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

Hatchery and Genetic Management Plan

Russian River Steelhead Integrated Harvest Hatchery Program, California

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 Integrated Harvest Hatchery Program and Accompanying Hatchery and Genetic Management Plan

NMFS Environmental Consultation Organizer (ECO) Consultation Number: WCRO-2022-01929

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	Yes	No
Central California Coast steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No
California Coastal Chinook (*O. tshawytscha*)	Threatened	Yes	No	Yes	No

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

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

Issued By:

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Date: January 8, 2024

TABLE OF CONTENTS

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

The National Oceanic and Atmospheric Administration'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].

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

1.2. Consultation History

The United States Army Corps of Engineers (USACE) is responsible for mitigating and enhancing steelhead in the Russian River watershed under Congressional authorization and annual congressional appropriations. To accomplish this mission, USACE partners with the California Department of Fish and Wildlife (CDFW) to operate the Russian River Steelhead Integrated Harvest Program (Program). The USACE contracts with CDFW to operate hatchery operations at the Don Clausen Fish Hatchery (DCFH) and Coyote Valley fish facilities (CVFF) (Contract # W912P723C0006). Implementation of this Program is a collaborative effort among USACE, CDFW and NMFS with input from a Technical Advisory Committee (TAC). The Program is intended to meet the mandated responsibility to mitigate for habitat that has been lost due to the construction of Coyote Valley Dam in 1959 and Warm Springs Dam in 1982 (Public Law 93-251-MAR. 7, 1974, Sec.95).

The NMFS (2016) Coastal Multispecies Recovery plan includes recommendations regarding the use of improved hatchery practices to maintain and recover populations of Central California Coast (CCC) steelhead. This includes steelhead rearing in the Russian River basin. Additionally, the 2008 Russian River biological opinion (RR BiOp) for Water Supply, Flood Control Operations, and Channel Maintenance developed by NMFS for the USACE, Sonoma County Water Agency (now Sonoma Water) and the Russian River Flood Control and Water Improvement District in the Russian River (NMFS 2008) provided incidental take exemption for the USACE for hatchery operations (among others). A Reasonable and Prudent Measure (RPM) required the USACE to develop a Hatchery and Genetics Management Plan (HGMP) to minimize effects to natural origin CCC steelhead. Specifically, in order to receive the take exemption, RPM 7 required that the USACE and CDFW operate the DCFH and CVFF steelhead programs in a manner that minimizes adverse genetic effects to steelhead within the Russian River and within the CCC steelhead Interior and North Coast Diversity Strata (DPS).

A technical advisory committee (TAC) was convened on March 30, 2018 to develop the HGMP for the two USACE hatcheries operated in the Russian River watershed. The TAC members included resource agency (i.e., CDFW, USACE, NMFS) biologists, resource managers, geneticists, hatchery managers and USACE dam managers. These TAC meetings were convened approximately every two weeks until June 30, 2021, when the proposed HGMP was completed and provided to NMFS in support of the USACE request for an ESA section 10(a)(1)(A) Enhancement Permit (see below). Coordination and agreement on the hatchery operations and management of the CVFF in the upper Russian River and the DCFH (aka Warm Springs Hatchery) on Dry Creek were discussed and were central in the development of the final HGMP for USACE hatcheries on the Russian River.

The USACE has applied for a section 10(a)(1)(A) permit for 10 years to operate a salmonid hatchery program at DCFH and CVFF. The final HGMP details current and proposed hatchery operations, and related fish monitoring, and was provided to NMFS on July 6, 2021 (CDFW and USACE 2021) which supplements the permit application.

As the federal action agency responsible for the decision on whether or not to issue the section 10(a)(1)(A) permit, NMFS initiated internal section 7 consultation for the operation of the Program. The internal section 7 consultation analyzes the potential effects of implementing the Program on endangered CCC Coho salmon, CCC steelhead, and California Coastal (CC) Chinook salmon and their designated critical habitats.

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

1.3. Proposed Federal Action

The proposed action is NMFS' issuance of a ten-year section 10(a)(1)(A) permit for a HGMP submitted by USACE and CDFW through NOAA Fisheries online application system, the Authorizations and Permits for Protected Species (APPS). The HGMP for the Russian River Steelhead Program, dated July 6, 2021 (CDFW and USACE 2021) describes how USACE and CDFW will conduct steelhead hatchery operations and monitoring associated with the DCFH and CVFF in the Russian River watershed, California (see Figure 1). NMFS' permit (APPS No. 26277) would be issued to USACE for the operations and implementation of the steelhead HGMP with the CDFW as a co-investigator on the permit.

Following the submittal of the HGMP to NMFS for a section 10(a)(1)(A) permit, a new mating protocol was proposed by CDFW and NMFS at the August 22, 2022 steelhead TAC meeting. The new protocol along with some additional hatchery protocols was provided to NMFS by D. Muir, CDFW (email communication, September 2022) and a follow-up memo (M. Lacy, CDFW October 20, 2022). The D. Muir's September 22, 2022 email communication and October 20, 2022 CDFW memo to NMFS include protocols for incorporating jacks (2-year old males), fertilization, incubation of natural origin eggs, and a marking quality control program. These modified actions are incorporated into the Russian River Steelhead Integrated Harvest Hatchery Program (CDFW and the USACE 2021) as part of the proposed project.

Figure 1. Russian River watershed in California, showing the mainstem river, major tributaries and the location of two USACE steelhead hatcheries.

1.3.1 Overview of Program

The USACE proposes the continuation of hatchery operations at two facilities located within the Russian River. DCFH is located on Dry Creek at the base of Warm Springs Dam, within Sonoma County, California. DCFH is located approximately 14.4 miles upstream of the confluence of Dry Creek and the mainstem Russian River, which in turn is approximately 33 miles upstream of the mouth of the Russian River. CVFF is located 42 miles north of the DCFH facility on the East

Fork Russian River at the base of Coyote Valley Dam, in Mendocino County, California (Figure 1). The CVFF is approximately 1 mile upstream of the confluence of the West Fork and East Fork branches of the Russian River, which in turn is about 96 miles upstream of the mouth of the Russian River.

The purpose of the hatchery program is to "mitigate" for the loss in natural steelhead production due to habitat loss from the construction of Warm Springs and Coyote Valley dams. The hatchery does not have a conservation purpose wherein hatchery-produced fish are used to increase natural steelhead abundance and spawning escapement in the Russian River basin. However, because of the negative effects that hatchery fish may have on natural steelhead populations, the Program includes actions designed to minimize the effects hatchery fish may have on ESA listed salmon and steelhead in the basin.

Funding for these facilities includes direct annual operation of the Russian River steelhead programs (including genetic analysis and monitoring and evaluation components (M&E)) by the USACE, San Francisco District, with additional expertise provided by CDFW (CDFW operates both facilities under contract to the USACE). The annual hatchery operating budget funded by USACE in recent years has averaged approximately $1,511,770, which covers both the Russian River Coho salmon Captive Broodstock Program (RRCCBP) at DCFH and steelhead programs conducted at DCFH and CVFF. The RRCCBP is permitted under section 10(a)(1)(A) permit 21501 issued January 2021.

As described in the HGMP (and for 10-years from the issuance of a section 10 permit), the steelhead program would be operated as an integrated program as defined by the California Hatchery Scientific Review Group (CA HSRG 2012) and the Pacific Northwest Hatchery Scientific Review Group (HSRG 2004a and 2004b). The intent of an integrated program is for the natural environment to drive the adaptation and fitness of a composite population of fish that spawn both in the hatchery and in the wild (i.e., naturally in the stream). Integration of the two components of the population is achieved by incorporating natural origin (NOR) fish into the broodstock along with hatchery origin fish (HOR) and controlling the proportion of the total natural spawning escapement consisting of hatchery origin fish (pHOS).

Program integration is expected to increase adult abundance, productivity, and fitness while minimizing the genetic divergence of hatchery fish from the naturally spawning population. For a properly integrated program, the HSRGs require that the proportion of the broodstock consisting of NOR adults (pNOB) exceed pHOS estimates.

Implementation of this program is a collaborative effort among USACE, CDFW and NMFS with input from the steelhead TAC. Implementation of the program as proposed is dependent on scientific protocol, 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 implementing the HGMP relies on periodic feedback from the program's monitoring and evaluation activities relative to the targets associated with each Program performance indicator identified in HGMP.

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 (e.g., adjusting adult collection techniques, modifying juvenile production targets, changing release strategies, modifying feeding schedules). Program guidance by the responsible agencies may follow formal discussion by the TAC. Alternatively, if immediate changes to the program are required due to unforeseen circumstance such as low adult return years (< 300 adults at each facility), the responsible agencies may propose activities to be implemented through adaptive management, whether at the hatchery or in the field, which can be presented to NMFS for consideration and approval.

1.3.2 Hatchery Operations

Table 1. Program hatchery use, origin of individuals, life stage, number of fish to be utilized and hatchery action or use permitted by the section 10 (a) (1)(A) permit for both Don Clausen Fish Hatchery and Coyote Valley Fish Facility.

Species	Hatchery Use	Production Origin	Life Stage	Expected Number Permitted in Sec 10	Hatchery Action
Steelhead	Broodstock	Hatchery origin	Adult	<14,000	Spawning
Steelhead	Broodstock	Natural Origin	Adult	389	Spawning
Steelhead	Broodstock	Natural origin	Juvenile	13,500	Hatchery rear and release
Steelhead	Green Egg	Hatchery and Natural origin	embryo	1,190,000	Hatchery rearing to smolt size
Steelhead	Smolts	Hatchery and Natural origin	Juvenile	500,000	Hatchery rearing and release

Broodstock Collection

The goal of the future broodstock collection protocol for DCFH and CVFF is to maintain genetic diversity and genetic continuity with the naturally spawning steelhead populations in Dry Creek and the Upper Russian River populations respectively. The intent is also for the natural environment to drive the adaptation of both the natural and hatchery populations associated with each hatchery facility. Historically, broodstock for the programs were collected solely from HOR adult steelhead returning to the DCFH or CVFF ladder and trap, as few NOR steelhead returned to either facility. Broodstock were sourced systematically across the entire adult return period, with weekly capture goals formulated on the basis of a 10-year mean. With the implementation of the HGMP, both adult HOR and NOR steelhead will be sourced from DCFH and CVFF ladder and traps, with NOR adult steelhead and juveniles collected at a number of locations and by several different methods, towards integration objectives as described below.

The Program proposes to collect up to 389 adult NORs each year for use as broodstock at the two facilities. NOR (Table 1). Broodstock for DCFH may be collected from a combination of methods to include but not limited to adult returns to the hatchery, a weir on Dry Creek or its' tributaries (e.g., Mill Creek), at the Wohler fish ladder (requiring genetic identification), or by sport or agency fishers catching NOR adults downstream of Dry Creek. NOR Broodstock for CVFF may be collected from a combination of methods to include but not limited to adult returns to the hatchery, at the Wohler fish ladder (requiring genetic identification), or by sport or agency fishers on the mainstem above Dry Creek. NOR adults may also be collected by anglers within the legal fishing areas of the Russian River or within tributaries (via special permission) that are geographically proximate to each facility program. NORs collected within the legal sport fishing area will be considered part of the HGMP Program when they are placed in an HGMP collection box (live car) or given to Program staff for broodstock purposes.

Additionally, up to 13,500 NOR fry (Table 1) may be collected each year in total, from lower river tributaries (i.e., Austin Creek, Green Valley Creek, Mark West Creek, Maacama Creek, and Dry Creek populations) and from the Upper Russian River population tributaries. Fry would be collected using downstream migrant traps, seining, or backpack electrofishing. Collected NOR fry will be transferred to DCFH, reared to the yearling life stage and then released as smolts either at DCFH or CVFF. NOR smolts from the Upper Russian River population will only be released at CVFF; NOR smolts from lower river tributaries will be part of DCFH releases (unless otherwise directed by NMFS and CDFW geneticists). The Program reared NOR smolts will be uniquely marked (i.e., maxillary clip) so they may be identified upon their return to each hatchery facility as natural origin adults (without adipose clips or coded wire tags). These returning adults would then be incorporated into broodstock at each facility. This approach is designed to meet pNOB objectives as it may be difficult to capture sufficient NOR adults through other methods identified (i.e., weirs, fishers) to meet program target objectives.

Spawning

As noted above, the Program proposes to collect broodstock at the two facilities (389 adult NORs), and the appropriate number of HOR's from facility ladders, to reach production goals as described below. The number of HOR adults collected for broodstock at each facility was set so that the production goal may be achieved even if no NOR adults are available for broodstock. The HOR adult number also assumes that 50% of the HOR eggs will be culled as per the spawning protocols (applies only to HOR X HOR matings). Actual numbers of NOR's and HOR's utilized will be dependent upon the number of NOR's able to be sourced for each facility following the respective pNOB production targets, and production goal set for that year.

DCFH will collect and spawn the number of adults required to release 200,000 juveniles each year. The pNOB target for this production is 50 percent. This will require a total of 90 NOR adults (30 female, 60 male) and 405 HOR adults (135 female, 270 male).

CVFF will also initially release 200,000 juveniles each year, unless the achievement of performance targets allows an increase to up to 300,000/year.[1] The pNOB target for CVFF production is 30 percent. For a production goal of 200,000 smolt production, it will require 72 NOR adults (24 female, 48 male). The number of HOR adults required to produce up to 200,000 juveniles if no NOR are collected is 405 HOR adults (135 female, 270 male). If a maximum of 300,000 smolt production is allowed, it will require 99 NOR adults (33 female, 66 male; to produce up to 300,000 juveniles if no NOR are collected is 609 (203 female, 406 male) HOR's are required.

Recycling/Release of Unspawned/Surplus Adult Fish

Because adult steelhead have the potential to spawn multiple times during their lifespan, they are not killed in the hatchery spawning process. A small air compressor unit is used to inject air into the egg cavity of female steelhead and force out eggs without harming the fish. Spawned HOR and NOR females, and only NOR males will be recycled back to the river. Unspawned HOR females may be stripped of eggs and released back to Dry Creek or the mainstem Russian River from DCFH and CVFF respectively. Unspawned DCFH or CVFF NOR females will also be re-released to the river, so that they may spawn naturally. Finally, spawned and unspawned HOR males will not be released in anadromous waters to prevent these fish from spawning naturally. The TAC will discuss the options available for utilizing excess adult hatchery returns and recommend to the USACE and the CDFW whether fish are to be released to non-anadromous waters within the Russian River basin for harvest, used in food programs, made available to local tribes, or destroyed and sent to landfills or other sites approved by regulatory agencies. Surplus/unspawned HOR adults showing any signs of injury or fungus or other obvious infections will not be released back to the river regardless of whether they were spawned or not.

Mating Protocols

The programs will follow the mating protocols as developed by NMFS and CDFW geneticists. A modified protocol (M. Lacy, CDFW memo, October 22, 2022) will maximize the contribution of all NOR fish used as broodstock and minimize effects of hatchery crosses when spawned. These protocols attempt to meet several challenging program goals: 1) increase the total number of parents used as broodstock to increase effective number of breeders, 2) maximize retention of

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[1] Hatchery production cannot be increased until Program performance metrics for pNOB and pHOS are achieved, and permission is granted by NMFS. Should total juvenile production be increased to 500,000 then a total of 99 NORs may need to be collected and used as broodstock if the pNOB objective remains unchanged.

NOR contribution to improve population fitness, 3) increase the effective population size of the integrated population (NOR and HOR) which maintains genetic diversity, and 4) reduce the number of age-2 adults used in broodstock. The spawning protocols may be modified during years when extremely low numbers of adults HORs reach the hatchery facilities and the TAC reviews and approves measures to maintain goals of the Program.

Incubation, Rearing and Acclimation Facilities

The Program will not rear more than 500,000 juveniles in any year. Incubation for both the DCFH and CVFF program components is conducted at DCFH. The egg incubation facilities are located within the hatchery building and consist of 22 stacks of 16-tray incubation units, as well as hatching jars in a variety of sizes (4-, 8-, and 12-inch diameter). All NOR eggs will be incubated in trays. Eggs from a single female will be incubated in two separate trays to prevent a total loss of genetic material if a tray lot is lost. The maximum loading density for each tray will not exceed 10,000 eggs. Trays will be flushed with iodine twice a day until embryos reach the eyed-egg stage.

As part of the education objective of the program, approximately 20,000 eggs or fry (HOR X HOR crosses) may be transferred and reared at the Casa Grande High School each year. These eggs will be reared to the yearling stage, then transported back to DCFH for release into the mainstem Russian River near Dry Creek. In addition, fertilized eggs (less than 10,000) that would be otherwise culled, may be provided to local classrooms for educational purposes (D. Muir, personal communication, 2023).

After rearing at DCFH for approximately one year, the CVFF juveniles are transported back to CVFF in groups for final acclimation and release. Each release group is held in the CVFF raceways for approximately 30 days. This 30-day residency occurs when juvenile steelhead typically go through smoltification, which prepares them for the transition from fresh water in the stream to salt water in the ocean. During the residency (or acclimation) period and smoltification process, the smolts become "imprinted" on the water released from Coyote Valley Dam that is expected to increase their homing fidelity to the release site by returning adults. The raceways at the CVFF are designed to allow the smolts to leave the facility without assistance (volitional release). Fish not leaving the facility volitionally will be encouraged to leave the raceways by crowding.

Release of Smolts and Fish Marking

The program will release up to 200,000 juveniles from DCFH and from 200,000 to 300,000 from CVFF annually. While initial Program release target has been capped at 400,000, the number of juveniles released at each facility may be altered dependent on achievement of pHOS, pNOB and harvest goals, however, the programs combined will not release more than 500,000[2] juveniles in any year without the permission of NMFS.

[2] CDFW contractual agreement with USACE allows for a production target within 10% of the total for estimation purposes.

All DCFH smolts (HOR and NOR) will be released near the mouth of Dry Creek, or in the mainstem Russian River near the War Memorial Dam in Healdsburg, California. All CVFF smolts (HOR and NOR) will be released from the hatchery, located on the East Fork of the Russian River, near Ukiah, California. Other smolt release locations may be added or recommended by the TAC, following monitoring results, to inform study results, or as necessary to incorporate disease/invasive protocols. In dry years (i.e., low river flow), CVFF smolts may be trucked downstream to improve survival. However, this action will only be implemented, upon approval by NMFS, if monitoring and evaluation indicates the stray rate of returning adults does not increase.

A quality control program will be implemented that checks the quality of all fish marked each day. Hourly subsamples of the marked fish will be taken and percentage of the fish accurately marked determined. The program goal is to have 99.5% of the fish accurately marked prior to their release. This quality control program is especially critical when using an ad-clip to distinguish HOR adults from NOR adults. If HOR fish are poorly marked, or the mark missing, returning adults may be counted as NOR adults both at the hatchery and on the spawning grounds, thereby confounding estimates of pNOB and pHOS. In addition, CDFW certifies the health and disease status of steelhead prior to release. Data are collected on smoltification, fat reserves and fish length and weight. The fish are examined for bacteria, whirling disease, viruses and external parasites following American Fisheries Society Blue Book protocols.

The HGMP provides a mechanism to maintain releases within 10 percent of the hatchery's maximum production goal of 500,000 yearlings (short term 400,000) by tracking in-hatchery survival rates by life stage. The TAC will discuss the options available for utilizing excess hatchery production and recommend to the USACE and the CDFW whether eggs or fish are to be released to non-anadromous waters, made available to other programs (e.g., Casa Grande Program), or destroyed and sent to landfills or other sites approved by regulatory agencies.

1.3.3. Avoidance and Minimization Measures

Broodstock Collection Measures

Hatchery steelhead will be 100 percent externally marked (ad-clip) so they may be distinguished from naturally produced steelhead. These marks will enable managers to determine the number and ratio of hatchery and natural steelhead spawning within the Russian River basin. Managers will use this information to alter hatchery practices and implement fisheries management strategies, to reduce the potential genetic and fitness impacts that hatchery fish spawning naturally pose to natural steelhead populations. When available, the California Steelhead Report Card, along with HGMP creel monitoring efforts, will be used to estimate the numbers of natural and hatchery origin adults encountered by anglers along the Russian River. To facilitate Program needs, NMFS has recommended the Steelhead Report Card be modified to include the ability to discern a Russian River catch between the two integrated programs (i.e., location caught, and tag/mark type, to be reflected on Steelhead Report Cards to identify Dry Creek and Upper River origin fish).

Broodstock collection at each facility, as well as the current effort of sport fishing[3] in the Russian River watershed, will be relied on to remove excess hatchery origin fish from the system. The objective of these collection efforts would be to achieve program performance indicators of pHOS in the wild and Proportionate Natural Influence (PNI).

The program will be operated to achieve a PNI of >0.67 and pHOS <0.30 in the geographic areas of program integration. In areas not integrated with the two programs (i.e., tributaries) pHOS will be maintained at less than 0.05.

Anglers recruited to catch natural origin fish for broodstock will be trained on proper handling procedures for transporting fish from capture point to adult holding facilities, traps or trucks. Barbless hooks (required by CA fishing regulations) will be used to reduce injury to NOR caught fish.

The following management is proposed to minimize domestication and genetic divergence, as well as mitigate adverse genetic or ecological effects to listed natural fish because of broodstock selection practices; These allow managers to determine and control the proportion of hatchery fish spawning naturally, thereby reducing adverse genetic impacts. Additionally, these could allow managers to implement selective fisheries for HOR adults by facility, if needed.

- All juvenile hatchery fish releases will be externally marked (ad-clipped).

- All juveniles that are produced from NOR x NOR mating will be marked to identify natural origin genetics and release facility of origin (e.g., such as a right/left maxillary clip to distinguish between release facility and population (i.e., Upper River and Dry Creek).

- Only local (i.e., Russian River) broodstock will be spawned and consist of hatchery fish originating from the two hatcheries or unmarked adult steelhead captured in fisheries, traps or returning to the hatcheries. Incorporation of natural origin fish as broodstock ensures that the hatchery population does not diverge genetically from the natural population.

- On average, 50 percent of the DCFH broodstock and 30 percent of CVFF broodstock will consist of natural origin steelhead. Fish used as broodstock will be genetically sampled (post spawning) to determine if unmarked steelhead spawned were simply unmarked hatchery fish.

- Broodstock will be collected throughout the entire migration to maximize retention of natural run characteristics, which helps ensure that hatchery practices are not selecting for specific traits that may reduce fitness.

[3] Sport fishing in the Russian River watershed is part of the Environmental Baseline and is not part of the proposed action.

- No more than 10% of the fish used for broodstock will consist of age-2 adults. Hatchery managers will establish a length age relationship to determine likely age of adults used as broodstock.

- Hatchery to wild composition of natural spawning escapement in Dry Creek and Upper Russian River will be managed to achieve a pHOS less than 30 percent.

Spawning Measures

Historically, fish surplus to broodstock needs at both facilities were recycled back to the Russian River with the intention to provide fish for harvest. On the average, 3,000 and 1,764 adult steelhead were returned to the river each year at DCFH and CVFF, respectively. While the proportion of these fish caught in fisheries is unknown, the condition of these fish was often poor due to being held, trucked and handled. Anecdotal information indicates these fish were either often released by fisherman, or spawned in the system, contributing to high pHOS rates. Going forward, the program proposes to eliminate or substantially reduce the recycling of adult surplus broodstock back to the Russian River from each facility. This action is designed as a means to achieve the pHOS performance metrics for each program. Specific actions that will be implemented to reduce pHOS include:

- Until the pHOS metrics are achieved only HOR surplus females stripped of eggs may be released back to the river (i.e., anadromous portion).

- No age 2 HOR males will be released to the river. Age 3 (or older) HOR surplus males may be released back to the river if it can be shown that pHOS metrics will be met.

- Surplus adult HOR fish may be released into non-anadromous waters within the Russian River basin to provide sport harvest opportunity. The TAC will recommend to the USACE and CDFW the locations and circumstances where surplus adult HOR may be released to non-anadromous waters within the Russian River basin.

- Any HOR adult steelhead released back to the river will be externally marked using floy tags or a tag agreed to by the TAC and approved by NMFS.

Mating Measures

All fish used as broodstock will be genetically sampled to determine the percent NOR used for that brood year. The number of natural origin fish used for broodstock will be limited to less than 100 adults at each facility, unless approved by NMFS. This action is designed to minimize the mining of natural populations. Each facility seeks to achieve an average PNI value of ≥ 0.67 (5-year running average). At a PNI of 0.67 the natural environment, rather than the hatchery environment, will drive local adaptation.

Incubation Measures

HOR eggs will be incubated using water treated with UV purification to prevent exposure to pathogens. In addition, the treated water is filtered with sand and gravel filters and temperature controlled. Vertical flow incubators have been phased out in favor of acrylic hatch jars, which have the following advantages:

- Eggs are continuously agitated (gently) to reduce fungal invasion.
- Chemical treatment of the eggs is eliminated.
- Eggs can be monitored readily (clear jars only).
- Higher egg to alevin survival ratios can be achieved.
- Eliminates handling sac-fry when moving from incubator to troughs.

Incubation trays will be used to rear the eggs from natural origin fish. Swim-up and ponding are performed manually by hatchery staff.

Rearing and Release Measures

Risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish under propagation include:

- Bird netting is installed on all raceways to prevent predation.

- Juvenile fish will be released at lengths ranging from170mm to 200mm to reduce residualism rates in the Russian River and associated tributaries.[4]

- Juvenile hatchery fish will be released in January through March to reduce ecological interactions with ESA listed Coho salmon, Chinook and steelhead.

Measures designed to reduce program impacts to ESA listed coho salmon, Chinook salmon and steelhead include:

- Fish will be released at a length greater than 170mm and less than 200mm and weight (8 fpp +/-0.8fpp) that is expected to result in fast migration out of the system, thereby reducing predation and competition effects.

- DCFH fish will be transported and released at the mouth of Dry Creek or the mainstem Russian River. This action will virtually eliminate predation and competition effects in Dry Creek from released hatchery steelhead smolts on natural origin steelhead, coho salmon, and Chinook salmon

- Steelhead production level at DCFH has been reduced from 300,000 to 200,000 fish to decrease the number of hatchery origin adults returning to Dry Creek and other tributaries. This results in decreased pHOS thereby reducing genetic risks to the natural

[4] It is recognized that in some years a minor component of the population may have lengths that fall outside of this range. These fish would still be released from the hatchery.

population. However, CVFF production may be increased to 300,000 once performance targets are achieved. Shifting production targets amongst facilities, to increase the number released in the Upper river allows additional fishing opportunity in time and space which also contributes to decreasing risk and pHOS in the lower river.

- Smolts from CVFF and DCFH will be released in January through March (at the locations specified above) prior to emergence of Coho salmon fry. This action is designed to reduce the probability that hatchery fish will prey on these species.

1.3.4 Performance Indicators and Standards

In order to meet the performance standards of an integrated program the steelhead program will be consistent with standards and their associated guidelines as developed by the CA HSRG (2012) to the extent possible. These performance standards are broad based and are designed to achieve best hatchery management practices, produce high quality smolts, achieve production targets, achieve conservation objectives, and achieve harvest objectives. The conservation objective of the program is to be consistent with the protection of genetic resources of Russian River steelhead and minimize predation and competition effects to ESA listed CCC Coho salmon, CC Chinook salmon and CCC steelhead.

Performance indicators are proposed in the HGMP (USACE and DFW 2021) to monitor and validate the potential benefits of HGMP implementation. Risks are likely if actions are not carried out or are not implemented at specific time steps during the permit period. The complete list of the performance indicators is incorporated by reference (USACE and DFW 2021) that will be utilized to monitor and inform the performance of the Program. Generally, performance indicators will be accomplished both with the monitoring of hatchery operations, and the monitoring of hatchery fish in the natural environment.

Indicators for hatchery operations will include in-hatchery survival of various age classes, from adults held for broodstock, through spawning to the egg life stage, through the smolt stage when fish are released. Spawning will be monitored to ensure mating protocols are adhered to, and to validate the proportion of broodstock consisting of natural origin adults (pNOB) in the spawning pool. Culture staff will also monitor disease indicators to prevent disease outbreaks from occurring, or as they occur at the two hatchery facilities.

Field performance indicators that reflect how the Program may be meeting overall performance standards set forth in the HGMP are based on the CA HSRG (2012) and focus on the percent of hatchery adults spawning (pHOS) with natural origin (NOR) adults in the watershed. An important performance indicator for this program is based on the HSRG (2014) which recommends that for integrated programs associated with populations of high biological significance (e.g., ESA Listed) that the pNOB should exceed pHOS by at least a factor of two, corresponding to a PNI value of 0.67 or greater, and pHOS less than 30 percent. The Program describes several ways to monitor the pHOS occurring in the watershed (hatchery fish spawning in the wild) which will subsequently be used along with pNOB to calculate the PNI. Another key indicator of the Program will be the number of smolts that survive to become adults and return to the watershed (i.e., the smolt to adult survival (SAR)). An SAR of > 2 percent will be an indicator of healthy smolts that can survive in the natural environment. A complete list of performance indicators can be found in the Program HGMP (USACE and DFW 2021).

1.3.5 *Monitoring and Reporting*

The HGMP proposes the following plans and methods of monitoring to collect data necessary to monitor each performance indicator identified in the plan. Reporting is necessary to demonstrate compliance with permit terms and conditions, and adjustment to protocol to demonstrate implementation of avoidance and minimization measures.

- In-hatchery monitoring - intended to inform and evaluate those hatchery operations required to produce healthy, disease-free fish that will survive to adulthood and return at high rates. Pathology Monitoring - maximize survival at all life stages using disease control and disease prevention techniques. Prevent introduction, spread or amplification of fish pathogens.

- Field monitoring - the steelhead monitoring and evaluation (M&E) program intended to ensure that performance indicators and standards identified in the HGMP are achieved. It includes measuring pHOS in each of the six Russian River steelhead essential populations (independent populations) to determine if HSRG guidelines for this parameter are achieved.

- Harvest Monitoring (reporting and census) - necessary to estimate harvest rates, contribution by facility and impacts to non-target listed fish.

- Predation Monitoring - Quantifying HOR steelhead predation risk to ESA listed salmonid species.

Reporting - The results of all data collection and analyses will be reported yearly as part of the hatchery operations report. Information provided in the report will follow recommendations currently being developed by the California Hatchery Scientific Review Group. While results of the M&E program will be evaluated by the TAC in coordination with NMFS, to adaptively manage the ratio of hatchery and natural components (i.e., capture and release numbers) of the Russian River steelhead population, the actual total numbers of HOR and NOR fish utilized or released will not exceed the authorized take limit.

Field Monitoring and Evaluation Program

Evaluation of risks to ESA species from straying (of hatchery spawners to non-stocked streams), harvest (of ESA listed adults by fishers during recreational fisheries for hatchery adults), and predation (of ESA listed juveniles by hatchery fish) will be conducted as described below, see Table 2 for a summary of these activities.

Table 2. Monitoring and evaluation activities, lifestages, methods origin of CCC steelhead for Russian the River HGMP.

HGMP Monitoring Activity	Salmonid Life Stage and Species	Monitoring Method	Number and Origin of Steelhead
pHOS census	Spawning CCC steelhead adults	Field surveys (visual observations)	Natural origin and hatchery origin spawning fish in the wild
pHOS effective	Collect 200 juveniles from 6 populations and 100 fish more from each if needed (CCC steelhead)	Outmigrant traps or other methods Genetic testing	A maximum of 1800 natural origin juvenile steelhead each year
Harvest survey	Adult spawners CCC steelhead CC Chinook CCC Coho salmon	Creel survey of anglers within sport harvest area of Russian River	Natural origin and hatchery origin adult salmonids
Predation monitoring	CCC steelhead Hatchery smolts	Outmigrant traps or other methods Gut sampling	7,200 hatchery smolts (3 years at 2 traps)
Predation acoustic tags	CCC hatchery smolts	Acoustic tracking	200 hatchery smolts each year

a. Straying

The program will develop annual estimates of pHOS (census) and pHOS (effective) for both the DCFH and CVFF facilities using a combination of spawner surveys and genetic sampling. This will be conducted to identify the proportion of hatchery spawners escaping harvest and straying from the hatchery, to non-stocked tributaries to spawn. A description of the methods proposed is provided below. Detailed study plans will be developed after the approval of the HGMP.

pHOS (census)

Steelhead spawner surveys will be conducted in each of the following Independent Populations (NMFS 2016) within the parent stream as an Index of watershed/population conditions:

- Dry Creek,
- Austin Creek,
- Green Valley Creek,
- Mark West Creek,
- Maacama Creek,
- Upper Russian River.

Field crews will look for, and enumerate, the number of ad-clipped (hatchery) and adipose present (natural) adult steelhead observed in each Index stream/population to calculate the percentage of hatchery origin spawners, or pHOS (census) using the below formula:

pHOS (census) = #ad-clipped adults/(#ad-clipped adults + #adipose present adults).

The estimates of pHOS (census) will be used as an index of the maximum risk naturally spawning hatchery fish pose to each of the six natural populations (independent populations) monitored. The estimate is considered a maximum value as it assumes that HOR spawning success is equal to that of NOR adults (i.e., a 100% relative reproductive success (RRS)).

pHOS (Effective)

Downstream migrant trapping will be conducted at the mouth of each Index stream/population identified above. Genetic samples will be collected from adipose intact juveniles to construct a genetic pedigree analysis of juvenile offspring from each brood year, to develop an estimate of pHOS (effective). The presence of hatchery origin genetics in juvenile offspring indicate that hatchery fish effectively spawned.

A parental pedigree analysis will be conducted to determine the proportion of the juveniles that originated from hatchery parents. Effective pHOS will be calculated as follows:
Effective pHOS = # of steelhead juveniles assigned to hatchery parents/Total number of juveniles sampled.

The pHOS (effective) will be divided by pHOS (census) to estimate the relative reproductive success (RRS) for HOR steelhead spawning naturally. The resulting RRS value will be used as a correction factor for pHOS (census) to estimate pHOS (effective) in areas where traps are not operated.

Depending on the number of fish collected, not all samples may be genetically analyzed. The objective will be to process 389 NOR fish from each population. Samples not analyzed will be stored in case they are needed for future analysis. Up to an additional 100 NOR juveniles will also be collected from each of the six steelhead essential populations (independent populations) each year and genetically analyzed. Collecting a large number of juveniles in each of the six independent populations may also allow managers to distinguish one population from another using genetic analyses. If this distinction is possible, then broodstock collection may be conducted at a single central point. Genetic sampling will allow the calculation of the number of offspring produced from HOR adults compared to NOR adults. This monitoring would collect up to a maximum of 1800 juvenile steelhead each year.

b. Harvest

To obtain more accurate estimates of steelhead harvest rates, and identify any harvest effects to natural steelhead populations, a creel survey may need to be implemented in the Russian River for three consecutive years. The results of these surveys will be compared to available Steelhead Report Card information to determine the accuracy of the Steelhead Report Card estimates, as well as improve estimates of the local harvest rate, origin of fish (hatchery and natural) harvested, or caught and released, as well as inform facility released from (DCFH or CVFF) and location caught (Upper or Lower River). Additionally, creel information will provide estimates of non-target listed species (CC Chinook, CCC steelhead) encountered in fisheries. A correction factor, based on creel survey results, will be applied to the annual Steelhead Report Card data to estimate harvest parameters in the future. The creel surveys will be repeated every five-years to update the correction factor applied to the Steelhead Report Card.

c. Predation

Results of the Predation-Competition-Disease-Risk (PCDRISK[5]) analysis indicated that ecological risk of the program to ESA listed Chinook salmon, Coho salmon and steelhead can be quite high. Because it is difficult, if not impossible to quantify competition effects of the program, monitoring will focus on predation.
The study is limited to the mainstem Russian River as DCFH fish will no longer be released at the hatchery on upper Dry Creek but instead at or near the mouth of Dry Creek.[6]

Index of Predation - Stomach Sampling and Genetic Analysis

Estimates of HOR steelhead predation on NOR juvenile Chinook salmon, Coho salmon and steelhead will be collected by sampling the stomachs of hatchery smolts (400 per month at 2 sites) captured from two areas of the mainstem Russian River, one above Dry creek and one below. Other methods such as seines, hook-and-line may also be used along with screw traps from February to July 1 each year for three years. Over the three-year period a total of 7,200 hatchery smolts would be checked to determine the predation on ESA listed salmonids. Sampling will occur at sites upstream and downstream of Dry Creek. Sites upstream of Dry Creek will be used to estimate predation risk of steelhead released from CVFF on Coho salmon, Chinook salmon and steelhead present in this portion of the basin. The sites downstream of Dry Creek will represent the predation risk to these same species from the combined hatchery release from both DCFH and CVFF.

Fish remains found in stomachs will be identified to species, if possible. The gut contents of all HOR steelhead captured will be sent for genetic testing to determine the species of fish consumed (Skaala et al. 2013). Because the genetic analysis cannot separate the genetic material of consumed steelhead from the juvenile steelhead sampled, physical identification of gut samples will be used to determine predation effects on naturally produced steelhead.
An Index of Predation Risk for each species will be determined using the following:

Index of Predation Risk = #Present / (#Present + #Absent)

[5] PCDRISK is a is a flexible computer model designed to assist in assessment and reduction of ecological risks to natural origin fish from hatchery fish releases. PCDRISK simulates predation, competition, and disease impacts on naturally produced salmonids caused by hatchery smolts in fresh water as they move downstream or residualize after release.

[6] Predation effects from future hatchery steelhead releases to Dry Creek on rearing juvenile coho salmon, or natural steelhead populations within Dry Creek, are expected to be minimal as few hatchery fish are expected to migrate back upstream (resulting in minimal competition or predation within Dry Creek).

Wherein:

#Present = The number of stomachs where physical or genetic analysis indicate the presence of a consumed fish

#Absent = The number of stomachs where physical or genetic analysis indicate no consumed fish

Index of Total Predation - Acoustic Tagging

If the Index of Predation Risk from the above study exceeds 10 percent on juvenile Coho salmon, Chinook salmon or NOR steelhead in any month then an acoustic tagging study will be implemented to develop an Index of Total Predation. The 10 percent value was chosen as it was used as the piscivory rate in PCDRISK modeling in the HGMP. The amount of time hatchery steelhead spend in the system after release can be inferred from traps operated in the basin (See PCDRISK analysis in HGMP). The trap data indicate that hatchery steelhead juveniles are present in the Russian River and tributaries up to 120 days post release. What is not known is the number of hatchery juvenile steelhead that remain in the system over this time period.

To estimate hatchery fish abundance over time, 100 fish from each hatchery (200 total) release will be acoustically tagged and tracked as they migrate from their release point until they enter the Russian River estuary. The tags will be designed to have a signal life of 100-120 days based on trap data that show hatchery fish remain in the system for up to 120 days. The study will use the juvenile salmonid acoustic telemetry system (JSATS) for the collection of telemetry data. Stationary and mobile acoustic detection arrays will be used to determine fish location. Acoustic arrays will be placed at the mouth of the East Fork Russian River, Mirabel Dam and near the estuary.

The data collected will be used to determine the following:

- Travel time (days) from point of release to estuary entry,
- Index of Residualization.

An Index of Residualization will be calculated monthly for each release by simply dividing the number of tags present in the river each month by the total number of tagged fish released at each location. This value would then be used to estimate the total number of hatchery fish present in the system by month.

- Number of tagged fish released = 100
- Number of tagged fish detected in-river May 1 = 10
- Total number of hatchery fish released - 200,000

Then the estimated number of hatchery fish present on May 1 is calculated as:

$$10/100*200,000 = 20,000 \text{ fish}$$

The 20,000 value can then be combined with the results of the stomach sampling to determine the total number of juvenile salmon consumed (Index of Total Predation). For example, if stomach sampling results indicate that 1 percent of the hatchery steelhead sampled consumed a Chinook salmon, then the total number consumed would be calculated as:

1% *20,000 = 200 Chinook salmon

This value is simply an Index of Total Predation as it is unknown how many Chinook salmon each steelhead consumed from the time of its release to recapture.

2. Endangered Species Act: Biological Opinion And Incidental Take Statement

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

2.1. Analytical Approach

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

This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species". (81 FR 7214, February 11, 2016)

The designations of critical habitat for ESA listed salmonids uses the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414; February 11, 2016) that revised the critical habitat regulations (50 CFR 424) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

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

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

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

In this biological opinion, NMFS evaluates together the effects of the direct take of listed salmonids that would be authorized by the section 10(a)1(A) permit for the HGMP, as well as any adverse effects to listed species and critical habitats, and any resulting incidental take reasonably certain to occur if the permit is authorized.

2.2. Rangewide Status of the Species and Critical Habitat

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

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).

2.2.1 Species Description and Life History

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, i.e., 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.

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).

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 (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. 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

In this biological opinion, NMFS assesses four population viability parameters to help us understand the status of each species populations 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 2016), 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.

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 (SFSC) 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 SFSC 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 percent to 12 percent 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.

Overall, the available new information since the 2016 viability assessment indicates the extinction risk has not changed appreciably, with slight improvements in the two northern-most diversity strata, but little change in the Coastal Diversity Stratum and perhaps worsening conditions in the Santa Cruz Mountain Stratum. The extinction risk for CCC Coho salmon as a whole thus remains high (Spence 2022). Based on the 2023 status review, NMFS concluded that the CCC Coho salmon ESU remains endangered (NMFS 2023).

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 (J. Jahn, NMFS, personal communication 2010). Ocean conditions are suspected as the principal short-term cause because of the wide geographic range of declines (SFSC 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 2016 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 (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 and Pearse 2008), 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 SFSC 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 suggests that spatial gaps between extant populations along the Mendocino coast are not as extensive as previously believed (Seghesio and Wilson 2016). The new information available since 2016 indicates that recent trends across the ESU have been mixed and that overall extinction risk for the ESU is moderate and has not changed appreciably since the previous viability assessment (Spence 2022).

The NMFS's recovery plan (NMFS 2016) 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).

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 (J. 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 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 3 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). In summary, while data availability for this DPS remains generally poor, the new information for CCC steelhead available since the previous viability assessment (Spence 2016) indicates that overall extinction risk is moderate and has not changed appreciably since the prior assessment (SWFSC 2022).

The NMFS’s recovery plan (NMFS 2016) 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.

2.2.3 Status of 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 CC Chinook salmon and CCC steelhead 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 critical habitat includes the following PBFs: 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 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.

2.2.4 Climate Change

Another factor affecting the range wide status of CCC Coho salmon, CCC steelhead, CC Chinook salmon and aquatic habitat at large is climate change. Recent work by the NMFS Science Centers ranked the relative vulnerability of west-coast salmon and steelhead to climate change. In California, listed Coho and Chinook salmon are generally at greater risk (high to very high risk) than listed steelhead (moderate to high risk) (Crozier et al 2019).

Impacts from global climate change are already occurring in California. For example, average annual air temperatures, heat extremes, and sea level increased in California over the last century (Kadir et al. 2013). Snowmelt from the Sierra Nevada has declined (Kadir et al. 2013). Although CCC Coho salmon, CCC steelhead, and CC Chinook salmon are not dependent on snowmelt driven streams, they have likely already experienced some detrimental impacts from climate change through lower and more variable stream flows, warmer stream temperatures, and changes in ocean conditions. California experienced well below average precipitation during the 2012-2016 drought, as well as record high surface air temperatures in 2014 and 2015, and record low snowpack in 2015 (Williams et al. 2016). Paleoclimate reconstructions suggest the 2012-2016 drought was the most extreme in the past 500 to 1000 years (Williams et al. 2016, Williams et al. 2020, Williams et al. 2022). Anomalously high surface temperatures substantially amplified annual water deficits during 2012-2016. California entered another period of drought in 2020. These drought periods are now likely part of a larger drought event (Williams et al. 2022). This recent long-term drought, as well as the increased incidence and magnitude of wildfires in California, have likely been exacerbated by climate change (Williams et al. 2020, Williams et al. 2022, Diffenbaugh et al. 2015, Williams et al. 2019).

The threat to listed salmonids from global climate change is expected to 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 and the magnitude and frequency of dry years may increase (Lindley et al. 2007; Schneider 2007; Moser et al. 2012). Similarly, wildfires are expected to increase in frequency and magnitude (Westerling et al. 2011; Moser et al. 2012). Increases in wide year-to- year variation in precipitation amounts (droughts and floods) are projected to occur (Swain et al. 2018). 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). Some of these changes, including an increased incidence of marine heat waves, are likely already occurring, and are expected to increase (Frolicher, et al. 2018). In fall 2014, and again in 2019, a marine heatwave, known as “The Blob”, formed throughout the northeast Pacific Ocean, which greatly affected water temperature and upwelling from the Bering Sea off Alaska, south to the coastline of Mexico. The marine waters in this region of the ocean are utilized by salmonids for foraging as they mature (Beamish 2018). Although the implications of these events on salmonid populations are not fully understood, they are having considerable adverse consequences to the productivity of these ecosystems and presumably contributing to poor marine survival of salmonids.

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).

The geographic area where potential effects could occur as a result of the operation of the steelhead hatcheries in the Russian River includes the entire watershed, excluding the areas above each dam. Figure 2 below depicts the action area, which includes a total of 974 miles of potential CCC steelhead habitat throughout streams within Sonoma and Mendocino counties. The Russian River and its tributaries comprise the primary watershed in the action area that may be affected by the steelhead program because of potential straying of adult hatchery steelhead throughout the watershed. More specifically, the majority of the Program actions from DCFH (at Warm Springs Dam) take place in Dry Creek and the Lower Russian River) and their tributaries (areas 2-6), and the majority of the Program actions from CVFF (at Coyote Valley Dam) take place in the East Branch and upper Russian River and their tributaries area 1, north and upstream of Healdsburg, California). Additionally, potential effects of hatchery released smolts could occur to CC Chinook salmon and CCC steelhead throughout the watershed, and to CCC Coho salmon, in Dry Creek and Lower Russian tributary streams within the watershed (see Areas 2-6 on Figure 2). NMFS acknowledges that steelhead from the HGMP would also be present in the Pacific Ocean and a very small number of fish may stray to streams outside of the Russian River watershed. However, NMFS has concluded that the effects of either straying or hatchery steelhead presence in the Pacific Ocean negligible due to the low number of fish that stray and the relatively small number of fish that the steelhead from the HGMP represent in the Pacific Ocean. See Section 2.5.4.

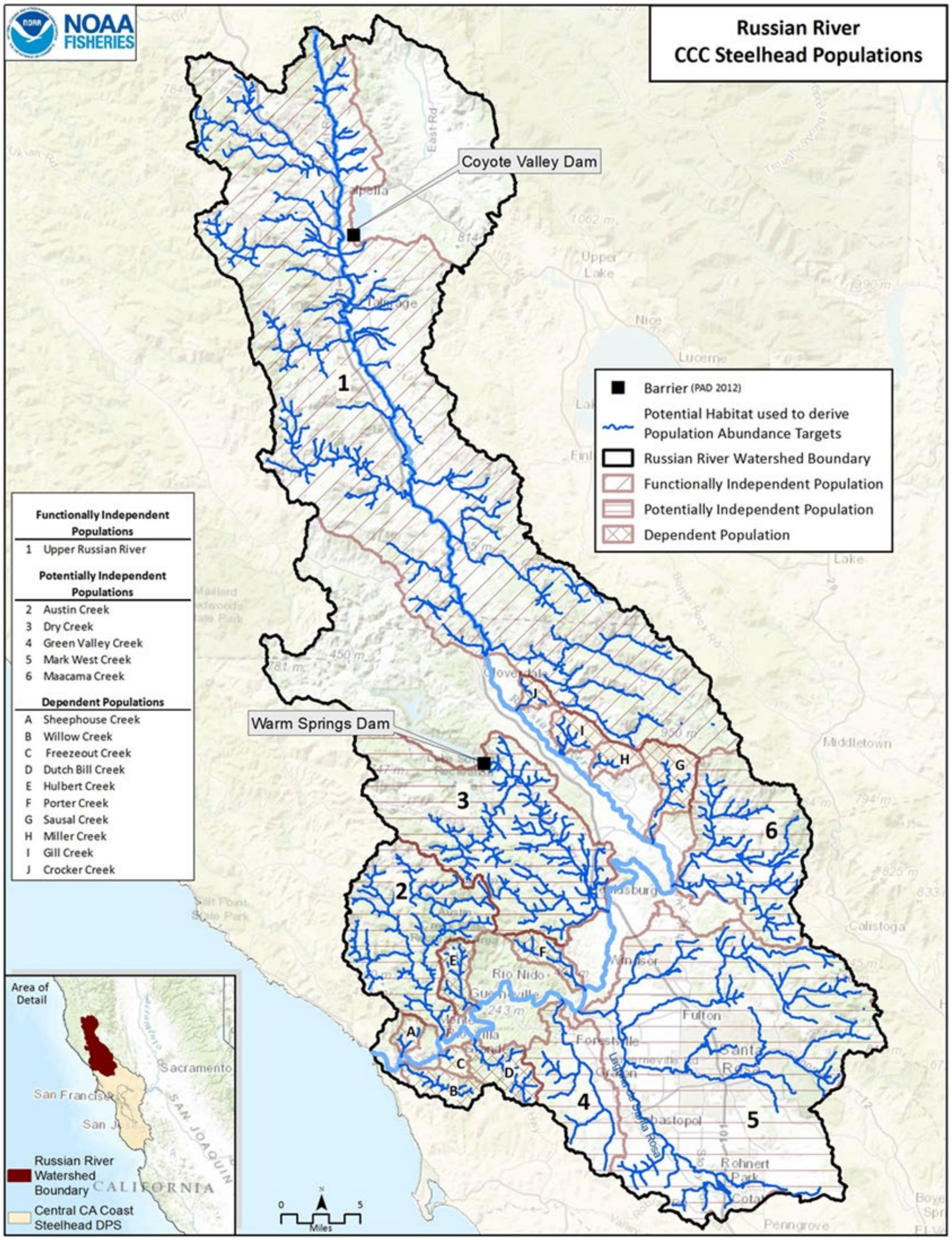

Figure 2. Action area included in the proposed HGMP and location of each hatchery facility at each dam; including independent and dependent CCC steelhead populations (as described by Spence et al. 2008).

2.4. Environmental Baseline

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

2.4.1 Status of Listed Species in the Action Area

Salmonid abundance and trends within the action area are dependent upon multiple factors that affect salmonid populations within the Russian River Basin. In the Russian River Basin, extensive habitat degradation and decreased carrying capacity, a long history of artificial propagation with the use of non-native stocks, and recent droughts and poor ocean conditions are among explanations for the current low abundance of salmonids (Weitkamp et al. 1995). Logging, agriculture and mining activities, urbanization, stream channelization, dams, wetland loss, water withdrawals and unscreened diversions for irrigation have contributed to the decline of salmonids within the Russian River Basin as well. These land use activities have altered streambank and channel morphology, stream temperatures, spawning and rearing habitats, connectivity of habitats, and recruitment of large organic debris and spawning gravels.

Historically, the Russian River contained four anadromous salmonid species: Chinook salmon, Coho salmon, pink salmon (*Oncorhynchus gorbuscha*), and steelhead (Moyle 2002). As with other river basins on the west coast, the Russian River has seen salmonid populations plummet (Nehlsen et al. 1991). The combined anadromous fish returns originally numbered in the tens of thousands, but since the settlement of the Russian River in the 1850's, fish resources have suffered (SEC 1996). The impacts identified above are directly or indirectly responsible for the current status of Russian River salmonids.

CCC Coho Salmon

Information on the historic run size of Coho salmon in the Russian River is limited with late 19th and early 20th Century records are sparse, or non-specific as to species (Chase et al. 2007). Coho salmon once occupied many tributaries throughout the basin, probably reared in backwater areas of the main stem, and were a major component of the fish community (Spence et. al. 2005). Bjorkstedt (2005) concluded that Coho salmon existed as two populations in the Russian River: a large independent population in the lower basin, and a smaller ephemeral population that occupied tributaries in the northwest corner of the basin. The lower river population represented what was historically the largest and most dominant source population in the ESU. Prior to 2001, they were restricted to only a few tributaries in the lower watershed (CDFG 2002), rearing only in isolated areas of suitable habitat.

The Russian River Coho Broodstock Program was initiated in 2001 to address issues with diminished adult returns. Since then, the program has been operated in accordance with conservation hatchery principles, including genetically guided artificial spawning of broodstock to reduce inbreeding. Initially, only natural-origin juvenile Coho salmon from the Russian River watershed were used as broodstock. However, the abundance of natural-origin juvenile Coho salmon in the Russian River watershed has been very low. Genetic analyses of Coho salmon sampled from Russian River tributaries are consistent with what would be expected for a population with such extremely reduced abundance. A review by Bjorkstedt (2005) found both strong departures from genetic equilibrium and evidence of recent, severe population bottlenecks. Historical hatchery practices may also have contributed to these results. This evidence suggests an acute loss of genetic diversity for the Russian River Coho salmon population.

Since 2004, the Coho Broodstock Program has released over 2 million juvenile Coho Salmon into the mainstem Russian River and tributary streams. Under this program, annual returns of Coho Salmon adults (predominantly hatchery-origin) have increased. From 2005 through 2009, a maximum of five adults were documented over each annual return period. As of the 2020-21 return season, 214 adult Coho Salmon were estimated to have returned. In recent years, expanded counts have been calculated from antenna detections of Passive Integrated Transponder (PIT) tagged adults returning and the known proportion of PIT-tagged juveniles from each group of hatchery fish released. However, in earlier years methods of obtaining adult counts include video monitoring and spawner surveys.

The current population of CCC Coho salmon are exposed to impacts of the two steelhead hatchery facilities that have been releasing from 300 to 500 thousand smolts into the Russian River since the early 1980's. The impact of hatchery origin steelhead on the Coho salmon is through competition and predation on Coho salmon smolts and juveniles and harvest impacts to adult Coho salmon from fisheries targeting hatchery steelhead (CDFW and USACE 2021).

Based on the decline in abundance, restricted and fragmented distribution, and lack of genetic diversity, the Russian River population of Coho salmon is in immediate danger of extinction. The Russian River population itself is in the middle of the CCC Coho salmon ESU's range and inhabits a watershed that represents fully a third of the ESU by area. For these reasons, irrespective of the condition of the watershed, the Russian River has great potential to provide important geographic continuity, diversity, and habitat space for the species. The continued existence of CCC Coho salmon in the Russian River is, therefore, significant to the survival and recovery of the entire CCC Coho salmon population.

CC Chinook Salmon

The Russian River is the southernmost extent of the range for the CC Chinook salmon ESU (64 FR 50394). The biological review team that reported on the status of the species felt these southern populations represented a considerable portion of the genetic and ecological diversity within the ESU (Myers et al. 1998).

Steiner Environmental Consulting (SEC) (1996) reported that there were no Chinook salmon population estimates until the 1960's, and by that time the returns appeared strongly associated with periods of sustained hatchery supplementation. Estimated Chinook salmon escapement was 1,000 in 1966 (CDFG 1965) and 500 in 1982 (USACE 1982). SEC (1996) reported that despite heavy fish planting in Dry Creek during the 1980's, a viable Chinook salmon run was not established. Returns to DCFH Dam from 1980 to 1996 ranged between zero and 304, with the biggest count in 1988. Hatchery of supplementation of Chinook salmon was finally terminated in 1996 (NMFS 2008).

Since 2000, the Sonoma County Water Agency (SCWA) has conducted annual counts of CC Chinook salmon moving past the Mirabel Dam water diversion facility located approximately 10 miles upstream from the proposed project. Between 2000 and 2013, the average number of adult Chinook salmon counted at Mirabel Dam was 3,283 fish, and in 2012, 6,697 adult Chinook salmon were counted at the station which was the highest total counted to date (NMFS 2016a). No data was obtained for 2014 and 2015. Between 2016 and 2019, the average number of adult Chinook salmon counted was 1320. In 2019, 909 adult Chinook salmon were counted, the lowest total since counting began (SCWA 2020). These data suggest a decrease in adult escapement in the past 20 years.

CCC Steelhead

Russian River steelhead runs once ranked as the third largest in California behind the Klamath and Sacramento rivers. The Russian River was renowned as one of the world's finest steelhead rivers during the 1930's and on through the 1950's (SEC 1996). Since the mid-20th Century, Russian River steelhead populations have declined. Estimates based on best professional judgment infer a wild run of 1,750- 7,000 fish near the end of the 20th Century (Busby 1996). Hatchery returns averaged 6,760 fish for the period 1992/93 to 2006/07, and ranged from 2,200 to 11,828 fish. The information available suggests that recent basin-wide abundance of wild steelhead has declined considerably from historic levels. A limited catch-and-release/hatchery sport fishery still offers a fishing season for hatchery steelhead in the Russian River.

According to the federal Steelhead recovery plan (NMFS 2016), little information is available on the historic abundance of adult steelhead in the Russian River watershed. Russian River winter steelhead were thought to have spawned and reared as part of 6 independent and 10 dependent populations in the mainstem, and in 240 named tributaries. Historically, upwards of 65,000 adult steelhead may have been present in the river system, dropping to 1,750-7,500 in the 1990’s.

Based on video counts of fish at Mirabel Dam on the mainstem Russian River, total adult steelhead (hatchery + natural origin) annual production averaged 367 fish from 2000-2016. Naturally and hatchery produced steelhead abundance ranged from 0-306, and 0-641 fish respectively over this time-period (USACE and CDFW 2021). Hatchery origin fish made up 67.2% of the identifiable steelhead recorded at the dam and small numbers of adult steelhead were also recorded at the Healdsburg fish ladder in 2014-2016 and in Dry Creek in migration years 2013-2016. Because the dam counts occurred over a small portion of the total steelhead run the numbers are considered an index of steelhead abundance.

The main factors responsible for the declines in species abundance are water diversions, dams, and other habitat alterations. For example, the construction of Coyote Valley Dam blocked access to the East Fork of the Russian River and its tributaries. These areas contained some of the best spawning and rearing areas in the basin (SEC 1996). Hatchery practices have also impacted steelhead populations within the action area. Since the1870's, millions of hatchery-reared salmonids have been released into the Russian River Basin. The combination of planting out-of-basin stocks, hatchery broodstock selecting processes, and interbreeding have led to a decrease in salmonid genetic diversity and loss of local adaptations (SEC 1996). There are two fish production facilities in operation within the Russian River Basin: Don Clausen Fish Hatchery (operational in 1980) and Coyote Valley Fish Facility (operational in 1991). Both facilities are owned by USACE and operated under contract by the California Department of Fish and Wildlife. The Coyote Valley Fish Facility was established in 1992 to mitigate for the loss of habitat above Lake Mendocino. The established mitigation goal is 4,000 adult fish based on the release of 200,000 yearling steelhead.

An estimate of natural origin adults was reported in CDFW and USACE (2021) based on hatchery returns from 2006 to 2015 for the Coyote Valley and the Don Clausen hatchery that average 6,233 fish. The natural origin adult abundance in the Russian River is unknown, but using sport angling data CFDW and USACE (2021, Appendix A) estimates the NOR population of approximately 3,233 adult NOR spawners by comparing HOR adults, which are caught in the sport fishery at a 2 to 1 ratio to natural origin adults. Other recent estimates from Russian River Coastal Monitoring Plan (CMP) surveys from 2018-2020 estimate the total population of adult steelhead spawning in the wild, including hatchery fish at 800-2000 adult steelhead (SFSC 2022). From 2017 to 2021, an average of 6,951 steelhead have returned to the hatchery facilities annually, the vast majority of these (>99%) being marked fish of hatchery origin (CDFW and USACE 2021). Thus, it is evident that hatchery-origin fish outnumber natural-origin fish by several fold. In this same time period, data from spawning ground surveys indicate that 51% of all fish observed in natural spawning areas were of hatchery origin (M. Obedzinski, California Sea Grant, unpublished data). Additionally, in 2021 and 2022, adult hatchery fish surplus to broodstock needs have been released into the system with floy tags, and these have been reported during subsequent spawning ground surveys. Thus, potential introgression between hatchery and wild fish is a significant concern (SFSC 2022). In addition to the current effects of adult hatchery fish spawning in the wild with natural origin fish, there are domestication effects due to rearing in the hatchery environment, and ongoing impacts to juvenile steelhead and salmon from competition and predation with hatchery smolts (CDFW and USACE 2021).

2.4.2 Salmonid Critical Habitat within the Action Area

Salmonid habitat quality in the Russian River and within the action area are primarily related to water quality and quantity, availability of clean spawning gravel and spawning areas, and access to important spawning and rearing areas. Much of the mainstem Russian River channel and riparian habitats have been degraded by the effects of urbanization and agricultural development. Urbanization and agriculture have degraded designated salmonid critical habitat through stream channelization, floodplain drainage, and damage to riparian vegetation (Botkin et al. 1995).

The upper mainstem Russian River below Lake Mendocino provides cool water to the upper reach of the river between Ukiah and Hopland. Below Hopland, California, the Russian River warms to temperatures that are stressful to salmonids, which can persist throughout the summer and early fall. According to SEC (1996) pool temperature stratification in the mainstem Russian River is impacted by summer releases from Coyote Valley Dam which releases 15-20 times the amount of pre-regulated flows in the mainstem Russian River with flows generally exceeding 125 cubic feet per second, resulting in marginal quality summer rearing habitat. Increased flows in the Russian River have created habitat conditions more favorable to introduced and non-native warmwater fish species such as Sacramento pikeminnow, bluegill, largemouth bass, smallmouth bass and striped bass. These non-native species likely prey on ESA listed salmonids during the spring and summer months (Sonoma Water 2016).

Channel simplification and increased summer flow has decreased the value of salmonid rearing habitat within the action area. Increased summer flow in the mainstem Russian River and Dry Creek are the result of dam releases from Coyote Valley and Warm Springs dams. The NMFS' September 24, 2008, biological opinion found that high flow releases jeopardized the survival and recovery of CCC steelhead and Coho salmon. The biological opinion based the jeopardy determination in part on the adverse effects of high flow releases on velocity and habitat quality (NMFS 2008). As a result, Sonoma Water petitioned the State Water Resources Control Board (SWRCB) to reduce summer releases from the Coyote and Warm Springs dams. The SWRCB has approved Temporary Urgency Change Orders (TUCOs) since 2009 to reduce minimum summer flow in the Russian River, which conserves reservoir storage while allowing for temporary cold-water releases from the two associated reservoirs to improve the quality of steelhead rearing habitat in the summer.

Reproduction of the natural Russian River steelhead population is primarily dependent on tributary spawning and some upper mainstem spawning which occurs in the Ukiah area. During drought years a large proportion of adult steelhead may rely on the mainstem for much of the spawning activity and subsequent rearing. The upper mainstem with cooler summertime stream temperatures, along with some major tributaries such as Pieta, Sulphur, and Robinson creeks generally provides much of the habitat capacity for the Upper Russian River steelhead population. This capacity in a portion of the upper mainstem has been enhanced by reducing the high flow releases as noted above and conserving the cold-water pool in Lake Mendocino. The middle mainstem reach downstream of Hopland, California has moderate to low quality summer rearing habitat due to elevated water temperatures, but is used by outmigrating smolts on their way to the Pacific Ocean. Similar to the changes made in flow releases in the upper Russian River, flow releases from Lake Sonoma now provide more suitable summer rearing habitat in 14 miles of Dry Creek for both Coho salmon and steelhead, which has enhanced habitat conditions due to cold water releases and habitat restoration work. The lower river tributaries provide much of the habitat capacity for numerous Lower River steelhead populations depicted in Figure 2 (areas 2-6).

Many tributary streams throughout the watershed and the mainstem channel have poor overwinter and outmigration habitat conditions from decreased habitat complexity which lack protection from predators, and carry an un-naturally high fine sediment load from surrounding landuse (NMFS 2015, Ritter and Brown 1971, North Coast Regional Water Quality Control Board 2000, California Department of Fish and Game 2002). Surrounding commercial and residential development and other land uses also contribute to poor summer rearing conditions in critical habitat areas throughout the watershed for Coho salmon and steelhead. Critical habitat conditions that represent PFBs for winter spawning, egg development, and summer rearing are considered marginal across the basin for ESA salmonids (NMFS 2015).

Given that streamflow and temperatures for salmonids the action area are currently stressed during the wet and dry periods of the year, we also rely on information from section 2.2.4 with respect to the broader climatic variables influencing the current condition of habitat in the action area. Variables such as air temperature, wind patterns, and precipitation are likely influencing localized environmental conditions, such as water temperature, stream flow, and food availability. These local environmental conditions can affect the biology of listed species and the functioning of critical habitat and its value for conservation. The combination of climate change effects and effects of past and current human activities on local environmental conditions further reduce the current condition of available habitat for salmonids in the Russian River and its tributaries due to the increase frequency of drought and flood events.

2.5. Effects of the Action

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

The Program including the two steelhead hatcheries has the potential to affect natural origin CCC steelhead, CCC Coho salmon and CC Chinook salmon in the Russian River. Potential effects from a variety of hatchery operations and interactions of released hatchery fish into the natural environment are likely to occur. NMFS' analysis of the Proposed Action is in terms of the expected effects the Program is to have on ESA-listed species and on designated critical habitat. Our analysis is based on the best scientific information for direct and indirect effect from hatchery operations and the result of hatchery fish that are released into the action. 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.

NMFS analyzes a proposed artificial hatchery program action for effects, positive and negative, on the attributes that define population viability, including abundance, productivity, diversity, and spatial structure. The effects of a hatchery program on the status of an ESU or DPS "will depend on which of the four key VSP attributes are currently limiting the ESU or DPS, and how the hatchery fish within the ESU affect each of the attributes" (70 FR 37204, June 28, 2005). The presence of hatchery fish within the ESU can positively affect the overall status of the ESU by increasing the number of natural spawners, by serving as a source population for repopulating unoccupied habitat and increasing spatial distribution, and by conserving genetic resources. Conversely, a hatchery program managed without adequate consideration can affect a listing determination by reducing adaptive genetic diversity of the ESU, and by reducing the reproductive fitness and productivity of the ESU. NMFS also analyzes and takes into account the effects of hatchery facilities, for example, and operation of fish collection facilities and water use, on each VSP attribute and on designated critical habitat.

The hatchery information that NMFS needs to analyze the effects of a hatchery program on ESA-listed species (Jones 2006) must be included in an HGMP. The HGMP for the Russian River Steelhead Integrated Harvest Hatchery Program, provided to NMFS on July 6, 2021 (CDFW and USACE 2021) details current and proposed hatchery operations, and related fish monitoring. Analysis of this HGMP and the Proposed Action for its effects on ESA-listed species and designated critical habitat includes consideration of the following factors:

(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.

2.5.1 Effects on Ecological and Genetic Diversity

Here we analyze broodstock practices for their impacts on the 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.

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). Hatchery steelhead utilized in the Program (Don Clausen, and Coyote Valley) are part of the listed population within the CCC steelhead DPS (71 FR 834).

The Program proposes to reduce genetic effects of hatchery fish on the NOR population by collecting NOR adults or NOR juveniles that will be reared and eventually used as part of the spawning in both facilities (CDFW and USACE 2021). In previous years (i.e., from 2006 to 2017), the proportion of broodstock consisting of natural origin fish (pNOB) used as broodstock ranged from 0-11% for DCFH and 0-1.66% for CVFF. However, genetic data collected on the broodstock after the fact, indicate that upwards of 50 percent of the supposed NOR adults may have actually been unmarked hatchery steelhead (J.C. Garza, personal communication 2022).

The HGMP proposes to increase the number of NORs used as broodstock[7] such that pNOB is at least two times higher than pHOS. This will result in a PNI of >0.67 (PNI = pNOB/(pNOB +pHOS)), the value recommended by the HSRGs for populations of high biological significance. The higher the PNI the more the natural environment drives local adaptation of the combined hatchery and natural population. Thus, the target proportion of the broodstock consisting of natural origin fish (pNOB) for CVFF and DCFH would be 30 percent and 50 percent, respectively.

The programs will collect approximately 180 NOR (but no more than 389) steelhead for broodstock annually. This action will reduce the number of NOR fish spawning naturally in the system. A reduction in adult abundance has the potential to reduce the viability of the steelhead population. Based on the estimated average size of the Russian River NOR steelhead population (2,000 -3,000) (CDFW and USACE 2021, SFSC 2022), the removal of 180 NOR adult steelhead each year will constitute a reduction of approximately 6-9 percent of the annual spawning population. However, because hatchery adult mating protocols and pHOS reductions proposed in this HGMP are expected to increase fitness of the steelhead population as a whole, NOR spawner escapement for the entire basin is modeled to increase slowly with the implementation of the HGMP (CDFW and USACE 2021). During the period of the section 10 permit the adverse effects to NOR fitness are expected to persist as modeling results suggest in the proposed HGMP. These adverse effects are reported by the California HRSG (CA HSRG 2012) to include the impact of hatchery-origin fish spawning in natural areas, domestication and other effects which will 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 (CA HSRG 2012). The analysis to determine the fitness and PNI for this Program was completed using the AHA (All-H Analyzer) model developed by the HSRG for analyzing anadromous salmon hatchery programs. This model (CDFW and USACE 2021) suggests that it will take 4 to 5 generations (16 to 20 years) before improvements will be realized with implementation of measures to improve fitness of NORs and reduce adverse effects of hatchery operations.

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[7] See Section 1.3.3. Avoidance and Minimization Measures, Broodstock collection and other measures proposed to improve fitness, which includes marking and genetic sampling. Genetic sampling will ensure the program increases the number of NORs to the specified level.

Given that the overall population fitness is expected to slowly improve from the implementation of the HGMP, the removal of 389 NORs for broodstock is not expected to cause adverse effects to the overall population abundance or spatial structure during the 10-year permit period. Furthermore, if pNOB targets reach 30 and 50 percent, we expect an improvement to the PNI (percent natural influence) above the target of 50 percent (which is recommended by the California HSRG (CA HSRG 2012).

Collection of NOR adults may result in some adverse effects during the holding, transport, or handling from the capture location to the hatchery facility. Some broodstock collection may occur via sport angling within the FMEP[8] area (i.e., mainstem Russian River) or beyond the FMEP area (i.e., in tributaries to the Russian River). While training of individuals collecting and handling of non-targeted adult salmonids by CDFW is expected to minimize mortality, many catch and release studies have shown that about five percent incidental mortality can be expected from sport angling of adult salmonids (Hooton 1987). Given that care and training is expected to occur with the angling collection, trapping and transport that is specific to the hatchery staff or volunteers we estimate that no more than five percent of 389 adult steelhead collected (i.e., 9-10 adult steelhead) will be lost due to the overall broodstock collection that is authorized by the section 10 permit, each spawning season.

Low numbers of CC Chinook and CCC Coho salmon are likely to be encountered in mainstem Russian River traps or tributaries streams where collection occurs. Coho salmon may be encountered in tributary streams in the lower Russian River and Dry Creek. Chinook salmon may be collected in Dry Creek and the upper Russian River and tributaries such as the West Fork Russian River, Robinson Creek and Feliz Creek. Given that few Chinook and Coho salmon are expected to be encountered during HGMP steelhead broodstock activities in the tributary streams, we estimate that a low number of these fish will be adversely affected because of training and measures to minimize losses of adult fish.

The collection (direct take) of up to 13,500 NOR juvenile steelhead from Russian River tributaries may result in adverse effects or mortality (incidental take) of non-targeted CCC steelhead, CC Chinook salmon, and CCC Coho salmon that may be encountered during these activities. Juvenile NOR fish collection, and handling of juvenile steelhead 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 steelhead are likely to be lost during

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[8] A Fishery Management and Evaluation Plan (FMEP) in development is expected to address adverse effects associated with sport angling regulated by CDFW in the mainstem Russian River.

transport activities due to measures such as tanks with cooling equipment, and highly 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 three percent of the fish subjected to handling, and transport to the hatchery. Incidental mortality can be reduced to near one percent with increased skill and experience of crews collecting and transporting fish. Given that broodstock activities are expected to be conducted by trained CDFW crews, we estimate fish mortalities of two percent or less per year (i.e., 240 juveniles) will occur during collection activities that are proposed during the 10-year permit period.

In addition to physical effects to individuals 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 a large portion of the collection of natural origin broodstock for this program will be at the juvenile life stage, which are available in comparably higher numbers with respect to numbers of adults. Collection of juveniles for rearing as broodstock will also be conducted in multiple sub watersheds (populations) and tributaries within population areas which is expected to further minimize the potential of population level affects. Much of the juvenile collection may be conducted by Sonoma Water during their monitoring activities in the Russian River under section 10 permit # 14419-4R. Collection under Permit 14419-4R is expected to reduce the effects of collecting juvenile broodstock because these fish can serve the purpose of monitoring under Permit 14419-4R and also be collected as broodstock under the HGMP.

In summary, while these activities are likely to cause some mortality of ESA listed salmon and steelhead (i.e., up to five percent of non-targeted adult salmonids captured, and up to two percent of juvenile salmonids encountered), these losses are expected to be minimal given the experience of biologists, and measures (i.e., training of fishers/capture crews) employed to minimize and avoid adverse effects.

2.5.2 Effects of 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 evaluates 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 reduction in fitness in hatchery fish, and in the progeny of natural fish spawning with hatchery fish, relative to the expected diversity and productivity in natural populations. Hatchery fish thus pose a threat to natural populations, when they interbreed with fish from natural populations.

The interbreeding of hatchery fish with NOR steelhead has been identified in the Program HGMP as an adverse effect due to the large number of HOR returns that spawn in the mainstem

Russian River and potentially stray to tributaries throughout the basin. Hatchery fish mating with natural origin fish has the potential to decrease average fitness which may result in decreased abundance, productivity, and diversity in natural populations.

Gene flow occurs naturally among salmon and steelhead populations, a process referred to as straying (Quinn 1993; Quinn 1997). Natural straying patterns serve 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).

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, and are expected to 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.

In the past, both Program facilities released surplus unspawned female and male adult HOR to the upper mainstem and lower Russian River. Large numbers of hatchery fish have been documented spawning in the mainstem Russian River and tributaries. The previous program recycled on average, over 4,700 surplus adults back to the river each year (CDFW and USACE 2021). These recycled fish were intended to provide anglers with harvest opportunities. However, these fish often stray and spawn with other HOR adults or NOR steelhead which results in decreased fitness of the natural population through increased pHOS. A decrease in fitness may result in lower adult abundance, population productivity and genetic diversity.

The previous number of HORs on the spawning grounds have led to an estimated pHOS of 48 percent (CDFW and USACE 2021). The future Program proposes to minimize the number of

HOR adults recycled back to spawning areas which is expected to reduce pHOS by 61 percent. By reducing pHOS and increasing pNOB, the programs goal is to achieve the percent natural influence of >0.67 which will result in a 66 percent and 70 percent increase in fitness for DCFH and CVFF programs, respectively (CDFW and USACE 2021). Therefore, fitness is likely to improve in the Dry Creek and Upper Russian River steelhead populations as well in the non-integrated (i.e., Austin, Green Valley and Mark West and Maacama creeks) steelhead populations of the Russian River. Reducing pHOS to less than 30 percent in both Dry Creek and the Upper Russian River is proposed to reduce competition for spawning habitat between natural origin and hatchery origin steelhead adults. The goal of reducing pHOS to less than five percent in the non-integrated populations (i.e., Austin, Green Valley, Markwest, and Maacama creeks) if achieved, will reduce competition for spawning habitat between NOR and HOR adults. If these metrics for pHOS are realized, an increased spawning success of NOR adults would result in fewer mating's with HOR steelhead adults that should result in increased population fitness (CDFG and USACE 2021).

Given the proposed changes to the Program with respect to pHOS, and pNOB, we expect only minimal adverse effects on both the genetic fitness of wild listed salmonids and reduced spawning habitat availability for wild listed salmonids due to competition with hatchery fish.

2.5.3 Effects of 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 spawned hatchery origin adults and released hatchery smolts share juvenile rearing areas with wild fish. Generally speaking, competition and a corresponding reduction in productivity and survival may result from direct interactions when hatchery-origin fish interfere (i.e., compete) with the accessibility to limited resources of 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 and Predation

Competition may result from interactions between hatchery fish and wild fish or more indirectly, as when utilization of a limited resource by hatchery fish reduces the amount available for naturally produced fish (SIWG 1984). Specific risks 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.

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. This behavior has been studied and observed, most frequently in the case of hatchery steelhead. Adverse impacts on naturally produced salmonids is definitely a consideration, especially given that the number of smolts per release is generally higher. 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.

Hatchery release of smolts from both facilities are expected to result in predation and competition risks to natural origin juvenile salmonids. Steelhead smolts released from the CVFF facility are likely to compete with juvenile Chinook salmon and steelhead for food and space as they migrate from the upper Russian River to the estuary during the spring. Steelhead smolts released from the Don Clausen facility are expected to compete with natural origin Coho salmon, Chinook salmon and steelhead as they migrate down river. This competition may result in a decrease in NOR juvenile abundance, population productivity and even diversity. Less interaction is likely during years when higher stream flow occurs (wetter winter and increased spring flows), which allows for faster transit time of hatchery smolts. However, during years with decreased streamflow (drier years), the effects to habitat space and competition for food are likely greater due to longer transit times for smolts and a greater number of hatchery smolts that may residualize in the mainstem Russian River. The permit period is 10-years, and current science is unable to make precise predictions regarding the number of dry or wet years that may occur in the next ten years. However, given recent climate conditions (a long-lasting drought punctuated by a few wetter years), we anticipate more dry than wet years during the permit term.

Another potential ecological effect of hatchery releases from the Program is predation. Salmon and steelhead are piscivorous and can prey on other salmon and steelhead. Predation, either direct consumption or 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 released as smolts are more likely to emigrate quickly to the ocean, but can prey on fry and fingerlings that are encountered during the downstream migration. Some of these hatchery fish may not emigrate and instead take up residence in the stream (residuals) where they can prey on stream-rearing natural juveniles over a more prolonged period. 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, or when habitat, particularly refuge habitat, is limited, and when environmental conditions favor high visibility.

We use the best available information to analyze the effects of predation and of hatchery smolts on ESA listed juvenile fish with the use of a PCDRISK model that is presented in the HGMP (CDFW and USACE 2021). The PCDRISK model was run to develop qualitative estimates of the predation and competition (i.e., ecological) risks hatchery steelhead pose to naturally produced steelhead, Coho salmon and Chinook (Pearsons and Busack 2012). The analysis was required because quantitative data on ecological risk were not available for the program. The data to run the PCDRISK model was primarily from Coastal Monitoring Plan juvenile trapping efforts conducted in Dry Creek and the mainstem Russian River, by the Sonoma Water (Martini-Lamb and Manning 2022). Many of the assumptions used in HGMP modeling for this analysis are best estimates. Therefore, the results of this modeling (CDFW and USACE 2021) are used as an index of ecological risk that the program poses to ESA listed salmonids in the Russian River. Modeling results indicate that the ecological risk hatchery steelhead juveniles pose to natural steelhead, Coho salmon and Chinook salmon can be quite high.

To reduce ecological risk, the Program proposes to implement the following changes to minimize and avoid adverse effects of released hatchery smolts to ESA listed juveniles and their critical habitat:

- DCFH origin steelhead smolts will be released on the mainstem Russian River upstream of Dry Creek, below Veteran’s Memorial Dam in Healdsburg, instead of at the headwaters of Dry Creek (currently a 14-mile overlap with Coho rearing), unless an alternate release location at the mouth of Dry Creek is established by CDFW and USACE.

- Smolt release size at both facilities will be reduced from 225mm (4fpp) to larger than 170mm (8fpp +/- 0.8fpp) and no greater than 200mm (typical size of NOR smolts captured in Russian River traps) for three-years. After three years, the adult age structure and its effects to Coho and Chinook will be reviewed by the TAC to determine if fish size should be adjusted.

- All releases will be conducted to provide migrating smolts with volitional release from facilities 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.

- Operating hatchery programs and releases to minimize the potential for residualism through recommendations by the TAC.

- If steelhead piscivory rate, defined as the percent of steelhead stomachs sampled that show evidence of predation to Chinook, Coho, or steelhead exceeds 10 percent, the program will consider reducing hatchery production even lower (i.e., less than 400,000). In addition, increased monitoring will be conducted in areas upstream of Dry Creek in the Upper Russian River, to inform and validate targets or additional management actions.

Despite the above minimization measures, adverse effects to salmonids are expected as a result of released hatchery smolts from the Program as they migrate downstream, and when hatchery smolts residualize in the Russian River. Natural origin CCC steelhead throughout the mainstem Russian River will be affected through predation and competition as seen in the results of the PCDRISK model developed for the Program. Both smolts and juvenile CCC steelhead will be adversely affected during periods when large numbers (e.g., 100,000) of hatchery smolts are released twice each year in the upper Russian River from CVFF and twice each year near Healdsburg from the DCFH. According to Pearson and Busack (2012) the effects of large hatchery smolts on natural origin smolts is through competition by increasing encounters, dominance, and/or probability that dominance results in body weight loss. The predation and competition for hatchery smolts on natural origin smolts and juveniles is estimated by the PCDRISK model to affect a total of 6.9 percent of NOR smolts and 14.7 percent of NOR juveniles in the mainstem Russian River. Adverse effects estimated by the PCDRISK model can be mortality through predation or loss of body weight and reduced survival or loss of preferred habitat which my result in predation by steelhead smolts released by the program.

We expect natural origin CCC steelhead juveniles to experience these effects from February to April when the majority of hatchery smolts are migrating down the Russian River to the estuary. As mentioned previously, we are unable to predict the number of dry and wet years during 10-year section 10 permit period, though we expect more dry years to occur. During low flow or drought conditions effects of predation and competition may be increased due to higher stream temperatures, longer smolt transit times, increased density of HOR smolts in riverine habitat, and a higher percentage of hatchery smolts that may residualize in the mainstem Russian River. During wetter years with higher February through April flows in the Russian River hatchery smolt transit times will be reduced and the potential for predation and competition effects to CCC steelhead is expected to be less.

Similar effects are expected to impact CCC Coho salmon in the Russian River. Overall, only a relatively small portion of the Coho residing in the Russian River will be adversely affected due to the Program's release locations, which prevent large amounts of interactions between steelhead hatchery releases and Coho salmon. For example, table 3 of the HGMP reports a predation and competition risk to Coho salmon juveniles in the upper mainstem Russian River of 99.0% percent. This high percentage is due to the low number of Coho smolts or juveniles reside in the upper Russian River, therefore, the model run shows a high percentage of impact to a very small portion of the Russian River Coho salmon population (K. Malone, NMFS, personal communication, August 2022). A total of 9.7 percent of the natural origin and hatchery origin Coho smolts are expected to be impacted by Program steelhead smolts in February and March and possibly into spring and summer (CDFW and USACE 2021). The majority of the interactions are expected to be between Coho salmon smolts and hatchery steelhead smolts as they migrate in the mainstem Russian River from Dry Creek to the estuary. Few juvenile Coho salmon are expected to be in the mainstem Russian River as they typically rear in cool tributary streams and Dry Creek during the summer. The HGMP steelhead smolt releases are made in the mainstem Russian River near Healdsburg to minimize and avoid impacts to juvenile CCC Coho salmon in Dry Creek. Additional impacts from predation or competition are not expected from potential changes to the release locations that the TAC may recommend. These effects will be considered during TAC discussions and by must be approved by NMFS prior to changing release site locations.

Juvenile CC Chinook salmon are also expected to be adversely affected by Program steelhead smolts (400,000 total) in the mainstem Russian River. A low number of juvenile Chinook salmon (<1 percent) are likely to be adversely affected in Dry Creek according to the PCDRISK model (CDFW and USACE 2021). Also, a relatively low number of juvenile Chinook salmon in the mainstem Russian River are estimated to be impacted (2.4 percent) as Program smolts migrate downstream to the estuary in the spring and early summer months.

Table 3. Index of Ecological Risk for the Current and Proposed Steelhead Hatchery Programs at DCFH and CVFF

Species	**Life Stage**	**DCFH (Dry Creek)**		**CVFF (Russian River)**	
		Current	**HGMP**	**Current**	**HGMP**
Steelhead	Smolts	5.5%	<1%	6.9%	6.9%
	Juveniles	3.5%	<1%	14.7%	14.7%
Coho salmon	Smolts	4.2%	<1%	9.7%	9.7%
	Juveniles	96.8%	<1%	99.0%	99.0%
Chinook salmon	Juveniles	6.2%	<1%	2.4%	2.4%

In conclusion, the Program would have largely low amounts of adverse effects to ESA listed CCC steelhead, CCC Coho salmon and CC Chinook salmon because the size of smolts will be small and releases will be made at specific locations to minimize effects to natural origin smolts and juveniles. A relatively high number of CCC steelhead (i.e., 14.7 percent of juveniles and 6.9 percent of smolts in the mainstem and < than 1 percent in Dry Creek) are at risk of adverse effects from Program steelhead smolts. The adverse effects to CCC steelhead smolts may be increased during drier low flow years when NOR juveniles may be more susceptible to effects of predation and competition. The PCDRISK model predicts adverse effects to almost 15 percent of the juvenile steelhead and seven percent of the smolt population in the mainstem could reduce individual natural origin CCC steelhead in the upper Russian River population and lower river populations as they migrate to the ocean. During low flow years when hatchery smolt outmigration takes longer, increased interactions of predation and competition on ESA listed salmonids may reach the values predicted by the PCDRISK model. The HGMP has proposed to reduce the size of hatchery smolts thereby decreasing overall predation of wild salmonids by hatchery smolts. The percent of wild fish predicted by the PCDRISK model and shown in Table 3 is not expected to be all mortalities, rather it is the percent of each species that are at risk of predation or ecological encounter through competition. NMFS expects that many of these fish will not be lost due to these interactions, especially because the size of hatchery smolts to be released would be smaller under the HGMP. Natural origin juveniles will be better able to compete with and avoid, if needed, these smaller hatchery fish.

2.5.4 Effects of hatchery fish and the progeny of naturally spawning hatchery fish in the migration corridor, estuary, and ocean.

Hatchery salmon are released into the ocean primarily so that returning adult salmon can support salmon harvests by local fishermen. However, hatchery salmon and steelhead can migrate long distances at sea and intermingle with distant natural-origin stocks, leading to unintended consequences when those natural-origin stocks are less productive (Ruggerone and Irvine 2018).

The timing and extent of migration of juvenile steelhead in U.S. West Coast waters is diverse. Catches of juvenile steelhead in research vessel surveys off Oregon and Washington during springs and summers, 1981–1985, were generally low and decreased from May to August, and no juvenile steelhead were present in September, indicating they had already migrated out of coastal waters (Pearcy and Fisher 1990). In spring through early summer of their first year, steelhead smolts enter the sea and move directly offshore and by late summer of this first year at sea, most North American fish have moved well offshore and are concentrated in the western Gulf of Alaska (Light et al. 1989). Unlike steelhead, Coho and Chinook salmon are generally present off the continental shelf and oceanic waters off the Pacific and found almost exclusively in continental shelf waters (Peterson et al. 2010). Hassirick (2016) found that in the weeks to months following ocean entry, California's juvenile Chinook salmon population appears to be primarily constrained to coastal waters near natal river outlets.

Given that steelhead occupy areas further offshore in the ocean environment we do not expect that 500,000 hatchery smolts from the CVFF or DCFH facilities will be sufficient to result in adverse effects to other ESA listed salmonid species. In addition to the difference in ocean migration and areas occupied, NMFS (2008c) concludes 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 (Ruggerone and Irvine 2018), the degree of effect or level of influence is not year well understood or predictable. More importantly, the HGMP operations considered here are considerably smaller than the large-scale hatchery production of facilities such as Prince William Sound in Alaska that released a total of 643,064,000 hatchery pink salmon (*Oncorhynchus gorbuscha*) in 2016 (Stopha 2016). Thus, any impacts are likely to be very small compared to facilities that release hundreds of millions of young salmon into the Pacific Ocean annually.

For the mainstem river and estuaries as it pertains to this consultation, NMFS analyzed the impacts of hatchery released smolts on ESA-listed salmonids in the mainstem Russian River, a migration corridor, in Section 2.5.3 above. Effects in the estuary of the Russian River are low because hatchery smolts are expected to move through the estuary and to the marine environment within a few weeks. Density-dependent interactions in the Russian River estuary are not expected due to the size and length of this estuary.

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 re-initiate section 7 consultation 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).

2.5.5 Effects of Research, Monitoring, and Evaluation

NMFS also analyzes proposed RM&E for its effects on listed species and on designated critical habitat. 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 can cause harmful changes in behavior and reduced survival. NMFS also considers the overall effectiveness of the RM&E program.

The steelhead monitoring and evaluation (M&E) program is focused on ensuring that performance indicators and standards identified in the HGMP are achieved. Measuring pHOS in each of the six Russian River steelhead essential populations (independent populations) to determine if HSRG guidelines for this parameter is achieved. Those hatchery operations required to produce healthy, disease-free fish that will survive to adulthood and return at high rates. The in-hatchery monitoring will track performance indicators as described above in the project description. The results of this monitoring will be reported in the annual hatchery report.

PHOS and pHOS Effective

The program will develop annual estimates of pHOS (census) and pHOS (effective) for both the DCFH and CVFF programs using a combination of spawner surveys and genetic sampling. PHOS census will require that field crews look for, and enumerate, the number of ad-clipped (hatchery) and adipose present (natural) adult steelhead observed in each population. No impacts to spawning NOR steelhead are expected to result from the pHOS census surveys because fish will only be observed, not captured. Minor avoidance behavior during the surveys may occur but not to the extent that adverse effects would result.

Collection of juvenile steelhead to conduct the pHOS (effective) will require that genetic samples be taken from all ad-present steelhead juveniles collected at outmigrant traps or by field crews seining or backpack electrofishing. The objective will be to process 389 NOR fish from each population in the upper Russian River and lower Russian River via outmigrant traps. Additional NOR juveniles (up to 100 fish) will be collected from each of the steelhead essential populations (independent populations) each year and genetically analyzed. The total number of juvenile CCC steelhead collected each year under this section 10 permit is 1800, which includes fish collected at outmigrant traps and other sampling conducted for the six independent populations.

Collecting a large number of juveniles in each of the six independent populations is expected to result in injuries or mortalities of natural origin ESA listed salmonids. Juveniles collected in the lower Russian River and Dry Creek are likely to be CCC steelhead, CCC Coho salmon and CC Chinook salmon. Upper Russian River collecting will likely encounter CCC steelhead and CC Chinook salmon. CC Chinook salmon are expected to be encountered during fish sampling in the spring in outmigration traps, but will not be present during summer collections because the vast majority of juvenile Chinook salmon migrate to the ocean within a few months of emergence from stream gravels.

Effects from collection efforts are likely to be in the form of injuries which occur in outmigrant traps, collection with seines, nets, or handling during genetic tissue sampling. Non-target fish collection, handling and tissue collection 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 effects of fish collection are described previously in section 2.5.1 of the effects section above. Monitoring and evaluation collection activities are expected to be similar to the effects described above with incidental take for ESA listed salmonids of 2 percent or less for pHOS (effective) fish collections. Given that tissue collection is expected to be conducted by trained CDFW, or agency crews, mortalities of 2 percent or less per year will occur during collection proposed during the 10-year permit period. Many of the outmigrant traps where juveniles will be sampled will be taken from existing traps that have section 10 (a)1(A) permits. The traps that Sonoma Water currently operates for their monitoring activities on the Russian River under permit No. 14419-4R will minimize the number of additional juveniles needed to conduct monitoring for under this section 10 permit.

Stomach Sampling and Genetic Analysis

Evidence of HOR steelhead predation on juvenile Chinook salmon, Coho salmon and steelhead will be collected by sampling the stomachs of juvenile hatchery steelhead (200 per month) captured using methods such as seines, hook-and-line or two screw traps in the mainstem Russian River from February to July 1 each year for three years, a maximum of 7,200 hatchery smolts over three years. Effects to natural origin smolts could result when sampling for the HOR smolts. Chinook salmon and Coho salmon are less likely to be captured with hook and line methods due to their smaller size. CCC steelhead smolts that could be hook and line sampled may be injured or killed due to hooking mortality or post mortality after release. We assume a low percentage of incidental mortality, two percent or less, due to trained individuals using collecting gear, including smolt traps or seining that minimizes impact to smolts being collected. Incidental mortality to listed salmonids for this activity is expected to be similar to those discussed above with less than two percent mortality of salmonids handled for this monitoring activity. Sampling of hatchery smolts will also be minimized with the use of existing traps for the activities carried out by Sonoma Water (permit No. 14419-4R).

2.5.6 Effects of Masking

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 the masking and whether and to what extent listed salmon and steelhead are at increased risk. The analysis also considers the role of the affected salmon and steelhead population(s) in recovery and whether unidentifiable hatchery fish compromise important RM&E.

Releasing unmarked hatchery fish can mask the abundance and productivity of natural salmon populations. This occurs because HOR adults cannot be distinguished from NOR adults. Masking is not expected to be an issue for the program as all hatchery fish released from both programs will be externally marked with an adipose fin clip or other external mark (i.e., max clips). In addition, all adults used for broodstock will be genetically sampled to ascertain whether they were produced from NOR or HOR parents and to provide intergenerational genetic marks in juveniles. This same sampling approach will be implemented for all NOR juveniles collected in traps or collected for incorporation into broodstock (CDFW and USACE 2021).

2.5.7 Effects of Construction, Operation, and Maintenance of Facilities

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.

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 provided in the Program HGMP, a high percentage of mortality from hatchery operations comes at the eyed egg to hatch lifestage and egg culling with as much as 50 percent reduction occurring in most years (CDFW and USACE 2021). Egg-to- fish release survival (including fingerlings, advanced fingerlings, yearlings, and smolts) has averaged 82 percent at CVFF and 72 percent at the DCFH facility for the years 2006-2017 (CDFW and USACE 2021).

The performance indicator proposed for egg to fry and fry to parr are very high with a greater than 90 percent survival to be met for the Program. Measures to minimize incidental losses from hatchery rearing include disinfection of equipment, general fish health maintenance and sanitation procedures, and feeding practices (DFW and USACE 2017). In order to maintain high survival rates within the hatchery rigorous maintenance sanitation procedures are a continuous part of standard daily hatchery operations. All cleaning equipment and nets are disinfected in Argentyne (iodine-based disinfectant) prior to use, and separate cleaning instruments are kept for each raceway. Overall fish health maintenance and sanitation procedures include daily pond cleaning, which, in addition to removing accumulated solids and fish feces, also puts the ponded fish through fluctuating flow regimes and is suggested as a possible benefactor to fish condition. In addition, weekly prophylactic salt flushes are given to all life-stages of steelhead throughout the duration of rearing.

Feeding practices are continuously monitored and feeds are continuously rotated and inventoried. Overcrowding is prevented by monitoring rearing density. Fish condition is observed daily by hatchery staff, and treatment of routine fish diseases is administered by the hatchery manager as needed. Very high standards are proposed in the HGMP for survival at various life-stages (Table 2. Above) which require high standards to be met to minimize hatchery operations losses of CCC steelhead. These incidental mortality at various life-stages due to normal hatchery operations are determined to be acceptable for the proposed operations. Hatchery operations are not expected to effect ESA listed salmonids due to the separation of these facilities with salmonids rearing in the wild.

Hatchery Spawning Practices

The California HSRG (CA HSRG 2012) states that mating protocols must not substantially contribute to inbreeding in the stock. Inbreeding occurs when related individuals mate and produce offspring, with many of their gene copies then identical by descent. Inbreeding leads to the expression of deleterious recessive traits, reduces genetic diversity and has been shown to decrease fitness in salmonids dramatically. For programs that use less than 250 females (both CVFF and DCFH spawn less than 250 females) the California HSRG recommends that eggs from each female be split into two or more lots and that each lot be fertilized by sperm from a different male in a separate pan, and also that eggs from no more than two females be incubated in a single incubator tray (CA HSRG 2012).

Both facilities will follow the mating protocols as developed by NMFS and CDFW geneticists per M. Lacy's memorandum (M. Lacy, CDFW memorandum, October 22, 2022). These protocols propose to meet several challenging program goals: 1) increase the total number of parents used as broodstock to increase effective number of breeders, 2) maximize retention of NOR contribution to improve population fitness, 3) increase the effective population size of the integrated population which maintains genetic diversity and 4) reduce the number of age-2 adults used in broodstock.

This modified protocol (M. Lacy, CDFW memorandum, October 22, 2022) will maximize the contribution of all NOR fish used as broodstock. Also, this protocol avoids take associated with discarding NOR eggs, and maximizing effective population size for these facilities. Take of crosses that have at least one NOR parent will be avoided because these eggs will not be culled. The spawning protocol proposes equalizing the size of HOR x HOR families, to the extent possible, which is critical to meeting the conservation goal of maximizing effective population size for these facilities. The spawning protocol does this by keeping all small families and to reduce large families by reduce eggs per female to 2,500 fertilized eggs. The proposed protocols generally meet the California HSRG recommendations which NMFS expects will minimize the potential effects of hatchery mating on CCC steelhead.

Hatchery Rearing Effects

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. Le 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 modifications induced by hatchery rearing (Le 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.

Steelhead juveniles reared to various sizes are expected to be affected by domestication selection from the hatchery rearing environment. Four to five-hundred-thousand steelhead smolts per year are produced, and released to the mainstem Russian River. Juveniles reared in the hatchery environment are likely to experience reduced fitness from hatchery rearing domestication, which will likely result in lower SARs. Monitoring reported in CDFW and USACE (2021) report of SAR averaged 1.2 percent for the existing program. The SAR for the Program proposes to meet a survival of 2 percent or greater, which aligns with natural steelhead survival of 2 to 3 percent in California (Shapovalov and Taft 1954). The Program proposes to improved its SARs over a ten-tear period by improving husbandry practices, and increasing the number of NORs in the broodstock. We acknowledge that many factors can affect the SAR but given the fact that SAR return information suggests that the past Program adult fish return at a low rate, the continued effects of hatchery rearing is expected to result in some reduction in fitness due to domestication. We anticipate this reduction in fitness will decrease over the time of the permit due to the increase in the percent of natural origin broodstock.

Water Quality at Don Clausen and Coyote Valley Facilities

Effluent from these facilities has the potential to affect ESA listed salmonids in receiving waters of Dry Creek and the East Branch Russian River. Effluent water quality discharge limits are established to meet beneficial use of the receiving waters by the North Coast Regional Water Quality Control Board (NCRWQCB). The water quality for the receiving waters are set within the NCWQCB Basin Plan for cold water fish, specifically salmonids (NCWQCB 2018). NCWQCB's Basin plan further designates surface waters for threatened and endangered species as "RARE" for these areas based on data within the California Department of Fish and Wildlife's Natural Diversity Data Base (CNDDB).

The daily maximum effluent limits established in the National Pollution Discharge Elimination System (NPDES) permits are required to meet beneficial uses for cold water fish and RARE species and allow for either a minimal acceptable change or no change to the receiving waters. DCFH and CVFF are permitted through the NCRWQCB general permit for hatcheries and cold-water animal production facilities ORDER R1-2021-0010 General NPDES NO. CAG131015 (NCRWQCB 2021). In Dry Creek and the Russian River, these beneficial uses include cold water fish fauna, which reflects the general water quality requirements for the ESA listed Coho salmon, steelhead, and Chinook salmon.

These facilities are required to monitor and report various constituents that are discharged such as total suspended and settleable solids, pH (potential of hydrogen), DO (dissolved oxygen), temperature and other parameters (CDFW and USACE 2021). Compliance is monitored by sampling the facility effluent two times per month, with results submitted in a monthly and annual report to the NCWQCB. It is further stipulated that sampling occur during chemical treatments and cleaning operations, because this is the component of fish production most likely to produce poor water quality conditions. Settling basins have been installed at both facilities to ensure that hatchery effluent discharges comply with the discharge standards and conditions of the NPDES permit.

Stream temperature monitoring of receiving waters measured and reported for the end of July 2022 (CDFW 2023a) show and increase from 15.9 ºC to 18.7ºC from effluent releases at DCFH. This increase in temperature may expose juvenile Coho salmon rearing in Dry Creek to adverse effects. NMFS recovery plan (NMFS 2012a) for CCC Coho salmon states that optimal growth for juvenile Coho salmon occurs when instream temperatures average 12-14° C. When maximum weekly average temperatures exceed 18°C, Coho salmon are absent from otherwise suitable rearing habitat (Welsh et al. 2001). The DCFH facility reports a grab sample temperature of 18.7ºC in July of 2022 (CDFW 2023a). The 2022 reporting data for the facility's grab sample and is not sufficient to determine the overall effects to rearing from the waste discharge at DCFH. We reviewed continuous stream temperature monitoring data from the Lambert Lane USGS stream gauge (11465240) six miles downstream and found that temperatures did not exceed 18ºC during the summer months of 2022. The waste discharge from the DCFH facility likely increases stream temperature for a short distance downstream just below the discharge site. The resulting temperature regime in Dry Creek is not expected to be lethal for Coho salmon but may have minor impacts on growth of fish residing near the discharge site in Dry Creek during the summer months. During the 10-year permit period effluent releases from this facility will cause marginal habitat conditions for juvenile Coho salmon during a portion of the summer rearing period just below the facility, but not in the majority of the rearing areas of Dry Creek which stay below 18ºC.

Another important water quality parameter for salmonid survival is DO in receiving waters. Impacts to salmonids are expected if effluent from these facilities reduce DO to levels that that reduce food conversion and growth which is at concentrations less than 5 milligrams per liter (mg/L) (Meehan 1991). Reporting information for both facilities shows that DO in receiving waters below effluent releases are not reduced by the discharge (CDFW 2023a, CDFW 2023b). DO for these facilities range from 9 to 11 mg/L, with many measurements for DO showing increased levels downstream of discharge sites.

Other notable water quality measurements such as settleable solids and turbidity are in compliance the majority of the year. High turbidity or settleable solids can reduce water quality for salmonids by impacting gill surfaces, disrupt feeding and result in avoidance response at 70 nephelometric turbidity units (NTUs). Settleable solids have been reported to be tolerated by rainbow trout in recirculating aquaculture systems at concentrations of up to almost 70 mg/L (Becke et al. 2019). The DCFH and CVFF have a 15mg/L discharge permit threshold. Monitoring data from DCFH shows that for 2022 the threshold was exceeded by 0.1mg/L for one grab sample taken in December of 2022. Minor increases in turbidity or settleable solids do not appear to be increase receiving waters sufficiently to adversely affect salmonids residing in stream reaches below each hatchery facility.

CVFF discharge monitoring data (CDFW 2023b) reported for 2022 into the East Fork Russian River show that water quality levels do not reach levels that adversely affect steelhead. CVFF is operated during the winter and spring months and temperatures monitored in the receiving waters are reported to range from 9.4ºC to 11ºC which is not likely to result in affects to salmonids in the East Fork Russian River below the facility. Other parameters such as DO, pH, settleable solids, etc. are within ranges that do not adversely affect salmonids.

We also evaluated the other effluent constituents such as ammonia, total hardness ($CaCO3$), pH and these facilities do not report any discharges or changes in receiving waters that reach levels that are expected to cause adverse effects to ESA listed salmonids in downstream reaches. Based on the current water quality measured and reported for hatchery effluent being discharged at the CVFF and DCFH we determine that no adverse effects to salmonids in East Fork Russian River are likely, with minor temperature effects in Dry Creek. During the summer the DCFH facility may periodically affect a short reach of Dry Creek with temperature increases that are just above the threshold for juvenile Coho salmon. The increase is not expected to be sufficient to result in adverse effects as these effects are likely short in duration, and are likely to only have minor, if any, impacts on fish growth near the discharge. And, fish near the discharge would be able to move to seek out lower temperature areas if desired.

Disease Transmission

Hatcheries have the potential to transmit diseases and adversely affect natural origin ESA listed salmonids. With regard to adult fish, all surgically-related equipment (i.e., needles for egg harvest, and tissue collection utensils) are disinfected in argentyne prior to use. All harvested eggs are disinfected as well. Bacterial kidney disease (BKD) screening is not carried out routinely on hatchery steelhead due to the low incidence of infection from this pathogen. However, each spawning season, each facility typically collects samples for BKD analysis, compiled from the ovarian fluid of approximately 20 hatchery adult females. Samples are screened by pathology for incidence of BKD and to screen for viruses. Returning hatchery origin adult steelhead with any anomalous deformations are culled from the run (a very rare occurrence) to maintain the health of the run.

Based on past history at the facilities, it is rare for disease occurrences to result in significant mortality (FishPro and Entrix 2000). Effects associated with pathogens known to occur at these facilities includes Flexibacter psychrophilus (Bacterial Coldwater Disease), which is expected to be a low risk of amplification or dissemination to salmonids in receiving waters as rearing steelhead are reported to respond well to treatment. Renibacterium salmoninarum (Bacterial Kidney Disease) does not typically affect steelhead, and is known to occur throughout a large geographical area, especially where chinook and Coho salmon occur (FishPro and Entrix 2000, Delghandi et al. 2020).

If disease outbreaks occur the hatchery manager requests CDFW pathology staff to do health assessments. Treatment methods are prescribed by fish pathologists for disease outbreaks and treatment protocols are carried out by hatchery staff under the direction of the hatchery manager. Depending on the cause of an outbreak, treatment methods may vary. Chemical treatments for external parasites are limited to the use of salt, formalin, and hydrogen peroxide. Bacterial infections are generally infrequent with post-larval steelhead but could include the use of penicillin G or oxytetracycline. CDFW, also certifies the health and disease status of steelhead prior to release. The fish are examined for bacteria, whirling disease, viruses and external parasites following American Fisheries Society Blue Book protocols. Given the protocols and methods in place to treat disease outbreaks, no adverse effects to ESA listed species that reside in downstream areas are expected from the two hatchery facilities during the proposed 10-year permit period.

Catastrophic Risk Management

The HGMP for this Program includes catastrophic risk management protocols designed to reduce the risk of injury and mortality of listed salmonids 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 backup water supply systems and risk aversion measures that would be implemented at each facility to minimize the likelihood for listed steelhead mortalities resulting from equipment failure, water loss from power failure, vandalism, and flooding. NMFS expects that these management protocols, backup systems and safeguards will minimize or avoid the catastrophic loss of hatchery or natural origin steelhead held at the facilities.

2.5.8 Effects of Fisheries

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 of the program) and listed species are 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.

Following the NMFS guidance regarding the effects of fisheries that exist because of the HGMP, we determine that these effects will not result from the project as proposed. The fisheries in the Russian River have existed for decades and are well known to steelhead anglers throughout the world. Furthermore, the steelhead angling fisheries do not exist as a consequence of the hatchery program and the HGMP does not propose a specific angling program as a tool to reduce HOR adults. The HGMP does suggest that fisheries managers (CDFW) act to increase harvest rates on HORs to at least 50 percent to provide a better fishing experience and to reduce the number of HORs spawning naturally. The recommended harvest goal is for Russian River anglers to harvest 50 percent of the hatchery origin steelhead adults returning to the system each year. On average, to meet this goal, anglers are expected to harvest approximately 3,500 adults each year, an increase of 2,600 adult HORs per year. To achieve this level of harvest would require that catch bag limits be raised, or other changes in regulations. Setting possession and bag limits, and other regulations that may increase angler harvest is at the sole discretion of the California Fish and Game Commission and is not reasonably certain to occur. Therefore, implementation of the HGMP and issuance of a section 10 permit for operations is not expected to cause additional effects or incidental take to ESA-listed salmonids as it relates to sport angling. Any incidental take that is associated sport angling is expected be covered in a future approved FMEP that would be conducted between NMFS and CDFW for the sport angling program carried out by the State of California. Completion of the FMEP is expected prior to the first review of performance indicators (i.e., within three years).

2.5.1 Effects of Action on Critical Habitat

The action area for this biological opinion includes designated critical habitat for CCC Coho salmon, CC Chinook salmon, and CCC steelhead. The effects to physical habitat are associated with the direct effects to PBFs for CCC Coho salmon, CC Chinook salmon and CCC steelhead critical habitat, and their associated essential features within freshwater. One of the PFBs identified for freshwater rearing sites is freshwater migration corridors free of excessive predation, and critical habitat with adequate space to provide rearing of juvenile salmon and steelhead.

Releasing large numbers of steelhead smolts in the spring from both facilities has the potential to adversely affect the essential feature identified as critical habitat “space”, which is required for stream rearing juvenile salmonids. The PCDRISK analysis conducted to assess impacts of steelhead smolts on ESA listed salmonids predicts the loss of juvenile steelhead, Coho salmon and Chinook salmon from the release of large numbers of steelhead smolts into the mainstem Russian River coupled with reduced flows. This occurs because habitat carrying capacity and space become limiting. The result is predation and competition with natural origin salmonids rearing the mainstem river. During water years with drought conditions NMFS expects that CCC steelhead and CC Chinook critical habitat in the upper and lower mainstem will be adversely affected. In low flow years, migration of smolts takes additional time as they must travel almost 100 miles downstream to the estuary. Under lower flow regimes habitat space is reduced for natural origin steelhead and CC Chinook in the upper mainstem. Below Dry Creek the mainstem Russian River is larger with increased habitat capacity and likely less impact to critical habitat for salmonids including CCC Coho salmon due to the increased size of the lower river.

The Program proposes to minimize these adverse effects by releasing Program smolts at a smaller size to reduce competition for space and releasing smolts during higher dam release flows or storm events to minimize migration travel time and effects to natural origin steelhead and salmon in the mainstem. During critically dry years when Lake Mendocino releases flows of 25 cubic feet per-second (cfs) in the East Branch Russian River, increased impacts to critical habitat space are expected due to reduced habitat availability as hatchery smolts migrate downstream. Critically dry-year water years are difficult to predict, but we expect that during the permit period there would be two or three years when these conditions would slow smolt migration to the estuary. When these conditions exist, hatchery smolts may affect the feeding and holding areas that natural origin salmonids occupy. McMichael et al. (1999) found that when larger hatchery smolts are released with wild salmonids, the hatchery fish dominated and displaced their wild counterparts. Hatchery steelhead behaviorally dominated wild O. *mykiss* in most situations, and were generally larger and behaved more aggressively and violently than wild fish (McMichael et al. 1999). This and other similar studies report that wild fish are displaced or impacted by larger hatchery smolts as they migrate down river to the ocean.

The effects to rearing to habitat space for NOR juvenile Chinook salmon, Coho salmon, and steelhead may be minimized with annual release plans by the TAC (CDFW and USACE 2021). Release plans from both facilities is expected to improve hatchery steelhead smolt survival while minimizing effects to critical habitat and ESA listed salmonids. Critical habitat designated for CCC steelhead and CC Chinook salmon in the mainstem Russian River from Ukiah to Healdsburg is expected to be affected during the months of January through May when hatchery smolts are at their highest densities in reaches of the Russian River. During wet and normal water years, flows are likely to be sufficient to decrease travel time for hatchery smolts to reach the Russian River estuary. In these wetter water years with sufficient flow (hundreds of CFS) the impact on critical habitat rearing space is unlikely to be limiting for salmonids and thus PBFs of adequate habitat space and free from excessive predation would not be adversely affected.

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 Multispecies recovery plan (NMFS 2016) but we do not expect major increases in these threats due to existing land use county zoning and development regulations. Similar 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 steelhead (NMFS 2016). Threats reported in the NMFS (2016), such as agriculture, timber harvest and recreational fishing are not expected to increase significantly over the 10-year permit period.

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

2.7. Integration and Synthesis

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

The environmental baseline in the action area for the proposed HGMP is an example of a highly disturbed watershed. The two large dams affect the hydrology and allow for anthropogenic development to thrive within the watershed. Loss of salmonid habitat upstream of these dams has resulted in mitigation hatcheries that the USACE is mandated to operate. These dams, Coyote Valley Dam in the upper watershed and Warm Springs Dam on Dry Creek in Sonoma County do provide cold water habitat in downstream reaches that support salmonids. Gravel extraction, residential development, and agriculture have further degraded salmonid habitat conditions in the action area which includes all anadromous reaches in the basin. Tributary habitat conditions are reported to be unsuitable due to recent drought years, with notable climate impacts on salmon which have occurred throughout the 2012–2016 in California (SFSC 2022). In streams that are critical for Coho salmon (steelhead cohabitate these streams) in the Russian River system, for example, the dewatered portion of the river network over summer increased from 28 percent in the first year of the drought to 58 percent in the third and fourth years (Deitch et al. 2018, cited from SFSC 2022).

Beneficial actions across the basin have occurred over the last decade, including major habitat improvements to Dry Creek off-channel habitats by Sonoma Water and the USACE, numerous minor habitat improvement projects undertaken by private landowners, and continued operation of the Coho salmon captive brood hatchery program at DCFH. Also, improved reservoir management in Lake Mendocino and Lake Sonoma has maintained minimum flow in the mainstem Russian River and Dry Creek during recent drought periods.

In the last five years, an average of 6,951 steelhead have returned to these facilities annually (E. Larson, CDFW, unpublished data 2019), the vast majority of these (>99 percent) being marked fish of hatchery origin. Thus, it is evident that hatchery-origin fish outnumber natural-origin fish by several fold. In this same time period, data from spawning ground surveys indicate that 51 percent of all fish observed in natural spawning areas were of hatchery origin (M. Obedzinski, California Sea Grant, unpublished data, 2020). Additionally, monitoring shows that during the last two years that adult hatchery broodstock fish have been released into the system, they have been observed at relatively high proportions during subsequent spawning ground surveys. Thus, potential introgression between hatchery and wild fish is a significant concern (SFSC 2022).

Currently there are no populations of the CCC steelhead DPS as described in the Status Section that meet the viability targets (Spence et al. 2008). Most populations of CCC steelhead have declined in abundance to levels well below moderate risk level within the action area and in each diversity strata. Recent information provided in SFSC (2022) report adult abundance in the Santa Cruz diversity strata in the San Lorenzo River and Pescadero Creek appear to typically number in the low hundreds of fish, while other independent populations appear to number in the tens of fish. Population estimates are not available for these the Santa Cruz Area of the DPS, but current information suggests very low population numbers and limited data that make it difficult to determine the current status of steelhead in these diversity strata (SFSC 2022). The action area for this consultation includes populations of CCC steelhead within the North Coastal and Interior diversity strata. The North Coastal diversity strata includes small coastal watersheds in Marin County which are not included in the action area of this consultation. The Russian River represents the majority population abundance of these two diversity strata and the anchor for maintaining population viability in the CCC steelhead DPS.

Currently, adult hatchery fish are listed as part of the Russian River population (70FR 37160). NMFS (2012a) recommends the expansion and efforts to secure long term funding of the DCFH Hatchery Program to provide an expeditious alternative to conserve broodstock across the ESU. The 2008 Russian River biological opinion's (NMFS 2008) incidental take statement requires[9] (among others) 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 HGMP permit period over the next 10 years.

The Program will follow the recommendations of the California HSRG report (HSRG 2012) to improve and restore natural origin populations within Russian River. The Program will produce 20 percent fewer hatchery smolts which will result in a reduced number of fish causing adverse effects to natural origin steelhead and salmon. Changes in release timing and location and size of smolts is expected to result in less interaction of juvenile natural origin smolts and hatchery released smolts. To improve fitness of hatchery origin fish the Program proposes to increase the percentage of broodstock consisting of NOR steelhead adults. By reducing the Program from 500,000 smolts to 400,000 smolts the HOR component of the adult population abundance is estimated to be maintained at approximately 5,000 adult spawners (CDFW and USACE 2021).

This integrated Program is intended to maintain the genetic characteristics of a local, natural population among hatchery-origin fish by addressing the genetic effects of domestication (CA HSRG 2012). Though these hatchery-origin fish are considered part of the ESA listed CCC steelhead DPS, the current high fraction on natural spawning grounds is well above the recommended proportion of hatchery-origin fish on natural spawning grounds (< 30%) for integrated hatchery programs to avoid erosion of population fitness (HSRG 2015).

[9] In order to receive the exemption from the ESA Section 9 take prohibitions, compliance with a biological opinion's incidental take statement is required.

Implementation of measures to reduce pHOS across the action area, such as reducing the number of HOR spawners relocated back the Russian River is expected to improve pHOS to less than 30 percent and reduce adverse effects of hatchery adults spawning with natural origin fish. Other independent populations described by the NMFS (2016), (i.e., Austin Creek, Green Valley Creek, Mark West Creek, and Maacama Creek) will be monitored to determine if pHOS meets the California HSRG (HSRG 2012) recommendation of less than five percent. The improvements from increasing the percent natural origin broodstock and reducing the proportion of hatchery spawners in the wild are likely to improve population fitness, but the full effect will not be observed for up to 20 generations. (CDFW and USACE 2021). Even though the impacts to fitness will take time, the measures proposed in this HGMP are a key to maintaining fitness of CCC steelhead in the future as climate change impacts increase

Incidental take of non-targeted ESA listed salmonids is expected from broodstock collection of adult and juvenile natural origin steelhead. Monitoring and evaluation 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. Minimization measures ensure that care is taken during adult NOR and juvenile collection in each watershed, stream, and habitat to minimize the effects to natural origin fish in each sub basin. Additionally, fish rescued during efforts to avoid stranding of juvenile salmonids during reduced flows from droughts may be utilized as part of broodstock collection. Release of hatchery smolts results in competition with natural origin juveniles for habitat space, or natural origin juveniles could become prey to larger hatchery smolts as they emigrate out of release areas on the mainstem. These effects on natural origin juveniles and critical habitat will be minimal due the short period of time Program smolts reside in release streams, their smaller size and release locations that minimize interactions with ESA listed fish. Combined, the adverse effects from broodstock collection, monitoring and evaluation, and Program smolt releases are not expected at levels that reduce survival or impede recovery on CCC Coho salmon, CC Chinook salmon or CCC steelhead because the Program will help in the long-term recovery and survival of wild Russian River steelhead populations. As stated in the California HSRG (CA HSRG 2012) the primary goal of the HGMP is to devise biologically based artificial propagation management strategies that ensure the conservation and recovery of listed ESUs.

The upper Russian River and Dry Creek represent large independent populations within the Interior diversity strata of the CCC steelhead DPS. Overall, the proposed Program is likely to continue to maintain abundance, and improve the diversity of natural origin CCC steelhead in the Russian River. The integrated hatchery production at the CVFF and DCFH facilities is likely to maintain a hatchery return of approximately 5,000 to 6,000 adult fish (CDFW and USACE 2021) in the Interior Diversity Stratum of the CCC steelhead DPS. The natural origin abundance within the Russian River is estimated to be approximately 2,000 natural spawners (SFSC 2022). The recovery target (NMFS 2016) for the integrated area (Diversity strata) is 17,200 spawning adults. The hatchery produced and natural origin abundance is expected help contribute the diversity of the upper Russian River and Dry Creek populations during the 10-year permit period. While maintaining abundance, the HGMP will also improve the fitness over time which is expected to improve survival of natural origin steelhead within the action area.

This biological opinion analyzes the authorization of a section 10 (a)(1A) of the ESA permit by NMFS, which would allow the artificial hatchery production of steelhead for a 10-year period. Given the Program's breeding, rearing and release protocols that minimize impacts to steelhead and other federally listed salmonids in the action area, the 10-year permit for operating the proposed Program is not expected to pose viability risks to populations of CCC steelhead, CC Chinook salmon, or CCC Coho salmon in the Russian River and thus not appreciably reduce the likelihood of both the survival and recovery of these listed species in the wild by reducing their numbers, reproduction, or distribution at the DPS or ESU scale. The adverse effects described above to rearing habitat for CCC Coho salmon, CC Chinook salmon and CCC steelhead are expected to be minimized by the implementation of the HGMP and, therefore, are not likely to appreciably diminish the value of designated critical habitat as a whole for the conservation of these species.

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 steelhead, CCC Coho salmon, CC Chinook salmon 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). "Harass" is further defined by interim guidance as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

Below we describe the incidental take that is exempted as part of this biological opinion. All expected direct take described in the biological opinion above is authorized in the Section 10(a)(1)(A) permit.

2.9.1. Amount or Extent of Take

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

1. Broodstock Collection

Broodstock collection for juvenile NOR steelhead will employ seining and backpack electrofishing methods that can cause incidental mortality of CCC Coho salmon, CC Chinook salmon, and CCC steelhead. During the ESA section 10 authorized collection of 13,500 natural origin CCC steelhead juveniles each year for rearing and release as smolts, other ESA listed juvenile salmon may be incidentally collected, injured or killed. Incidental mortality is generally less than two percent for these activities that are carried out by experienced biologists. Recent juvenile broodstock and rescue collections in Russian River tributaries report incidental losses of less than 1 percent (D. Hines, email communication 2022). Incidental take for juvenile broodstock collection will be exceeded if mortalities from collection and transportation to the hatchery facilities exceeds two percent.

Collection of 200 natural origin adult broodstock utilizing sport angler programs, traps or weirs will be authorized in the section 10(a)(1)(A) permit as direct take for the HGMP. During collection of NOR adult broodstock (excluding legal angling) there is the potential for incidental collection of CC Chinook salmon, CCC Coho salmon or CCC steelhead that are not appropriate for collection that could be injured or killed. We expect the number of adult salmon or natural origin steelhead to be killed due to incidental capture, and handled to be very low. If more than 5 percent of the non-targeted adult salmonids are injured or killed then incidental take is exceeded.

2. Hatchery Fish Spawning in the Wild

Reproductive success of CCC steelhead 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 steelhead 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 steelhead and would be cost prohibitive due to the level of monitoring required to estimate reproductive success of each brood year 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. In the event the proposed increase of NOR adults does not occur, overall steelhead production will be decreased by another 20 percent (or 100,000 smolts).

Because estimating the reduction in reproductive success is not practicable, the HGMP's NOR target for hatchery spawning adults will be used as a surrogate for the extent of incidental take. Incidental take for reduction in reproductive success will be exceeded if the Program does not implement the increase of NOR adults into the hatchery spawning as proposed in the HGMP.

3. Predation and Competition from Hatchery Smolts

Released hatchery smolts typically move out of the mainstem Russian River within a few weeks. As these smolts 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, and CCC 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. PCDRISK analysis conducted estimated that up to 15 percent of juvenile CCC steelhead and 7 percent of natural origin steelhead smolts may be adversely affected by hatchery released smolts. The majority of these affects are expected to occur in the mainstem during a short period when smolts are moving downstream to the estuary.

Predation and competition of hatchery released smolts is predicted to affect 2.4 percent of Chinook salmon juveniles in the mainstem Russian River. Few Coho salmon smolts are expected to be impacted in the mainstem Russian River above Healdsburg due to the low or nearly non-existence of Coho salmon in the upper areas of the watershed. Up to 10 percent of endangered CCC Coho salmon are expected to be adversely affected by hatchery released steelhead smolts during the spring. Adverse effects are expected in the mainstem Russian River below the confluence with Dry Creek. Effects to Coho salmon smolts in Dry Creek are predicted by the PCDRISK model to be less than 1 percent due to modifications in release sites of hatchery steelhead smolts that avoid interaction with Dry Creek fish.

Because predation and competition across the Russian River watershed cannot be precisely quantified, NMFS will use two surrogates for the extent of take: 1) the extent of take will be exceeded if the program releases greater numbers of juvenile fish than those proposed in the proposed HGMP submitted by USACE and CDFW and does not implement measures described in the HGMP to minimize adverse effects of Program smolts; 2) furthermore, if monitoring and evaluation work finds that predation of natural origin salmonids is greater than that estimated by the PCDRISK model then take would be exceeded.

4. Monitoring

The proposed section 10 permit would authorize the collection of tissue samples for measuring pHOS effective via sampling of a total of 1,800 ad-present juvenile steelhead at traps located near the mouths of each independent population unit, or within each independent population unit.[10] Collection for tissue sampling could result in incidental take of CCC Coho salmon, CC Chinook salmon, and CCC steelhead. Incidental mortality may occur during downstream migrant trapping as a result of anesthetizing, trapping, tagging, and tissue sampling of juveniles. The proposed section 10 permit would also authorize spring trapping and summer electrofishing. Similar to above, these activities are expected to result in low levels of mortalities of juvenile salmonids at outmigration traps and other collection reaches within tributary streams. Incidental take levels for these actions are expected to be similar to those reported above for juvenile broodstock collection. Collection in the upper Russian River is likely to result in incidental take of CCC steelhead and CC Chinook salmon. Collection of tissue samples from areas below

[10] The collection of these 1,800 ad-present juveniles may not be required in years when NOR fry are collected for use as broodstock.

Healdsburg, California on the mainstem river and lower Russian River populations are likely to result in take of steelhead, Chinook salmon and Coho salmon. Incidental losses from this activity are expected to be less than two percent and likely less than one percent as reported for similar activities (D. Hines, CDFW, email communication 2022). The extent of take will be exceeded if mortalities for the monitoring and evaluation for one year exceed two percent for all of the activities combined.

Incidental take may also occur during seining, hook and line, or outmigrant trapping at two sites on the mainstem Russian River associated the capture of hatchery origin smolts for predation monitoring. The two traps would sample 400 fish during a six-month period for three years. A maximum of 7,200 hatchery smolts would sampled to determine the level of predation occurring. Many of these smolts may be sampled under existing section 10 permits with coordinating agencies on the mainstem the capture and handling of these smolts may result in a small number of natural origin juvenile salmonids becoming injured or killed. It is assumed that mortality rate for the incidental collection of NOR juveniles will be less than 2% (Muir et al. 1995).

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 measures that are necessary or appropriate to minimize the impact of 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 section 10(a)(1)(A) permit for the USACE's operation of the broodstock program:

1. Minimize incidental take of non-target ESA listed species during broodstock collection.
2. Minimize incidental take of listed species by meeting all Program Performance Standards and Criteria.
3. Minimize the effects of hatchery released smolts into action area streams on natural origin ESA-listed salmonids.
4. Minimize genetic effects (i.e., inbreeding depression, loss of fitness, etc.) of Program operations on natural origin fish.
5. Performance indicators will be evaluated to evaluate the impacts associated with the HGMP. Minimize incidental of non-target listed species via adherence to performance indicators.
6. Minimize the impacts of monitoring and evaluation activities on ESA listed salmonids.

2.9.4. Terms and Conditions

The terms and conditions described below are non-discretionary, and NMFS as the permittee, and the USACE 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. The section 10 permit for the program will include Terms and Conditions, and reporting requirements such that the applicant shall report annually to NMFS and the TAC regarding the progress towards performance objectives and relevant RPMs addressed below.

1. The following terms and conditions implement reasonable and prudent measure 1:

    a. NMFS shall ensure that collection of juveniles for broodstock shall be conducted to maximize the number of family groups in each watershed.
    b. NMFS permit shall ensure that collection of NOR Broodstock maximize family groups and minimize the potential for the collection of greater than 10 percent of adult NOR in each CCC steelhead independent population.
    c. NMFS shall ensure that injury and mortality of adult salmonids collected but not retained for use as broodstock is minimized.
    d. Coordinate of juvenile CCC steelhead for broodstock collection with Sonoma Water conducting activities under section 10 permit # 14419-4R.
    e. NMFS shall require that the USACE coordinate broodstock collection activities with any future NMFS approved FMEP in the Russian River.

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

    a. NMFS shall require that performance indicators that are not met during the Permit period to be assessed by the TAC and recommendations will be developed to meet indicators within 3 years.

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

    a. NMFS shall require that the TAC evaluate the measures to minimize and avoid effects of hatchery releases to natural origin smolts. If the TAC determines that changes to releases strategies are needed to reduce adverse effects, recommendations will be developed and implemented by CDFW and the USACE the following release season. If NMFS does not approve these recommended release strategies, they will not be implemented.

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

    a. If advances towards pHOS targets are not implemented by year 3 (March 2026), NMFS shall require that the TAC shall evaluate, and USACE shall implement other measures, including reducing total hatchery production by an additional 20 percent, terminating the release of surplus hatchery fish to anadromous waters, reduce stocking of specific populations, tributaries or reaches where pHOS is high, or other measures identified by the TAC.

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

   a. NMFS shall require that performance indicators be reviewed by the steelhead TAC each generation (every 3 years). If performance indicators are not being met the TAC shall develop recommendations to adaptively manage the program. Prior to implementing any new recommendations, NMFS shall determine if recommendations that are proposed to be implemented would result in the exceedance of 1) incidental take anticipated for the issuance of section 10 permit 26277, or 2) the direct take authorized in the section 10 permit, prior to approving recommendations from the TAC.

6. The following terms and conditions implement reasonable and prudent measure 6:

   a. Coordinate of juvenile CCC steelhead for monitoring and evaluation with Sonoma Water activities conducted under section 10 permit # 14419-4R.

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).

- In the event that production continues at 400,000 smolts or is decreased by 20 percent in subsequent years, the USACE should develop CCC steelhead restoration projects in the Russian River watershed. These restoration projects could be funded with the expenditures that would have gone to the full production of 500,000 smolts for the mitigation. This funding that would otherwise go to the production of 100,000 smolts would help meet the requirement set forth by Congress (Water Resources Development Act - Public Law 93-251-MAR. 7, 1974, Sec.95) and their obligation under Section 7 (a)(1) of the ESA.

2.11. Reinitiation of Consultation

This concludes formal consultation for Hatchery and Genetic Management Plan for the Russian River Steelhead Integrated Harvest Hatchery Program, California.

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.

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

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

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

3.1. Essential Fish Habitat Affected by the Project

This analysis is based, in part, on the EFH assessment provided by the CDFW 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 steelhead HGMP. 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 steelhead smolts from the hatchery program are likely to compete for space with natural origin young-of-the-year Chinook salmon and Coho salmon in the mainstem Russian River. Losses of natural origin Chinook salmon and Coho salmon from habitat interactions and potential predation from Program steelhead are expected to be low and not sufficient to reduce the survival or recovery of their respective ESUs. The duration and magnitude of the effects to EFH associated with the proposed Program steelhead smolts on natural origin salmon space and predation will be minimized with measures to reduce the size of hatchery smolts and release of hatchery fish at specific mainstem Russian River sites that reduce the effects to natural origin juvenile salmonids.

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 others interested in the conservation of the affected ESUs/DPS. Individual copies of this opinion were provided to CDFW and USACE. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adhere to conventional standards for style.

4.2. Integrity

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

4.3. Objectivity

Information Product Category: Natural Resource Plan

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

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and EFH consultation 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, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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