to avoid extirpation of CCC coho salmon in the Russian River watershed, USACE is already required to conduct annual genetics analysis and the monitoring and evaluation components of the RRCSCBP until 2023 via RPA 7 of the 2008 Russian River Biological Opinion.[7] NMFS should require ongoing funding for and annual genetic analysis and management of the Program for the duration of the permit through 2028.

4. The following terms and conditions implement reasonable and prudent measure 4:

    a. USACE is already required to conduct monitoring and evaluation components of the RRCSCBP until 2023 via RPA 7 of the 2008 Russian River Biological Opinion (NMFS 2008a). Require ongoing funding and implementation of an annual monitoring program to evaluate the effectiveness and performance criteria and ensure adaptive management of the program for the duration of the Permit (2023 to 2028).

5. The following terms and conditions implement reasonable and prudent measure 5:

    a. Evaluation and adaptive management is necessary to evaluate and ensure overall progress towards program objectives. While progress towards achieving performance criteria should be already underway, evaluation of progress toward achieving indicator targets should be reviewed at 1-generation intervals following permit issuance (i.e., every 3 years). Adjustments to program operations can then

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[7] NMFS 2008. Biological Opinion for Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed.

be made to ensure ongoing progress towards program and recovery plan objectives. Suitability of performance criteria/targets should also be evaluated each generation, based on feedback from monitoring and evaluation to adaptively manage the program.

b. While high proportion of program hatchery spawners (pHOS) or hatchery juveniles may be considered acceptable during the early phases of conservation broodstock programs that operate to prevent local extirpation and recolonize population areas, measures to reduce pHOS or density of hatchery juveniles should be implemented as recolonization by natural spawners increase and generational targets are approached. These measures could include reducing total hatchery production, reduce stocking of specific populations, tributaries or reaches where pHOS is high, or other measures identified by USACE.

c. Require monitoring of captive rearing target numbers for adult coho salmon spawners for a population or watershed over 3 consecutive years (per Table 11 in DFW and USACE 2017), and adjustments to releases to maximize abundance or minimize hatchery effects on fitness. To address longer term genetic effects or in absence of robust monitoring, after three generations (i.e., 9 years) require an assessment of the benefits of reducing specific Program releases to minimize hatchery effects on fitness.

2.10 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

1. CDFW and USACE should identify streams (or reaches) within the action area where ongoing threats exist that reduce the potential for survival and recolonization of coho salmon. An example of an ongoing threat that reduces the potential for recovery is the ongoing diversion of summer stream flow that currently limits survival of juvenile CCC coho salmon. The TAC for this Program should evaluate the continued stocking of streams where ongoing threats have not yet been abated. Use of Program fish in areas with higher recovery potential (i.e., where threats are low and suitable habitat conditions and carrying capacity exists) that provide for the completion of each life history phase should be prioritized. This recommendation is expected to increase the probability for CCC coho salmon recovery in the Coastal and Navarro Point diversity strata by increasing the survival of Program coho salmon.
2. To ensure that adult coho salmon can reach the hatchery during all periods of their migration, passage in Dry Creek via several fish ladders that were installed at grade control structures by USACE, should be monitored and improved if passage is shown to be an issue at lower flows (80-120 CFS).

2.11 Reinitiation of Consultation

This concludes formal consultation for the Russian River Coho salmon Captive Broodstock Program Hatchery Genetic Management Plan.

As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.12 "Not Likely to Adversely Affect"' Determinations

NMFS has determined that, while the Proposed Action may affect Southern Resident killer whales, due to their dependence on Chinook salmon as a prey item, the Proposed Action is not likely to adversely affect SDPS Southern Resident killer whales. This determination was made pursuant to Section 7(a)(2) of the ESA implementing regulations at 50 CFR Part 402.

The applicable standard to find that a Proposed Action is "not likely to adversely affect" ESA listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous beneficial effects without any adverse effects on the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are extremely unlikely to occur.

The Southern Resident killer whale DPS composed of J, K, and L pods was listed as endangered under the ESA on November 18, 2005 (70 FR 69903). The final rule listing Southern Resident killer whales as endangered identified several potential factors that may have caused their decline or may be limiting recovery. These are quantity and quality of prey, toxic chemicals which accumulate in top predators, and disturbance from sound and vessel traffic. The rule also identified oil spills as a potential risk factor for this species. The final recovery plan includes more information on these potential threats to Southern Resident killer whales (NMFS 2008b). NMFS published the final rule designating critical habitat for Southern Resident killer whales on November 29, 2006 (71 FR 69054). Critical habitat includes approximately 2,560 square miles of inland waters including Puget Sound, but does not include areas with water less than 20 feet deep relative to extreme high water. The PBFs of Southern Resident killer whale critical habitat are: (1) Water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging. On September 19, 2019, NMFS proposed additional areas of designated critical habitat for Southern Resident Killer whales (84 FR 49214). This proposed rule would revise critical habitat by designating six new areas along the U.S. West Coast that would add 15,626.6 square miles of marine waters from the U.S. international border with Canada south to Point Sur, California.

Southern Resident killer whales spend considerable time in the Georgia Basin from late spring to early autumn, with concentrated activity in the inland waters of Washington State around the San Juan Islands. By early autumn, the range of the whales, particularly J pod, expands to Puget Sound. By late fall, the Southern Resident killer whales make frequent trips to the outer coast and are seen less frequently in the inland waters. In the winter and early spring, Southern Resident killer whales move into the coastal waters along the outer coast from southeast Alaska south to central California.

Southern Resident killer whales consume a variety of fish and one species of squid, but salmon, and Chinook salmon in particular, are their primary prey (review in NMFS 2008b). Ongoing and past diet studies of Southern Resident killer whales conduct sampling during spring, summer and fall months in inland waters of Washington State and British Columbia (Ford and Ellis 2006, Hanson *et al.* 2010, ongoing research by the Northwest Fisheries Science Center (NWFSC)). Therefore, the majority of our knowledge of diet is specific to inland waters. We know less about the diet of Southern Resident killer whales off the Pacific Coast. However, chemical analyses support the importance of salmon in the year-round diet of Southern Resident killer whales (Krahn *et al.* 2002, Krahn *et al.* 2007). Prey and fecal samples recently collected during the winter and spring indicates a diet dominated by salmonids, particularly Chinook salmon, with the presence of lingcod and halibut (NWFSC unpubl. data). The predominance of Chinook salmon in the Southern Resident killer whales' diet when in inland waters, even when other species are more abundant, combined with information indicating that the killer whales consume salmon year round, makes it reasonable to expect that Southern Resident killer whales predominantly consume Chinook salmon when available in coastal waters.

Adverse effects to Southern Resident killer whales associated with the Proposed Action are not likely to occur because population level effects to CC Chinook salmon in the action area are not expected as described in the Biological Opinion above. Population level effects to CC Chinook in the Russian River are not expected because the proposed action will impact low numbers of individual juvenile fish during broodstock collection, monitoring activities and some reaches where predation and competition may occur. Conversely, Southern Resident killer whales could benefit slightly from hatchery production to an increased forage base of coho salmon, which is a potential prey item for killer whales. NMFS concludes that the effects of the Proposed Action are not likely to adversely affect SDPS Southern Resident killer whales, nor would it adversely affect their designated critical habitat.

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. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." 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) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

3.1 Essential Fish Habitat Affected by the Project

This analysis is based, in part, on the EFH assessment provided by the DFW and USACE, and descriptions of EFH for Pacific coast salmon (PFMC 2014). Pacific coast salmon EFH may be adversely affected by the proposed action. Specific habitats identified in PFMC (2014) for Pacific coast salmon include Habitat areas of Particular Concern (HAPCs), identified as: 1) complex channels and floodplain habitats; 2) thermal refugia; and 3) spawning habitat. HACPs for coho salmon and Chinook salmon include all waters, substrates and associated biological communities falling within the critical habitat areas described above in the accompanying Biological Opinion for the Russian River coho salmon captive broodstock program. Essentially, all CC Chinook salmon and CCC coho salmon habitat located within the proposed action is considered HACP as defined in PFMC (2014).

3.2 Adverse Effects on Essential Fish Habitat

NMFS has evaluated the proposed project for potential adverse effects to EFH pursuant to Section 305(b)(2) of the MSFCMA. As described and analyzed in the accompanying BO, NMFS anticipates some adverse impacts to habitat areas will occur at various project locations throughout the action area (see Figure 2 and 3). During each year, released coho salmon from the broodstock program are likely to compete for space with natural origin young-of-the-year Chinook and coho salmon. Losses of natural origin Chinook salmon and coho salmon from habitat interactions with Program coho salmon are expected to be low and not sufficient to reduce the survival or recovery of their respective ESUs. In addition, construction of streamside incubators will require moving substrate and minor pruning of vegetation. The duration and magnitude of the effects to EFH associated with the proposed Program construction work will be minimal due to small scale of these projects that are operated for a short duration (a few weeks) each spring.

3.3 Essential Fish Habitat Conservation Recommendations

Section 305(b)(4)(A) of the MSFCMA authorizes NMFS to provide EFH Conservation Recommendations that will minimize adverse effects of an activity on EFH. Although potential adverse effects are anticipated as a result of project activities, there are no EFH additional Conservation Recommendations necessary at this time that would otherwise be implemented to offset the adverse effects to EFH.

3.4 Supplemental Consultation

NOAA Fisheries must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that effects the basis for NMFS' EFH Conservation Recommendations (50 CFR600.920(1)).

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 are the CDFW and USACE. Other interested users could include other resource agencies and the UC California Sea Grant*,* and others interested in the conservation of the affected ESUs/DPS. Individual copies of this opinion were provided to CDFW and USACE. This opinion will be posted on the Public Consultation Tracking System. The format and naming adheres 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 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*,* 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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